PSYCHOLOGICAL DIFFERENTIATION: GENERAL INTELLIGENCE OR ANALYTIC ABILITY?

A STUDY OF WITKIN'S HYPOTHESIS

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CURRICULUM STUDIORUM

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ABSTRACT OF

Psychological Differentiation: General Intelligence or Analytic Ability? A Study of Witkin's Hypothesis[1]

Critics of the Witkin differentiation hypothesis have proposed that general intelligence rather than analytic ability is the basis of the established relationship between overall IQ measures and measures of psychological differentiation, but problems related to the part/whole relationship of analytic ability and general intelligence have confounded interpretation of research results.

Using a brain-damaged sample and a multiple regression design, an assessment was made of the role of analytic ability and general intelligence, as these are measured by the Wechsler Adult Intelligence Scale, in relation to extent of differentiation as measured by the Rod-and-Frame Test. A brain-damaged sample, heterogeneous as to loci of organic impairment, was selected to minimize the high, part/whole correlation between general intelligence and analytic ability normally found in organically intact groups of subjects. The WAIS was divided into two measures. One of the latter, comprising nearly 75% of the total WAIS,

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reflected primarily general intelligence. The second derived variable comprised the three subtests identified by Witkin as reflecting analytic ability. *F* tests on the separate omission of each measure from the multiple regression showed that the measure of analytic ability provided a strong and significant contribution to the multiple regression of the RFT above and beyond, or *independently* of, what the former contributes in association with the measure of general intelligence. By contrast, the measure of general intelligence added nothing of significance to RFT variance explanation beyond that supplied by the analytic ability measure alone.

A minor test of the role of organic impairment in relation to extent of differentiation, using the Halstead-Wisconsin Impairment Index as the measure of organic impairment, indicated that *kind*, rather than degree, of impairment may be the factor of major relevance in established relationship between extent of differentiation and brain damage. More specifically, apart from its association with analytic ability, degree of organic impairment showed only a proportionally small though statistically significant improvement in RFT variance explanation. Age and sex played no significant role in this study when analytic ability and organic impairment were controlled.

ABSTRACT

Results of analyzing the analytic ability composite measure, which showed it to be largely dominated by Block Design performance, entered into the discussion of the special ability versus cognitive style controversy current in the literature in this area. Discussion also included suggestions for further research, notably replication of present or similar results in "normal" groups. Further research was also indicated to resolve some inconsistencies noted in relationships among the relevant variables.

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INTRODUCTION

Witkin's hypothesis of psychological differentiation has been the focus of a great deal of theoretical and research interest in the area of perceptual-personality relationships. While his demonstration of impressive and extensive correlations between measures of perceptual field dependence and a variety of personality measures has been readily recognized and acclaimed as an important and meaningful psychological phenomenon, Witkin's theoretical explanation of these relationships in terms of a broadly based cognitive style, which is manifested in a self-consistent manner in broad areas of the individual's functioning, has been less widely accepted. One of the more serious challenges to the hypothesis relates to the well-established relationship between total Intelligence Quotient (IQ) and accuracy of performance on measures of field dependence.

For some critics the consistent, significant, positive relationship between field independence and IQ strongly suggests that general intelligence, rather than Witkin's proposed dimension of psychological differentiation, is the basic common factor reflected in the established perceptual-personality relationships. In support of this view it has been pointed out that many of the personality measures used to establish the perceptual-personality links are measures which also significantly reflect intellectual functioning. The possibility that general intelligence might be the underlying factor in the communalities observed in their data was considered by the Witkin workers themselves. However, the question was settled for them in a series of studies which led them to conclude that the correlations consistently found between their measures of perceptual differentiation and total IQ were not based on general intellectual ability per se, but were based on a more circumscribed ability (analytic ability) common to success on the perceptual tasks and only some portions, or particular subtests, of standard intelligence tests. Subsequent research provided conflicting data, some of which supported the Witkin results and interpretation and some of which represented a challenge to the latter. Contradictory research results continue to be reported in the literature and the question on the role of general intelligence in differentiation research appears to remain unresolved. Since this issue challenges the Witkin theoretical formulation in its most fundamental aspects, a resolution of the issue would appear to be of crucial importance for the continued viability of the differentiation hypothesis.

The purpose of the present study is to attempt some clarification of the research issue described above by examining, by multiple regression procedures, the relative importance of general intelligence versus analytic ability as these relate to extent of differentiation in a brain-damaged sample. Selection of brain-damaged subjects for the study was based on the expectation that heterogeneity of organic impairment would result in a lowering of the normally high, part/whole correlation between general intelligence and analytic ability which has likely been a significant source of confounding in prior research. Use of brain-damaged people also provides an opportunity to study the role of the organic impairment variable as it relates to extent of differentiation, and this is a secondary aim of the present research.

The study will be presented in the following order. In Chapter I, divided into five sections, a review of relevant literature will be presented in the first four sections under the following sub-headings: (1) The Field Dependence Construct; (2) The Differentiation Hypothesis; (3) Critical Reaction to the Witkin Studies; and (4) Psychological Differentiation and Intelligence. The fifth section, completing the chapter, will present a discussion of brain damage as it relates to differentiation research and the presenting problem, followed by the statement of the research problem and the null hypotheses proposed for its study. In Chapter II the research design used to test the null hypotheses will be presented. It will include discussion of; the psychometric instruments used, the subjects, the procedure, the statistical techniques used to analyze the data, and the additional analysis of the data. In Chapter III the results of the study will be presented in four sections which, in order, deal with: the reliability of the psychometric measures; the results for the main hypotheses; the results for the supplementary hypotheses; and additional analysis of the data. Following the presentation of the results they will be discussed in the fifth and final section of the chapter, following which a summary and conclusion section will be presented.

CHAPTER I

REVIEW OF THE LITERATURE

The work of Herman Witkin and his colleagues in the area of perceptual-personality relationships, which culminated in the psychological differentiation hypothesis after over a decade of research and theoretical development, has by now been the focus of over 25 years of theoretical interest and research investigation. From the vast body of literature now available on the subject, a selective review will be discussed in the following order. The first section will discuss the field dependence hypothesis in Witkin's early work. The next section will report on the elaboration of the field dependence construct into the hypothesis of psychological differentiation. The third section will present a discussion of critical reactions generated by the Witkin research and theorizing. A fourth section will take up the topic of the role of intelligence as it relates to theoretical and research aspects of Witkin's work. The fifth and final section will present a discussion of brain damage as it relates to the research problem and will conclude with the presentation of the research problem and the hypotheses proposed for its study.

REVIEW OF THE LITERATURE

1. The Field Dependence Construct.

Witkin's early work on spatial orientation, conducted in collaboration with Asch (Asch & Witkin, 1948a, 1948b; Witkin & Asch, 1948a, 1948b), served as the basis for his later research and theorizing on perception-personality relationships. That early series of investigations attempted to clarify a controversy as to which of the cues, visual or kinesthetic, was the primary source of information for perception of the upright. The results of their studies clearly showed that both postural (body) and visually perceived, external (field) cues are used, but, in the presence of a strongly articulated field, visual factors tend to play a dominant role. Along with their clarification and quantification of this perceptual function, the researchers discovered unexpected and striking individual differences. They found that people differ widely as to the degree to which one or the other determinant influences their perception of the true vertical. It was found that some persons depend to a marked degree on outer (visual or field) factors to determine their position in space, while others rely primarily on inner (postural) cues The origin of the field approach or field dependence construct may be seen here.

REVIEW OF THE LITERATURE

The construct of perceptual field dependence (Witkin, Lewis, Hertzman, Machover, Meissner & Wapman, 1954) is clearly demonstrated in a description of the inventively devised spatial orientation tests which became the core of the later work on perception-personality relationships. These include the Rod and Frame Test (RFT) and the two tests comprising the Tilting-Room-Tilting-Chair Test (TRTC), namely, the Body Adjustment Test (BAT) and the Room Adjustment Test (RAT). The Embedded Figures Test (EFT), though not a space-orientation test as such, was later included as part of the standard battery.

In the RFT a subject is seated in a totally darkened room on a chair which can be tilted from right to left to a number of precisely measurable positions. The only visual stimulation comes from an illuminated frame in the center of which is an illuminated rod. Both frame and rod are pivoted at the center and can be independently tilted to various calibrated positions from one side to the other. The subject's task is to move the rod, or instruct the examiner to move it, to a position which the subject perceives as coincident with the true vertical. Under various combinations of body, rod, and frame positions the amount of information for perception of the upright is thus controlled, and the relative influence of each source of cues can be determined precisely. Though people under normal circumstances have no difficulty in perceiving the true vertical, when the cues are thus put into conflict marked individual differences in accuracy in determining "which way is up" emerge. Some subjects, to see the rod as vertical, consistently move it in the direction of the frame regardless of the frame's relation to the true vertical. Moreover, they often do so in the presence of strong opposing, but ignored or unnoticed, postural stimulation. These persons are thus determining the position of the rod primarily on the basis of the visual field which surrounds it, depending more on the field outside them for judgment of spatial position than on information from inner bodily experience or sensation. Their perception has been termed "field dependent." Other subjects are significantly influenced by cues from body position and adjust the rod in terms of postural information regardless of orientation of the frame or tilt of the chair. By attending to inner sensations they are able to overcome the influence of a prevailing, misleading field and maintain a more accurate perception of the upright than the former subjects. The kinesthetically determined perception has been labeled "field independent."

For the TRTC (Witkin et al., 1954) the subject is seated in a tilting chair within a small, specially constructed room mounted on ball bearings. The entire room can be tilted left or right to varying degrees. In the first part of this procedure, the BAT, the subject is required to adjust his body, tilted in the chair, while the room--and thus the entire visual field around it--is at deviance from the vertical. To do so accurately he must overcome the influence of the appearance of the room around him and advert to postural sensation for judgment. Alignment of the chair with the vertical axis of the tilted room despite body tilt indicates the strong influence of field factors and results in inaccurate, field dependent perception. In the second part of this procedure, the RAT, the subject is required to adjust the tilted room, or the entire field, rather than his body, to the upright. Here again, he may succeed in making the room straight through use of postural sensations, thus overcoming the influence of the field and showing field independent perception. On the other hand, he may use the vertical axis of the room as indicating the true upright and accept the room as straight in its tilted position--a field dependent perception.

These three space-orientation tests provide the subject with all the main aspects of orientation to the upright (Witkin et al., 1954). They investigate the way in which he establishes the direction or position of an object external to himself within its environment, or the visual field which surrounds it (RFT); the direction of the field as a whole (RAT); and the position of his own body in relation to the field (BAT). Scoring in all tests is based on deviation of the adjusted object--body, rod, or room--from the true vertical in the series of trials required by the particular test, with a high score for deviation indicating a high degree of field dependence and a low score showing a more field independent perception.

The EFT (Witkin, 1950) makes use of the figures developed by Gottschaldt as modified by Witkin for his study. A subject is first shown a complex geometrical figure which contains within it a simpler figure as part of the overall design. The subject is then shown the simpler figure by itself. His task is to find the simpler figure in the complex design when the latter is presented to him for the second time. The length of time which he takes to complete the series of figures given is his score for the test. As may be seen, this test is similar to the space-orientation tests in requiring perceptual differentiation of an item within the field of which it is a part.

As noted earlier, some generalization on the dominant role of visual field factors in spatial orientation was drawn from the results of the studies. However, the marked individual differences in the results precluded a definitive description of the process of perception of the upright which would apply to all persons. The researchers discovered that consideration of the stimulus and of the neural and sensory variables of traditional perceptual research were inadequate to account for the differences found. They were forced to the conclusion that these differences must be related to basic differences in the personal characteristics and personality organization of the perceivers (Witkin et al., 1954). Consequently, these individual differences in perception were in themselves made the focus of further study in the hopes of discovering the personality correlates suspected. In the researchers' view, the new orientation also provided the possibility of developing a new method of personality investigation which would be more objective and precise than traditional assessment procedures.

As a first step in the newly oriented research, the self-consistency and stability of the individual's performance on the space-orientation tests were examined (Witkin et al., 1954). Correlations of the subject's performance from test to test and within different parts of the same test were generally significant for both men and women, though, as with basic mode of field approach, sex differences were clear. The latter in itself lent weight to the hypothesis that perceptual differences were related to fundamental differences in personality traits, and significant sex differences have generally been found in later research on field dependence with the exception of studies of geriatric groups (Hellkamp, 1967). A recent study (Dreyer, Dreyer & Nebelkopf, 1971), however, indicates that sex differences may also be found in children of kindergarten age. Satisfactory stability of individual performance on the space-orientation tests was demonstrated in generally high and significant test-retest correlations for periods ranging from five weeks to three years (Witkin et al., 1954).

To investigate the possible generality of the individualized perceptual "style" which characterized the subjects' perception of the upright, the latter was compared with performance on a variety of non-orientation perceptual tests (Witkin et al., 1954). While the selected tests did not involve body position or orientation to the upright, they did appear to resemble the space-orientation tests in requiring perceptual discrimination of parts comprising a whole or of separation of an item from its surrounding field. Examples of the latter tests are the EFT and brightness constancy tests. It was found that subjects who had difficulty in separating the rod or body from the surrounding field of the tilted frame and the tilted room, respectively, also had difficulty separating out or locating the simpler design in the more complex whole configuration in the EFT. Similarly, in brightness constancy tests these subjects tended to match standards under the influence of field conditions rather than in terms of the stimulus value of the standard. The significant intercorrelations of scores on these and other non-orientation tests suggested that an individually preferred mode of perception was not restricted to perception of the upright but seemed rather to be a pervasive aspect of a person's functioning in a variety of perceptual situations (Witkin et al., 1954).

On analyzing the task requirements of the various tests the researchers concluded that successful performance on each lay in the ability of the individual to keep an item--whether body, rod, or geometric figure--perceptually separate from the context of which it is a part. It was necessary to be able to distinguish the various parts in an entire situation and to deal with the whole in an active, analytic manner. Unsuccessful subjects, on the other hand, unable to separate the parts from the background, experienced the situations in a global manner, submitting passively to the influence of the prevailing, distracting background or field factors. It was at this point that the labels of field dependence and field independence were applied as designations of the consistent and pervasive "style" which characterized an individual's functioning in a variety of perceptual tasks (Witkin, 1959).

With the above preliminary data at hand and the field dependence construct as the connecting link, the investigation of the personality correlates of the demonstrated differences in perceptual field approach was begun. Subjects for this long-range project (Witkin et al., 1954) included a basic normal adult group of 58 college men and 56 college women, psychiatric patients, and groups of children at five age levels from age eight through age seventeen. For the normal adult group a correlational design was used. For the children and psychiatric samples, because of limited numbers and sampling selectivity, respectively, a correlational design was not suitable. Division of the subjects in the latter two groups into three categories on the basis of their perceptual test scores and comparison of these sub-divisions on mean personality test scores allowed for determination of personality factors which differentiated the subgroups along the field dependence dimension. This technique provided, as well, for comparison among the three main samples of adults and children.

Personality assessment included a wide variety of objective, projective, self-report, and rating techniques. Among instruments used were the Stanford-Binet Intelligence Test, selected Rorschach and Thematic Apperception Test stimuli, Figure Drawings, autobiographies, and clinical interviews. The techniques used were selected on the basis of specific hypotheses derived from the field dependence construct (Witkin et al., 1954). For example, the successful reference to and awareness of body cues in the space-orientation tests might be expected to be reflected in a well-developed body image as identified by the Figure Drawings. Again, the analytic versus global functioning evident in perception of the upright might be expected to correlate with well-articulated versus poorly defined whole responses on the Rorschach.

The outcome of the long-range study of these issues was the conclusion--as indicated in the title of the researchers' major report (Witkin et al., 1954)--that the investigation of personality through perception was a feasible objective of psychological research, and that "field dependence" was a profitable construct to that end. The results revealed that distinctive personality configurations and characteristics were associated with differences in perception as reflected on the field dependence dimension. The authors discuss these findings under three major aspects of personality characteristics: the nature of the person's relationship to the world about him, and especially to other people; the manner in which he deals with impulses and striving and the type of controls and defenses manifested; and the nature of the self-concept.

Witkin et al. (1954) summarized their findings with the following remarks:

> field dependent persons tend to be characterized by passivity in dealing with the environment; by unfamiliarity with and fear of their own impulses, together with poor control over them; by lack of self-esteem; and by the possession of a relatively primitive, undifferentiated body image. Independent or analytical perceptual performers in contrast tend to be characterized by activity and independence in relation to the environment; by closer communication with, and better control of, their own impulses; and by relatively high self-esteem and a more differentiated, mature body image. These are the relationships that were revealed in our intensive study of a group of young, normal adults, and confirmed in studies of children and of hospitalized psychiatric patients (p. 469).

2. The Differentiation Hypothesis.

During the course of the research described above the researchers became alerted to systematic changes in the perceptual performance of subjects on the field dependence dimension as chronological age increased. Results showed that the young children in the study tended to approach the perceptual tasks in a relatively global, or field dependent, way, but perception grew increasingly analytical as age advanced up to the age of seventeen, which seemed to be about the age at which maximal field independence was reached. The change was evident in both longitudinal and cross-sectional data. While cross-sectional data revealed the increase clearly across age groups (Witkin et al., 1954), longitudinal data showed that the relative field dependence or field independence of the individual within his group was maintained over the years (Witkin, Dyk, Faterson, Goodenough & Karp, 1962). It was thus noted that field dependence was associated with persons at earlier stages of psychological development, while field independence was, in general, associated with persons at later stages of psychological growth.

In view of the developmental trends suggested in the age-related increase in field independent perception, the persistence of some children in a relatively field dependent perceptual functioning required explanation. It was hypothesized (Witkin et al., 1962) that these children had made less progress than their age-mates in some more general aspect of their psychological development. As to the nature of this "more general aspect," the researchers' theorizing focused on formal, as opposed to content, features of personality as these relate to perceptual style.

The studies thus far had shown that people similar in formal or structural features of personality (*how* they functioned) showed similarities of field approach. Content features of personality (*what* was present in their psychological world), however, were generally non-discriminatory insofar as perceptual style was concerned. With the recognition of the importance of structural features of personality in the research results, the concepts of differentiation and integration, the principal characteristics of any system's structure, readily suggested themselves as potentially useful explanatory concepts in further theorizing (Witkin et al., 1962). Furthermore, the nature of the personality traits which distinguished the contrasting perceptual groups seemed to lend itself readily to description in terms of greater or lesser differentiation as commonly understood. For example, the degree of self-concept definition, adequacy of body image, type of defenses and controls--which research had found as relevant correlates of field approach--all appeared to reflect the degree to which a person was differentiated in a given area of his functioning.

It was in view of these new considerations of their data that the field dependence hypothesis as conceived in their earlier studies now appeared to Witkin and his associates (1962) as too narrow. In their ongoing research to expand, confirm, and further investigate the perception-personality relationships already discovered, they thus reconceptualized the field dependence hypothesis to that of psychological differentiation, and the field dependence-independence dimension was then seen as reflecting "extent of differentiation" (p. 9).

Though some use of the concept of differentiation, whether so designated or not, would appear to be almost necessarily incorporated in any thorough description of psychological development, it is an explicit feature of the formulation of several theorists before Witkin et al. While Lewin's (1936) topological psychology and the description of child development in Parson's sociological theory (Baldwin, 1968) make significant use of the concept, it is most prominently used and detailed in the organismic-developmental theory of Heinz Werner (1948). Differentiation, integration, and hierarchic organization comprise the basic concepts of his orthogenetic principle of development, the term by which he refers to that "tendency (of an organism) to move from a state of relative globality and undifferentiatedness towards states of increasing differentiation and hierarchic integration" (Werner & Kaplan, 1963, p. 7). For Werner this represents the fundamental law of development.

A number of authors (Baldwin, 1968; Hellkamp, 1967; Trites, 1965; Yamada, 1968) have pointed out the similarities or close correspondence of the definitions, descriptions, and usage of the Witkin hypothesis of psychological differentiation with the theorizing of Werner. While the influence of Werner is readily acknowledged by Witkin (1960), he points out (Witkin, 1965) that his own work differs from Werner's in being primarily concerned with individual differences. He further noted (1965) that Werner concentrated much of his theorizing on cognitive development, with consideration of personality issues secondary and but little developed. By contrast, the latter is a major feature of Witkin's own work. In any case, the construct of differentiation plays a key role in both theoretical formulations.

In the description of Witkin et al. (1962), differentiation refers to the complexity of structure of a system, the degree to which its parts are homogeneous or heterogeneous. Since structure is basic to function, differentiation has, then, implied meaning for function as well as structure. With respect to a system's functioning differentiation refers to specialization. The greater the complexity of structure, or degree of differentiation, the greater will be the degree of specialization of function of the subsystems within the general system which includes them. By contrast, the more undifferentiated the system, i.e., the less diversity of structure, the more limited its scope or capacity for a variety of specialized functions.

As applied to the psychological system of a person, the differentiation concept supplies an efficient explanation for much of his behavior. For example, in a person with a high degree of differentiation in his psychological makeup, thinking, acting, perceiving, and feeling are discrete and well-articulated, though interrelated, aspects of his functioning and not, as is the case in the relatively undifferentiated child, mixed up with one another. Similarly, within the subsystem of perception, the perceptually more mature and more highly developed person readily distinguishes parts of perceptual fields as well as, and in appropriate relation to, the whole field which they comprise. On the other hand, perceptually less mature, relatively undifferentiated persons and young children have difficulty in thus analyzing a perceptual field. For the latter, parts of the perceptual field tend to fuse with their background and perception is often global. Again, in the highly differentiated individual specific stimuli are likely to evoke specific responses. In contrast, the poorly differentiated individual is likely to respond with a diffuse or non-specific response or reaction to a variety of stimuli, since these persons have a limited degree of structural, and thus functional, development for more adequate functioning.

Witkin et al. recognized, as had other theorists using the same concept, the importance of the person's relationship with his environment in an adequate accounting of his psychological functioning. In this regard differentiation refers to the clarity of separation of self from non-self. The highly differentiated person is able to identify clearly what belongs to the self and what must be identified as external to the self. Moreover, there are definite limits and boundaries in the experience of the self in the well-differentiated person.

In a description of any system the <u>integration</u> of the system must be considered as well as its differentiation. Witkin et al. (1962) describe integration as referring especially to the patterning of the total system--the form of the functional relationships among its various components. As with differentiation, it is necessary to consider the integration of the total system with the external field as well as the integration within the system itself. Two important, but not necessarily related, characteristics of integration are (1) complexity and (2) effectiveness. In a system with many, varied and specialized components, i.e., a highly differentiated system, the possibility of more complex relationships both within the system and between the system and its environment would appear reasonable according to Witkin's theorizing. Effectiveness of integration is noted to be less directly related to level of differentiation than is complexity, and effective and ineffective modes of integration are possible at any level of differentiation.

Though Witkin and his associates (1962) do not deal to any significant degree with the problem of integration, the distinction made above is important in considering the apparent contradictions which arise when a high degree of differentiation--usually associated with a greater level of maturity--is found in persons with marked pathology or failures of adjustment. In the latter cases it should be remembered that the adjustment of the person relates to the *effectiveness* of the integrations--simple or complex--that the person is able to make. Thus there is no necessary correspondence between degree of differentiation and healthy or adequate psychological adjustment in terms of the Witkin group's formulation.

In describing the development of differentiation in the process of psychological growth, Witkin and his collaborators (1962), on the basis of their data, postulated several dynamically interrelated "indicators" (p. 15) of differentiation. These included: an articulated (i.e., analytical and actively organized) way of experiencing the world; a clearly defined body image and a well-developed sense of separate identity, which together seemed to indicate a differentiated self; and controls and defenses which are specialized and structured.

In summary, for Witkin and his associates (1962):

> "Differentiation" thus serves as a construct for conceptualizing communality in several areas of psychological functioning. Specifically, the differentiation hypothesis proposes an association among the characteristics of greater or more limited differentiation, identified in the comparison of early and later functioning in each of several psychological areas; . . . Implicit in this hypothesis is the view that greater differentiation is associated with greater articulation of experience of the world. . . . . Development toward greater differentiation involves progress from an initial relatively unstructured state, which has only limited segregation from the environment, to a more structured state, which

> has relatively definite boundaries, and which is capable of greater specificity of function. . . . As children grow older they tend to become more differentiated. We may expect, however, that at any age level children would differ in extent of differentiation and that greater or more limited differentiation would be manifested in each of the indicator areas, although in varying degrees. This expectation has been called the differentiation hypothesis (pp. 16, 22).

Thus, in the second major stage of their ongoing research on perception-personality relationships, Witkin and his colleagues developed this new hypothesis. Studying both new and old samples in intensive and extensive investigation of intellectual, personality, and social functioning, they confirmed and expanded their original findings on perception-personality relationships and differences in perceptual styles. In addition, in this phase of their study they added significant data relating to the origins of some of the differences found. The latter involved investigation of child-rearing practices of mothers of the children involved and evaluation of the mothers themselves.

The psychological differentiation hypothesis has been a conspicuously significant stimulus to research and, as pointed out by Adelson's review (1969) of personality research, workers continue to invest time and interest in studying its results and leads. In the next section of this paper the theoretical and research reaction to the impressive investigations of Witkin and his collaborators will be presented.

3. Critical Reaction to the Witkin Studies.

From the time of publication of their first major report (Witkin et al., 1954) of their ongoing research, the Witkin group has met with healthy critical response. Holtzman (1955), in a book review assessing the work up to 1954, pointed out deficiencies in methodology and interpretation which he felt weakened the conclusions drawn from the data. He cited instances of probable spurious correlations in some of the data; imputation of significance to differences which were likely reflecting chance variations in small samples; and inaccurate reporting and interpretation of the researchers' own data which shook confidence in the objectivity of data reporting. He also pointed out, as Anastasi (1958) agreed, the possibility of bias in scoring on personality tests because of prior knowledge of perceptual test results. In addition, Holtzman felt that many of the interpretations were rather forced.

Postman (1955), reviewing the same work, concurred with Holtzman's evaluation, noted many of the same points, and concluded that "the evidence offered by the authors is doubtful and the logic of inference is faulty and forced" (p. 79). Postman described the selection of tests for personality as lacking in theoretical rationale, leading to a "shotgun correlationism" (p. 79), which he described as poor empiricism. He protested strongly the psychopathological tenor of the interpretations arising from the use of techniques developed primarily as clinical instruments. He pointed out the general absence of reliability information as well as the failure to provide adequate validity data on the projective techniques for which, he felt, the sole validation offered was their high intercorrelations.

Gruen (1957), in a searching evaluation, raised serious questions as to Witkin et al.'s analysis of the nature of the perceptual tasks and of the nature of the real and undisputed perceptual-personality relationships revealed in the research. In addition, the validity of some of the statistical techniques used in the studies was questioned. Gruen's criticisms were based in large part on a study (Gruen, 1955) replicating the Witkin design. Gruen compared the original Witkin college group with a group of carefully selected professional dancers in order to test the Witkin analysis of the role of the body experience in performance on the space-orientation tasks. It was expected that the dancers' special training in kinesthetic sensitivity and muscular awareness would be evident in a greater field independence than the untrained control group.

However, in general, no differences between the two groups were found, and those few that did occur failed to support (and even tended to run counter to) the Witkin analysis of the role of the body in the perceptual task performance.

In the Gruen study, different and generally lower correlations among the perceptual test scores of the dancers as compared to the same data for the controls suggested that the variables involved in these situations were less factorially pure than suggested by Witkin. While the perceptual-personality relationships approximated the Witkin data, the intercorrelations among the personality tests were low and generally insignificant, which suggested less communality among them than claimed by Witkin and his associates. The pattern of relationships made it seem likely that the different personality tests correlated with different sets of factors in the perception tests.

On the basis of his own research and that of others whom he cited, Gruen (1957) thus called attention to the complexities involved in perceptual behavior. As a minimum these require recognition that the same perceptual response may have different sets of determinants for different individuals. It was, Gruen felt, the failure to take this into consideration which rendered the Witkin group's interpretations unduly simplistic and left them with a unidimensional construct which cannot adequately account for the variety of perceptual-personality relationships suggested by Gruen's own data.

In addition to pointing out the failure to avoid the "correlation equals causation" fallacy, Gruen's observations on the questionable validity of statistical procedures, and interpretations based on them, added force to his rejection of the Witkin hypotheses. He noted, for example, that for any one series of the various space-orientation tests a subject could end up with a score indicating field dependent performance, yet within trials of that series he might perform in a field dependent way, and vice versa. Gruen thus questioned the acceptance of the final score as representative of a consistent and stable perceptual performance. This may perhaps be a point of basic importance, but seems to have received little attention in the literature apart from an elaboration of Gruen's point by Vardy and Greenstein (1972).

Criticisms of the second major report of the ongoing and expanded research of the Witkin group, though generally acknowledging the improvement in many of the methodological weaknesses of the earlier studies, continued to be leveled at the over-generalizations which appeared to characterize the researchers' theoretical formulations. In Gardner's (1963) review of the later book, Psychological Differentiation (Witkin et al., 1962), he recognized the work as a valuable contribution and commended it on both qualitative and quantitative grounds. Despite the positive aspects of his evaluation, however, he felt that the psychological differentiation hypothesis seemed to imply more generality than "warranted even by the notable consistencies described" (p. 710). Gardner pointed out the unaccounted for inconsistency evident in the authors' theorizing that intellectualization is, or should be, related to a high degree of differentiation, yet verbal skills--in which this defense mechanism is typically rooted--did not correlate with the researchers' measures of differentiation. He further noted that Witkin and his collaborators seemed to ignore studies in which defenses rated separately rather than, as in the Witkin studies, combined may show no correlation with the perceptual measures. On the basis of these and other observations Gardner felt that psychological differentiation probably has a number of different forms, only one of which is reflected by the Witkin measures.

Zimiles' (1964) review stated that, despite the broadening of the scope of the work and the greater generality of theorizing, the original hopes of the Witkin group for a new source of personality information based on precise and simple laboratory techniques had not materialized. Zimiles cited several aspects of the studies which appeared to raise questions of theoretical and procedural logic for him. One of these was the assertion that differentiation is not related to maturity, integration, and adjustment, despite the fact that almost every indicator of limited differentiation described by the authors is also a sign of poor mental health. His review also made note of an element of inconsistency in the emphasis of Witkin et al. on quantitative data and statistical analysis which was based in large part on methods and procedures involving varying degrees of inference. Though commending the authors for their continued attempts to pursue explanations and check out alternative hypotheses for their findings, Zimiles felt that some of the alternatives were rejected without sufficient justification. The reviewer's stated preference for the construct of field dependence over that of psychological differentiation was reflecting his objection to the over-generalization of the latter, which was seen as based on an over-simplification of complex psychological functioning.

Zigler's (1963a) review of the later research report of Witkin et al. had very little in the way of positive evaluation. Apart from noting its contribution to the fields of child psychology, perception, and personality as a scholarly summary by dedicated and active researchers, the only other favorable comment was the unavoidable recognition that the consistency of patterning of the numerous perception-personality relationships discovered indicated beyond doubt that something meaningful had been established. It was the Witkin group's interpretation of this "something meaningful" (Zigler, 1963a, p. 134) that drew Zigler's most stringent criticism. He found the interpretations of the revised theory but little advanced over those of the earlier book (Witkin et al., 1954). In fact, it appeared to Zigler, that there was no need for the differentiation concept at all, since all of its meaning seemed to be reduced to the ability to overcome an embedding context. It was this equation of differentiation with decontextualization which he felt led Witkin and his associates into theoretical difficulties. The observation, however, which made the greatest impact on later research was Zigler's view that general intelligence was a more likely basis for the many correlations linking perception and personality measures in the Witkin studies than was the psychological differentiation proposed by Witkin and his colleagues. The Zigler review concluded that the differentiation hypothesis had been pushed to a point at which it would no longer hold up, and that the researchers had no choice but to abandon the hypothesis--at least as interpreted by them in the studies under discussion.

That the decision to abandon the hypothesis would have been premature is suggested by the vast amount of research and theoretical consideration that the Witkin studies have engendered since Zigler's comments. Moreover, not all evaluations have been so negative. Kagan and Kogan (1970), in a recent review of individual differences in cognitive processes, have described the work of the Witkin researchers as "undoubtedly the most massive and thorough empirical examination of a particular cognitive structure in the psychological literature" (p. 1323). Again, a recent review of the literature (Singer & Singer, 1972) in the area of personality studies reported, in relation to the Witkin research, that "studies continue to emerge offering some support or in general indicating the value of this significant notion of how people organize their experiences" (p. 389).

While, as just noted, some studies have supported the Witkin findings, others, as to be expected, have challenged the Witkin et al. interpretations, offering alternative hypotheses for the meaning of the field dependence hypothesis. Among these alternatives are hypotheses that perceptual performance on the field dependent dimension may be reflecting: perceptual accuracy (Schooler & Silverman, 1969); selectiveness of attention (Gardner, 1962); minimal scanning (Silverman & King, 1970); organic impairment (Goldstein & Chotlos, 1965); and a specific cognitive ability (Goldstein & Shelly, 1971).

While the research and theorizing of Witkin and his co-workers have been far from fully accepted, they have more than demonstrated their usefulness as stimuli to research and theory evaluation. One of the more serious issues raised by the Witkin critics, since it threatens the core concept of the differentiation hypothesis, relates to the issue of intelligence in relation to differentiation. This latter issue, the subject of the study to be proposed in this paper, will be taken up in greater detail in the following section.

4. Psychological Differentiation and Intelligence.

In the early studies on spatial orientation, Asch and Witkin (1948b) at one point alluded to the possibility that intellectual computations might influence performance on their perceptual tasks. An investigation of this possibility led them to the conclusion that whatever the gain in performance a subject achieved through special intellectual techniques the actual mode of field approach was not affected. At any rate, the first phase of Witkin's perception-personality research (Witkin et al., 1954) did not include any significant consideration of intelligence as a relevant variable. The researchers did, however, hypothesize in their concluding review that the individual differences reflecting field dependent versus field independent functioning in a variety of perceptual and personality tasks might likely be found in intellectual functioning as well, as suggested in a preliminary study by Woerner and Levine cited by Witkin et al. (1954, Fn., p. 477; 1962, p. 60).

It was only in the second phase of research (Witkin et al., 1962) that the issue of intelligence acquired any focus of significance. On the basis of informal observations made during interviews in the earlier studies, it seemed that field independent children showed a greater degree of awareness of situations and people and had more highly developed interests and views of the future than field dependent children. These observations, along with the results of the Woerner and Levine study noted above, suggested the possibility that field independence might be reflecting superior intelligence. However, the finding in the Woerner and Levine study that the perceptual measures were more highly related to performance than to verbal scores of the Wechsler Intelligence Scale for Children (WISC) also suggested that correlations between Full Scale IQ (FSIQ) and field dependence measures might be "carried" primarily by those portions of intelligence tests which require the same ability the perceptual tasks require.

In the first of a series of studies the Witkin group (1962) made on the issue, the 1937 Revised Stanford-Binet

(Form L) was administered to 24 boys and 24 girls, all 10 years of age. Correlations of obtained IQs and perceptual index scores yielded significant correlations for both boys (r = .57, $p < .01$) and girls (r = .76, $p < .01$), confirming the Woerner and Levine findings with the WISC. Several later studies from independent laboratories yielding similar results were cited by the researchers as additional confirmation of their results. An attempt to go "beyond the IQ" and examine the basis for the relationship by specific item comparisons was unsuccessful since all children did not receive the same test items on the Binet test.

To examine the basis of the correlation between IQ and field dependence measures, the WISC was administered to a group of 12-year olds (25 of each sex) and to thirty 10-year-old boys. Again, significant relationships between perceptual index scores and total IQ were found for both male groups (r = .55, $p < .01$, at age 10; r = .73, $p < .01$, at age 12). The correlation for the 12-year-old girls was in the expected direction but was not significant (r = .36). Comparison of the relationships of perceptual scores with performance and verbal scaled scores separately showed a somewhat higher relationship to performance than to verbal functions, as in the Woerner and Levine study (Witkin et al., 1962).

Goodenough and Karp (1961) pursued the issue further in a factor analysis of the above data for each age group.

For the 10-year-old boys, data from a number of problem-solving and perceptual tasks were also included in the analysis along with the WISC, RFT, BAT, and EFT analyzed for both age groups. Three major factors, well matched in both analyses, emerged. A verbal-comprehension factor--with high loadings for WAIS Information, Vocabulary, Similarities, Arithmetic, and Comprehension subtests, in that order--was obtained in the analysis for each group. The Digit Span, Arithmetic, and Coding subtests loaded highly on Factor II, named the Attention-Concentration factor. The highest loadings on the third factor were contributed by the perceptual measures followed by the WISC Block Design, Object Assembly, and Picture Completion subtests. It was felt that, despite the heavy loadings of all the field dependence tests on this factor, the specific perceptual connotation of the label "field dependence" rendered it inadequate to represent the intellectual tasks also loading on the third factor. On analysis, it was judged that the common denominator of the perceptual tests and the relevant WISC subtests was a similar requirement of the ability to overcome an embedding context--to deal with a field analytically, whether the field be immediately present or symbolically represented. It was further considered that development of this "analytic ability" makes possible an analytic way of experiencing, while a deficiency in its development restricts one to a global way of functioning. Thus, Factor III was labeled Analytical Field Approach.

It was on the basis of the studies discussed above that Witkin et al. (1962) fully recognized that the field dependent-field independence dimension as they had been using it was the perceptual component of a more general cognitive style which finds expression in both perceptual and intellectual functioning. The correlation between total IQ scores and perceptual field-dependence scores was thus seen to be the reflection of this general style in both measures, with the correlation being "carried" chiefly by those portions of the intelligence test requiring analytic ability for successful performance. In the light of these findings the hypothesis that field independence was reflecting superior intelligence was rejected. In the authors' words, "The finding of striking differences in the extent to which various IQ subtests contribute to these relations rules out such an interpretation" (Witkin et al., 1962, p. 70).

From the Goodenough and Karp factor analysis, the Witkin workers derived a number of index scores which were to be of considerable use in later work. They included a verbal index (sum of the Wechsler Information, Vocabulary, and Comprehension subtest scaled scores); and attention-concentration index (sum of Digit Span, Arithmetic and Coding scaled scores); and an intellectual index (sum of the Block

Design, Object Assembly, and Picture Completion scaled scores). The latter, reflecting degree of analytic ability, is the counterpart in regard to intellectual functioning of the perceptual index (mean of the separate indices of the RFT, BAT, and EFT) in perceptual functioning. A cognitive index was also derived by summing the perceptual and intellectual indices. Intercorrelations of these various indices showed a significant relationship ($r = .66$, $p < .01$) between the perceptual and intellectual indices, and showed an absence of relationship between the perceptual index and the other two WISC indices (with verbal, $r = .26$; with attention concentration, $r = .18$). These results were felt to offer an alternative, confirming demonstration of the differences in contribution of various subtests to total IQ-field dependence correlations revealed in the factor analysis.

A factor analytic study by Karp (1963) provided considerable support for the Goodenough and Karp study (1961) with children. Karp (1963) gave the RFT, BAT, EFT and seven subtests of the Wechsler Adult Intelligence Scale (WAIS) to 150 male college students. Three factors, highly similar to those found in the children's analyses and similarly named, emerged from the matrix of intercorrelations of scores on the test battery.

In support of their view that analytic ability could be identified in both intellectual and perceptual functioning, Witkin et al. (1962, p. 71) cited a study by Guilford in which his adaptive flexibility factor--recognized by the Witkin group as similar to their analytical field approach factor--was found to be significantly related to such tasks as Match and Insight Problems. All of the intellectual tests involved appeared to require restructuring, or the ability to overcome an embedding context. As a more direct check on the similarity between the adaptive flexibility and analytical field approach factors, the Witkin group (1962) gave 31 college men nine cognitive tests, including Guilford's Match and Insight Problems, along with the RFT, BAT, EFT, and four of the WAIS subtests, Vocabulary, Block Design, Comprehension, and Picture Completion. It was hypothesized that measures of field approach and adaptive flexibility would tend to correlate with each other but not with verbal scores represented by Vocabulary and Comprehension. The results supported their hypotheses.

The Karp (1963) study with adults, noted above, included the nine cognitive tests mentioned in the preceding paragraph as part of a larger battery. Adaptive flexibility emerged on the same factor as did the measures of analytic field approach, providing support for the correlational study of these relationships.

Though examined only on an incidental basis, the findings of the Witkin group (1962) in regard to verbal skills and differentiation are pertinent to the present discussion. They reported that extent of differentiation was unrelated to some kinds of verbal skills. In fact, they found that some children showing limited differentiation in many areas showed a marked development in verbal expressiveness. The latter was described as the ability to give extended, fluent accounts, or to elaborate verbally. In attempting to account for this unevenness of cognitive development they suggest that verbalization achieves a compensatory function in these children who showed little in the way of other resources for more active coping with situations and problems. They further pointed to the usefulness of verbal communication for these usually dependent children in obtaining the guidance and support they generally need from others. Explanatory suggestions also came from the studies of mother-child interactions which the Witkin researchers included in their investigations. It was found that mothers of some poorly differentiated children were strongly motivated by needs for social acceptance and conformity to cultural standards. These mothers seemed to encourage verbal facility in their children as a socially pleasing and desirable characteristic.

A related basis for the exaggerated verbal development in some field dependent children was seen in a study by Haggard (cited in Witkin et al., 1962, p. 200). Haggard compared three groups of intellectually superior children on level of achievement in three areas: language and spelling, reading, and arithmetic. The children highest in language and spelling achievement showed personality characteristics similar to those found in the poorly differentiated children in the Witkin studies. It was felt that the learning of language and spelling require in large measure the obedient carrying out of rules learned by rote, which would likely be attractive to children in whom conformity and dependence on external guidance for effective performance were prominent characteristics.

One further point of significance from the studies on verbal skills relates to observations made in regard to studies of the ability to overcome an embedding context in verbal media. The researchers (Witkin et al., 1962) cited studies, including their own, in which scores on Camouflaged Words, Anagrams, and Reconciliation of Opposites tests--all presumed to present a subject with verbal material in an embedding context--failed to relate to adaptive flexibility, spatial decontextualization, and analytic ability, respectively. Witkin et al. interpret these studies as indicating that there may be little relationship between the ability to overcome an embedding context when dealing with verbal material, though this view is admittedly contrary to the expectations of their basic hypotheses.

The foregoing studies conducted or cited by the Witkin group form the basis for their theorizing on the relationships between extent of differentiation and intelligence; the latter may be summarized as follows:

1. Extent of differentiation is reflected in a cognitive style varying along a dimension of analytic versus global functioning and finding expression in both perceptual and intellectual functions.

2. The significant relationship consistently found between total IQ scores and measures of differentiation is "carried" principally by those portions of standard intelligence tests which, like the differentiation measures, require the capacity for analytic functioning, i.e., "analytic ability" is the basis of the communality found.

3. Some verbal skills, such as verbal expressiveness and verbal comprehension (as defined by the verbal index) show little relationship to differentiation measures and may follow a different developmental path from that of differentiation.

4. The ability to overcome an embedding context in the medium of language and in the medium of configurational

stimuli may not be related, and the tasks relevant to the two media may exploit different skills.

5. The hypothesis that variation in general intelligence is the basis for variation along the field-dependence dimension is rejected, and the broad array of significant relationships between measures of field approach and a wide variety of perceptual, intellectual, and personality measures cannot be attributed to differences in general intelligence.

The Goodenough and Karp (1961) study of 10- and 12-year-old children, in which the concept of analytic ability was more fully delineated, appears to play a central role in determining the eventual theoretical position of Witkin and his associates in this area. The extent of agreement with and support from other research for this particular study, then, is of considerable importance. It may be recalled that the Woerner and Levine study was cited in support of the correlations found between the perceptual index scores and WISC performance and verbal scaled scores for the 10- and 12-year-old subjects of the major study (Witkin et al., 1962), subjects who also served as subjects of the Goodenough and Karp factor analysis. While congruence of some findings was clearly evident, unemphasized discrepancies between the two studies may render the agreement between the studies less substantial than suggested. For example, in the major study (Witkin et al., 1962) correlations between the perceptual scores and the WISC performance scale score for the 12-year-old boys (the age of the Woerner and Levine subjects) was $\underline{r} = .71$ ($\underline{p} < .01$). In the Woerner and Levine study (cited in Witkin et al., 1954), for boys the correlation between the performance scale score and the RFT--the prototypic field dependence measure--was insignificant. Examination of the girls' results showed that, while in the major study no relationship was found for perceptual and verbal scores ($\underline{r} = .06$), significant relationships were found in the Woerner and Levine study between verbal scores and each of the perceptual measures common to both studies (RFT, BAT, EFT). Again, the perceptual index scores for boys in the major study showed significant relationship with the total IQ ($\underline{r} = .73$), which was related significantly only to the EFT ($\underline{r} = .71$) in the Woerner and Levine study. For girls, in the latter study, total IQ correlated significantly with all perceptual measures but failed to show significance in the major study. The perceptual index used in the major study apparently was not used in the Woerner and Levine study for which Witkin et al. (1954) reported only separate correlations for the various perceptual tests. While the latter may account in part for some of the differences noted, no information to this effect was stated.

The results for girls in the principal study are of special interest. Goodenough and Karp (1961), in describing the verbal comprehension factor, note that sex is loaded on the factor, and that the boys displayed greater verbal comprehension than the girls. As they point out, this finding is not consistent with the literature on sex differences in this area. In this connection, Zimiles' (1964) questions on the possible uniqueness, and therefore unrepresentativeness, of the Witkin et al. samples come to mind.

In view of the prominent role of the verbal index in various comparisons, both in the study in which it was developed (Witkin et al., 1962) and in later work, it would appear important to point out a rather puzzling feature of its derivation. This appears to have received little research attention in the literature except in a recent study by Roy (1971). In Goodenough and Karp's study (1961), the WISC Similarities subtest showed a considerably higher loading (.57 for 10-year-olds; .44 for 12-year-olds) on the verbal-comprehension factor than did the Comprehension subtest. However, Comprehension was selected for inclusion in the verbal index as one of the subtests most representative of the verbal-comprehension factor. It was reported (Witkin et al., 1962) that criteria for selection were size of loading on the given factor and lack of relationship with the other factors. It was explained that Similarities was not selected because of its high relationship with the perceptual index scores. The latter relationships are not specifically presented as part of the published data, but regardless of the degree of relationship in pre-factor analytic data, it would appear that its failure to load significantly on the analytic approach factor (loading, .06) would have left it a suitable measure for inclusion in the verbal index.

In addition to the above, the field dependence-adaptive flexibility study, which was cited in support of the basic children's study, showed that Comprehension correlated significantly with both EFT (r = .39) and Picture Completion (r = .40) and was correlated with the adaptive flexibility measures (Match Problems, r = .37; Insight Problems, r = .40) as high as were the BAT (Matches, r = .37) and the RFT (Insight, r = .40). Moreover, Cohen's (1959) factor analysis of the WISC, which Witkin et al. (1962) cited as similar to their own by Goodenough and Karp (1961), had shown a factor commonly loaded by Comprehension and Picture Completion. In view of these various considerations it would appear that there is some justification for suggesting that Similarities would have been a more appropriate choice for the verbal index than Comprehension. With such a choice one might further speculate that testing the hypothesis of differentiation in the verbal sphere might have revealed positive rather than negative results, especially in view of the somewhat analytic nature of the Similarities task.

Apart from the questions just raised in relation to the verbal index, the underlying rationale for the construction and use of the three derived indices has been challenged by Zigler (1963b). He called attention to Cohen's (1959) study, which revealed significant correlations for Block Design, Object Assembly, and Picture Completion with the general intelligence factor, or G ($\underline{r}$ = .55, .49, and .43, respectively), though correlations (with G) were higher for the three subtests of the verbal index. Zigler pointed out the inadequacy, then, of handling the general intelligence issue by showing that perceptual measures related more to one index than to the other since the question of G variance remains. It was, further, Zigler's opinion (1963a) that the correlations between the perceptual measures and many of the projective tests were reflecting general intelligence rather than differentiation as described by the Witkin authors.

Along with, and related to, Zigler's objections in regard to the general intelligence question was his strong criticism of the Witkin group's results and conclusions in relation to verbal functioning. That verbal skills were generally unrelated to differentiation, Zigler (1963b) found very difficult to reconcile with the ideas of leading developmental theorists. In this context he presented a strong argument that the verbal index, because so highly loaded with G, was a better indicator of differentiation than the intellectual index.

As may be seen, some of the criticisms of the basic studies raised serious issues which were considered in subsequent investigations. Later research has offered both support for and further questioning of the Witkin et al. results and interpretations.

One of the earlier studies which supported the Witkin position was an investigation on some aspects of creativity by Spotts and Mackler (1967). In a sample of 138 college males, these workers found a significant relationship between field independence and creative test performance, using Jackson's Short Form of the Witkin EFT and Jackson's Hidden Figures Test as measures of field dependence, and using two verbal plus two non-verbal factored tests of creativity taken from studies by Torrance and by Guilford and Merrifield. Of significance to the present discussion was the finding that field independence was significantly associated with the Q (quantitative) scale of the Schools and College Abilities Test (SCAT), but showed no relationship with either the total SCAT score or the L (language) score. The finding of a differential relationship of the field dependence measure to different kinds of intellectual functions, as well as the absence of relationship of the measure to the verbal measures, was believed to offer support for the Witkin results on this issue.

Bell and McManis (1968) studied mode of field approach in subjects differing in approach to a learning task in terms of reward-seeking or punishment-avoiding behavior. Their hypothesis that reward-seekers, as more active, success-striving persons, would show greater differentiation than the punishment-avoiding subjects was confirmed when significant differences were found between the two groups. The results were replicated when the effect of intelligence was factored out, thus indicating support for Witkin et al., who alleged distinctions between the effects of intelligence and extent of differentiation.

Yamada (1968), in a rare, direct study of the question, hypothesized that, with intelligence controlled, field independent subjects should perform better than field dependent subjects on tests weighted with analytic ability and should show no differences in performance from that of field dependent subjects on tests not so weighted. He administered a series of factored tests from Guilford's Structure of Intellect Battery, the RFT, and the EFT to a group of college students. He found some support for the Witkin hypothesis in that significant differences on tests weighted with analytic ability were found in favor of the field independent groups. However, the results were ambiguous since scores on almost all the other tests were also higher for the field independent subjects, though the differences between groups did not reach significance.

Less ambiguity was seen in the results obtained by Dickstein (1968) in a study of concept attainment and field dependence in nursing and university students. The concept attainment task used, taken from a Bruner study on thinking, was believed to require differentiation of the stimulus complex. The latter was an array of 81 cards each of which represented a unique combination of four attributes (shape, number, color, and number of borders), each of which may take one of three values (squares, circles, crosses; 1, 2, 3, etc.). The hypothesis was made that field independent subjects would perform on this task at a significantly better level than field dependent subjects. Significant differences were found and were interpreted as indicating that field independence was relevant to certain kinds of concept attainment tasks.

Though earlier studies on this question had produced similar results, their results remained ambiguous, according to Dickstein, because they had failed to control for intelligence. In the Dickstein study intelligence was controlled by equating the differing perceptual groups on Otis IQ scores. It was thus felt that concept attainment for this task had been shown to be more closely related to field independence than to intelligence, and that differences between perceptual groups could not be attributed to differences in intelligence. This conclusion was supported in a more direct analysis in which the 40 subjects were divided into groups with high (mean = 121.15) and low (mean = 111.9) Otis IQ scores. No significant differences were found on scores for the concept attainment task. This would appear to support Witkin's proposal of an analytic field approach factor which is independent of general intelligence per se.

More recently, Roy (1971), in a study of the verbal skills-field independence relationship, administered the EFT and the RFT and seven factored verbal tests to 84 female nursing students. Established field-orientation groups were equated on Otis IQ scores. Results of the correlation of the perceptual measures and the verbal test scores suggested that field independence was related to some tasks requiring the ability to overcome an embedding context. While the studies of Witkin et al. (1962) in this area were minimal and their observations on the work of others showed negative findings, the Witkin group did specifically recognize that differentiation should be demonstrable in this particular aspect of verbal functioning (tasks with embedding verbal media).

Recently, Gough and Olton (1972) provided a demonstration of the differential correlation of the field dependence measures with verbal versus non-verbal measures. The RFT was found to be unrelated to a vocabulary measure and to be significantly related to four other measures purported to tap similar functions as the RFT. None of these other procedures showed any association with the vocabulary measure either.

Though some support for the Witkin position has been seen in the previous studies, results from the studies to be discussed next indicate the controversial state of the intelligence-differentiation issue. One of the first major challenges came from a study by Crandall and Sinkeldam (1964). These workers studied 28 boys and 28 girls between the ages of six years, 10 months and 12 years, five months. The children were assessed on dependent and achievement behaviors in social situations, which were expected to relate to mode of field approach in opposite directions. Significant differences were found as expected, with field dependence showing a significant association with dependent behaviors and field independence related to achievement behaviors. However, when the effects of the Stanford-Binet (form unreported) IQ were partialled out, the findings were generally insignificant in relation to the five dependency scores used, though significance remained for the findings related to the achievement behaviors.

To further test the relationship between intelligence and the RFT, Crandall and Sinkeldam administered the WISC to all subjects. While some support for Witkin's findings was suggested in a high correlation of the EFT and WISC Object Assembly, there was strong evidence that the major portion of the WISC subtest scores had little or no relationship to the field dependence measures. Moreover, the results showed significant positive relationships for the EFT with the Vocabulary, Information, and Comprehension subtests, in direct contrast to the findings of the Witkin et al. studies (1962).

Several other investigators have found significant relationships between measures of differentiation and verbal measures. Powell (1970) found significant correlations for both EFT ($r = .41$, $p < .01$) and the RFT ($r = .40$, $p < .01$) with a vocabulary measure. When verbal intelligence was controlled in this study, significant differences in mode of field approach for patients divided as to hallucinatory versus delusional symptoms disappeared. Hellkamp (1967) found similar correlations to those reported above by Powell for his (Hellkamp's) psychiatric sample. Elliot (1961) found significant correlations between the EFT and the <u>L</u> score of the SCAT, in contrast to the Spotts and Mackler study

(1967), which showed no association between these measures, as noted above.

More recently, Dubois and Cohen (1970), in an attempt to clarify the issue, correlated the RFT and the EFT with a variety of aptitude and achievement scores from the State University Admission Examination, a standard admission test for the subjects of the study. The test gives a separate verbal and quantitative score along with five achievement scores assessing the areas of English, Social Studies, Art and Music Appreciation, Science, and Mathematics. Intercorrelations among the various measures showed that all but two correlations were significant, but small, and were of about the same order as intercorrelations typically found among separate measures of intellectual achievement. The variety of subject matter for the various achievement measures was deemed to rule out the possibility of "the ability to overcome an embedding context" as the explanation for the significant relationships found.

In one of an interesting series of studies of field dependence in alcoholics, Goldstein and Shelly (1971) reported findings in their adult sample which are similar to the findings of the Crandall and Sinkeldam (1964) study with children. The former performed a factor analysis of the following measures: the WAIS subtests; subtests of the Halstead neuropsychological battery; procedures added to the latter battery by Reitan; and the RFT. In this analysis the RFT constituted a relatively independent factor. While the WAIS Object Assembly subtest and the Trail Making Test also showed significant loadings on the latter factor (though only moderately so), no other measure, including the 10 remaining WAIS subtests, did so. The researchers suggested that the common characteristic reflected in the three commonly loading measures might be described as "a kind of analytic ability" (p. 39), and they suggested that the RFT seemed to be a measure of a particular aspect of intellectual functioning. While, on the one hand, the findings seem to be a refutation of the Witkin position, on the other hand, the interpretation sounds quite similar to Witkin's description of differentiation as manifested in intellectual tasks.

In another study of the series, Goldstein, Neuringer and Klappersack (1970) compared field dependent and field independent alcoholics and non-alcoholics with brain-damaged subjects on a number of RFT related cognitive, perceptual, and motor skills. Postural orientation was evaluated by means of the Heath Rail-walking Test and a tilting chair test devised by the authors. The more complex visual-postural skill was assessed with the standard rod-verticality test. The Witkin EFT and the WAIS Block Design, Object Assembly, and Picture Completion subtests were used to measure cognitive analytic ability. There were 20 subjects in each of the five research groups, with the brain-damaged subjects being undifferentiated as to mode of field approach. The latter was assessed for the other groups by the RFT.

In comparing the sample subgroups, Goldstein et al. found that the field dependent alcoholics had approximately the same pattern of RFT related cognitive, perceptual, and motor skills as do field dependent non-alcoholics, though the former showed a somewhat lower level of cognitive-analytic skill. Moreover, on the whole, field dependent subjects--alcoholic or non-alcoholic--did not differ in level of functioning from that of individuals with known brain damage. Field independent alcoholics performed better than the former three subgroups, with the field independent non-alcoholics showing the best performance of all, as expected. These results suggested to the researchers that their subgroups represented points along a continuum of organic dysfunction. Though recognizing that impairment may reflect a variety of etiologies--traumatic, developmental, organic, or functional--and that field dependence is likely multiply determined, Goldstein et al. proposed that the results of their study suggested that the field dependence-independence dimension may represent an intact-deterioration dimension of psychological functioning.

One important omission in this study was the lack of any indication of control for intelligence. Without the latter the results of this interesting study remain ambiguous.

In a recent research effort, Vernon (1972) administered eight spatial and field dependence measures and a number of reference tests of ability, achievement, interests, and personality characteristics to a large group of eighth grade boys and girls. In this study, which contains a good current review of the present problem, Vernon found that group paper-and-pencil tests of spatial ability, including the EFT and the Concealed Figures Test of Thurstone, do not define a factor distinct from a general intelligence factor, G, or from spatial ability. With intelligence held constant, the results indicated that the spatial ability tests show significant correlations with interests but few such correlations with personality. The RFT alone gave a different pattern of correlations and seemed to identify a distinctive visuo-kinesthetic factor independently of the other tests. It did, however, also show significant intercorrelations with indices of superior cognitive clarity. As did Goldstein et al.'s (1971) study noted earlier, Vernon's study appears somewhat ambiguous in its position with respect to Witkin's hypothesis.

As is evident in the foregoing account, there is still a great deal of debate and uncertainty over the relationship between intelligence and extent of differentiation, or field dependence, and conflicting findings continue to be reported in the literature. For some workers (Kagan & Kogan, 1970; Maccoby, 1964) the relevance of the debate is challenged on the grounds that the generality inherent in a substituted intelligence construct would provide no improvement in interpreting observed perception-personality relationships than the generality challenged in the differentiation concept. A recent common view that intelligence itself is an outmoded concept may add to the questions raised on the relevance of the debate. In an analysis of the noted view, however, McNemar (1964) has challenged the critics of the intelligence construct and has made a strong case for its retention. Supporting evidence in the literature--such as Butcher's (1968) book directed to the same question and a recent educational symposium (Dockrell, 1970) in Toronto on the same theme--lend credence to McNemar's view that intelligence still serves as a theoretically and practically useful and important construct. Besides this primary issue, even those who may question the relevance of the issue as above, point out the need at least for <u>control</u> of intelligence in differentiation studies (Kagan et al., 1970; Wachtel, 1972). The intelligence-differentiation question thus appears to be still very much relevant and worthy of research attention. Before proceeding to the final section of this chapter in which the research problem and hypotheses are presented, a brief overview of the review of the literature to this point may be helpful.

After indicating the origin, in early space-orientation studies, of Witkin's interest in perception-personality relationships, the development of the mode of field approach, or field dependence, construct was described. The field dependence-independence dimension was shown to be considered as a dimension of passive-global versus active-analytical functioning. Initially detected in perceptual situations, this individual stylistic mode of perceptual approach was, with further investigation, found to pervade a variety of psychological functions, being manifested in social, intellectual, and personality functioning within a given individual in a stable and consistent way. The Witkin et al. research findings and related theorizing on the developmental aspects of their studies were reported and the subsequent elaboration of the field dependence hypothesis into that of psychological elaboration was described. Critical reaction to the early and later reports of the Witkin work was indicated. It was seen that the major criticism of the work was directed at a perceived over-generalization in the development of the differentiation hypothesis. The effect of the massive body of research as a theoretical and research stimulus was indicated, and the present vigor of the Witkin hypothesis as a focus for study was noted. In an extended section of the review, the intelligence-differentiation debate (more adequately summarized at the beginning of the next section) was detailed. The relevance of this debate in the face of recent questions on the usefulness of the intelligence construct was then discussed, with the conclusion that intelligence, as well as differentiation, is still a viable and important construct for theoretical and research attention. Finally, in the light of the literature review, it was suggested that the intelligence-differentiation question warranted further attempts at clarification, the aim of the present paper. In the next section of this chapter the research problem and hypotheses will be presented following a consideration of brain damage as a relevant variable in differentiation research and in the present study.

5. Brain Damage and the Research Problem and Hypotheses.

As immediate background for this section, a summary of the key points in the intelligence-differentiation debate may serve to focus the discussion of the research problem and hypotheses.

The relationship between measures of intelligence and extent of differentiation is clearly established--only the basis of this relationship is in question. For Witkin et al. the basis of this relationship is analytic ability--the specific ability to overcome an embedding context, whether immediately represented in perceptual tasks or represented symbolically in intellectual tasks. Thus, for Witkin and his colleagues the total IQ-extent of differentiation correlation is "carried by" specifically those components of the intellectual measure which feature primarily this analytic ability, and the correlation has little or no other relevance to level of IQ or general intelligence. Witkin's critics, on the other hand, propose that the underlying correlation is a function of overall intellectual ability rather than of the more circumscribed analytic ability, and that the observed correlations are reflecting the level of general intelligence, or G factor, expressed in both measures.

The research problem may thus be seen to reside in the question: Is the significant relationship between complex measures of intelligence and measures of extent of differentiation, as Witkin et al. contend, a function of analytic ability or, as Witkin's critics suggest, is the observed relationship a function of general intelligence?

One of the major difficulties evident in this problem lies in the part/whole and normally high correlation between general intelligence and intellectually expressed analytic ability. This difficulty, however, is likely to be minimized in a heterogeneously brain-damaged group. Since it is well established that intellectual functions are differentially affected depending on the location and severity of brain damage, a brain-damaged group would include subjects of the same general level of intelligence who show relatively widely differing levels of analytic ability. Similarly, such a group would be likely to include subjects of similar levels of analytic ability who differed significantly with respect to overall level of intellectual functioning. In such a group the correlation between general intelligence, or full-scale IQ, and analytic ability would be reduced well below that expected in a non-brain-damaged sample. It might then be possible to study Witkin's hypothesis, at least as it may apply to a brain-damaged group, with less ambiguity than research in this area has thus far allowed with other groups.

Though brain-damaged subjects have been well studied in relation to the neuropsychological aspects of spatial orientation (Teuber, 1960), studies of the brain-damaged in a differentiation frame of reference have been relatively infrequent. Apart from one study by Trites (1969), investigating the issue of response sets in differentiation research, most of the studies which have included brain-damaged subjects have done so chiefly for purposes of comparison with other groups, e.g., alcoholics (Bailey, Hustmyer & Kristofferson, 1961; Goldstein, Neuringer & Klappersack, 1970). As noted in the last section, one of the latter studies (Goldstein et al., 1970) produced results suggesting that differentiation may be reflecting an intact-deterioration dimension of psychological functioning. In the sense that this suggests (with respect to intellectual functioning) a quantitative as opposed to qualitative factor underlying the extent of differentiation dimension, this suggestion appears to be similar to the general intelligence (quantitative) versus analytic ability (qualitative) debate under consideration in the present study. In any case, the present research will attempt to provide some information on Goldstein's hypothesis, though this will be clearly a secondary aim of the present study.

Apart from Goldstein's observations potentially relating organicity and extent of differentiation, the only other ready information on brain-damaged subjects from the differentiation literature is that, as a group, brain-damaged subjects consistently are found to function in the field dependent range (Bailey et al., 1961; Goldstein et al., 1965; Goldstein et al., 1970; Trites, 1969). Though the latter results may suggest a restriction on the range of extent of differentiation to be studied in a brain-damaged group, data in the studies cited suggest that field independent, as well as field dependent functioning is represented even in relatively small samples of organically impaired subjects. Moreover, in the sample to be used here, neurologically intact subjects will also be included, as will be described in a later section. With these comments as background, study of the research problem as outlined below was thus proposed.

On the basis of the review of the literature and the foregoing considerations of brain damage and the research problem, it is thus proposed to assess by multiple regression procedures the relative importance of analytic ability versus general intelligence as these relate to extent of differentiation in a heterogeneously brain-damaged sample.

If, as Witkin contends, analytic ability "carries" the correlation known to exist between complex measures of intelligence and extent of differentiation, then, in a three variable multiple regression with a measure of extent of differentiation as dependent variable and a measure of general intelligence, or G, and of analytic ability as independent variables, analytic ability should show a relatively large and significant contribution to the regression over and above, or independently of, its joint contribution with G. At the same time, G should show relatively little, if any, contribution of significance to the regression apart from, or independently of, its joint contribution with analytic ability. On the other hand, if Witkin's critics are correct the opposite results for the two variables should be expected. Hypotheses for this, the major issue of the present study, will be presented in null form at the conclusion of this section, along with null hypotheses for the following supplementary issues.

As indicated in the early part of this section, brain damage is one of the few variables consistently found to be of significant relevance in differentiation research in the few studies in which it has been considered. Use of a brain-damaged sample, as in the present study, thus requires specific consideration of the effects of this variable in the research results. From this aspect of the study it is also hoped to provide some information on Goldstein's (1970) hypothesis that extent of differentiation may be reflecting an intact-deterioration dimension of psychological functioning. For this purpose, the relationship between an overall measure of organic impairment and extent of differentiation will be studied in multiple regressions with the two intelligence variables, representing analytic ability and G, to see if impairment contributes significantly to extent of differentiation independently of its association with the intelligence variables. A significant contribution by the impairment measure in a multiple regression with either measure as second independent variable would appear to support the Goldstein hypothesis which, as suggested earlier, seems consonant with the views of Witkin's critics. While the interpretation of a failure to show a significant independent contribution to the regression with G is difficult to anticipate, such a failure in the regression with analytic ability would seem to offer little support for the Goldstein hypothesis.

Age and sex, as variables of known relevance in differentiation studies, must be considered in any research in this area and will be included as independent variables in a final multiple regression procedure. If either variable has any significant effect on the present results independently of the major variables under consideration, and each other, there should be a significant loss in multiple $\underline{R}$ when the given variable is omitted from the relevant regression. Null hypotheses for these as for the previously discussed research problems may now be proposed.

For all multiple regressions used in testing the following null hypotheses, a measure of extent of differentiation serves as the dependent variable.

Main Hypotheses

1. With a measure of G and a measure of analytic ability as independent variables, there is no significant decrease in multiple *R* when analytic ability is omitted from the regression.

2. With a measure of G and a measure of analytic ability as independent variables, there is no significant decrease in multiple *R* when G is omitted from the regression.

Supplementary Hypotheses

3. With a measure of organic impairment and a measure of G as independent variables, there is no significant decrease in multiple *R* when organic impairment is omitted from the regression.

4. With a measure of organic impairment and a measure of analytic ability as independent variables, there is no significant decrease in multiple *R* when organic impairment is omitted from the regression.

5. With a measure of intelligence (G or analytic ability), a measure of organic impairment, age, and sex as independent variables, there is no significant decrease in multiple *R* when age is omitted from the regression.

6. With a measure of intelligence (G or analytic ability), a measure of organic impairment, age, and sex as independent variables, there is no significant decrease in multiple *R* when sex is omitted from the regression.

CHAPTER II

RESEARCH DESIGN

This is a descriptive study designed to provide information on the relative importance of general intelligence versus "analytic ability" as these relate to extent of psychological differentiation. It also proposes to assess, secondarily, the role of organic impairment in the differentiation dimension. In this chapter, the research design for the proposed study of the problem and testing of the hypotheses will be described. The presentation will include discussion of the relevant aspects under the following headings: (1) the Psychometric Instruments; (2) the Sample; (3) the Procedure; (4) Statistical Techniques for Analysis of the Data; and (5) Additional Analysis of the Data.

1. The Psychometric Instruments.

The psychometric instruments used in this study consisted of the Rod-and-Frame Test (RFT) for measurement of extent of differentiation; the Wechsler Adult Intelligence Scale (WAIS) for measuring G, or general intelligence, and for measuring analytic ability in intellectual tasks; and the Halstead-Wisconsin Impairment Index (IMPI) which served to measure extent of organic impairment. Each of the instruments will be discussed in order in this section.

(a) Rod-and-Frame Test.- The RFT, a perceptual measure of spatial orientation, assesses a person's ability to locate the true vertical in a limited, or misleading, visual field (Witkin et al., 1954). In terms of the test, it assesses a person's ability to adjust, to the gravitational vertical, a tilted rod which is set in a context of misleading visual cues. As described in Chapter I, a subject is seated in a tilting chair in a totally darkened room facing a luminous rod which is surrounded by a luminous square frame. Frame and rod can be tilted from side to side independently of each other. The subject's task is to adjust the tilted rod to the true vertical as he perceives it. For successful alignment of the rod with the actual vertical, the subject must overcome the "embedding" influence of the field provided by the surrounding frame, which is always tilted off vertical. On some trials the test task is further complicated by adding body tilt as a condition. The size of the errors of adjustment, i.e., the extent of actual tilt of the rod when perceived as vertical, indicates the degree to which the person has been influenced by the field (frame) in making his judgment. Large errors indicate a relatively passive, global, or field dependent perception of the environment and submission to the field influence. Small errors, on the other hand, indicate a more active, analytical, more field independent perception of the environment, characterized by the ability to experience various aspects of the surroundings in a differentiated manner (rod and frame experienced as discrete aspects of perception). The size of the average error for the total test thus indicates the location of a subject on the field dependent-field independent dimension, reflecting the extent of differentiation which characterizes his performance.

The rod and frame apparatus used in this study, a product of the Marietta Manufacturing Company, Ohio, consisted of a square frame, with sides 40 inches long and 1 inch wide, in the center of which is mounted a rod 39.5 inches long and .75 inches wide. Both rod and frame were pivoted at their centers and were so mounted as to allow them to be tilted from side to side independently of each other. The position of the rod and frame in relation to the vertical could be directly measured by means of a protractor mounted on the control box containing the shafts which moved the rod and frame. The protractor was marked in one degree calibrations in both directions. A transparent plastic disc was situated directly over the protractor and moved with the frame to indicate, by means of a thread-line marker on the surface of the disc, the position of the frame in relation to the upright. The position of the rod was determined by means of a pointer which moved with the rod and indicated its position in relation to the protractor. While the frame was positioned manually in this setup, the rod was motor-driven and could be rotated about its axis in either direction through an arc of 360 degrees. An electric switch which controlled the rod's movement was provided on the control box of the apparatus for the examiner. A detachable switchbox was provided for the subject. With this switch the subject had full control of rod position, with opportunity for trial and error adjustment on any given trial of the series. Both rod and frame were painted with luminous paint, and during the test were the only objects visible in the room.

A wooden tilting chair, with a high back support, armrests, a headrest, and a footrest, was placed seven feet in front of the rod and frame apparatus. The chair was motor-driven and allowed for tilting the subject to a selected degree of right or left tilt. A black drawstring curtain, which extended from floor to ceiling, was positioned halfway between the chair and the rod and frame apparatus. This shielded the rod and frame and prevented possible visual cues when the rod and frame were being repositioned between trials.

The standard procedure for administration of this test comprises three series of eight trials per series. In the first series, the subject is tilted 28 degrees to the left. The initial position of tilt of the rod and frame are presented to the testee across the eight trials in the following pattern: frame left, rod left; frame left, rod right; frame right, rod right; frame right, rod left. Repetition of this pattern for the next four trials completes the eight trials for the series. The same pattern of rod and frame presentations is employed in the remaining two series of the test, in which the subject is tilted 28 degrees to the right for eight trials and then is seated erect during the last eight trials of the test.

The present study deviates from the standard procedure in using six instead of eight trials in a series. The pattern of rod and frame presentations across the six trials of a given series was accordingly altered to the following: frame and rod left; frame and rod right; frame left, rod right; frame and rod left; frame and rod right; frame right, rod left. This shortened version was adapted to lessen stress for patients in a full day of testing. According to Witkin et al. (1962) reliabilities for the test are generally high enough to warrant use of shortened versions for many research purposes. Furthermore, their suggestion (1962, p. 40) that scores for the third series may be substituted for the total RFT score without loss in validity has been widely accepted in later research. Thus the present procedure, using eighteen trials, would appear to be an acceptable substitute for the standard procedures for the purposes of this study.

The subject's score on any given trial was the degree of angle by which the adjusted rod deviated from the vertical position. These error, or deviation, scores were summed over all trials and averaged to a single total score for the test. These scores were then reflected so that higher scores indicated greater field independence or greater extent of differentiation, i.e., better, more accurate judgment of the upright on the RFT.

The reliability of the RFT has been found quite satisfactory by a number of investigators. As noted in Chapter I, test-retest correlations of .84 for men and .66 for women over a period of one to three years were obtained in the Witkin et al. (1962) longitudinal studies. Corrected odd-even coefficients for the various series ranged from .79 to .91 in their samples. Independent studies cited by the Witkin group (1962, p. 40) showed similarly high odd-even coefficients for the RFT, ranging from .89 to .92. More recently, Hellkamp (1967) and Yamada (1968) have reported odd-even coefficients of .92 and .90, respectively.

As to the validity of the RFT as a measure of field dependence or extent of differentiation, it may be noted that the RFT was one of the main instruments on which the concepts were based and developed. It, along with other measures of perceptual field dependence, was found to relate significantly to various "indicators" of differentiation across broad categories of psychological functioning--e.g., social, intellectual, and personality--and *Psychological Differentiation*, authored by the Witkin group (1962) is dedicated to the reporting of the findings and interpretation of their study. As noted in the review of the literature, many of their findings have been supported by subsequent and independent investigators. Thus the reliability and validity of the RFT as a measure of extent of differentiation would appear to be adequate for the purposes of this study.

(b) The *Wechsler Adult Intelligence Scale*.- The WAIS was used for the derivation of the intelligence measures of this study--a measure of G, or general intelligence, and a measure of intellectually based analytic ability. *Analytic Ability* (AA) was here operationally defined as the sum of the scaled scores on the WAIS Block Design, Object Assembly, and Picture Completion subtests. This measure, it may be recalled, was derived by Witkin et al. (1962) as a result of factor analytic studies during the basic work on the present problem. Of the WAIS subtests, the three indicated subtests, and these alone, significantly loaded on the same factor on which the perceptual field dependence measures loaded. It was thus labeled the intellectual index, representing the analytic ability counterpart in intellectual functioning of the perceptual index (mean of RFT, BAT, and EFT scores) in perceptual functioning. These subtests have also been used, either singly or combined, by other researchers (Goldstein, Neuringer & Klappersack, 1970; Morgan, 1966), as in the Witkin studies, as measures of intellectually based analytic ability. This use of the WAIS subtests also provides an opportunity to study the problem in terms of the basic Witkin research on the same issue.

To avoid the part/whole confounding involved in using the full-scale IQ--traditional WAIS measure of general intelligence--with the analytic ability measure used here, a substitute measure of general intelligence, or G, was derived from the WAIS. Labeled Non-analytic Ability (NAA) in this study, the measure comprised the sum of the scaled scores on the WAIS Information, Comprehension, Arithmetic, Similarities, Vocabulary, Digit Span, Picture Arrangement, and Digit Symbol subtests, i.e., all the WAIS subtests except the three which comprise the analytic ability measure. (It should be noted that the label does not intend to describe the G measure beyond defining it in terms of its relation to the measure of analytic ability.) Rationale for its use as an approximate measure of G is based on two major points. (1) Factor analytic studies of the WAIS have been quite consistent in finding highest loadings on G, or general intelligence factor, for Vocabulary, Information, Comprehension, Similarities, and Arithmetic. For example, Cohen's (1957b) study showed that for each of the latter subtests respectively, 69%, 69%, 52%, 59% and 50% of its variance was attributable to G. In contrast, Block Design, Object Assembly, and Picture Completion showed corresponding values of 49%, 56%, and 41%. While the studies indicated refer primarily to normal samples, findings with brain-damaged samples generally yield similar results (Mattarazzo, 1972). (2) To add to the effect of the individual G loadings of the subtests making up the NAA variable, the <u>number</u> of subtests included in the latter is almost <u>three</u> times the number included in the AA variable. NAA, then, represents 73% of functioning on the WAIS as opposed to 27% for AA. Considering these observations on its composition, it was felt that NAA could represent a relatively close approximation to the sum of WAIS-measured intellectual resources, or level of G, except for the special analytic ability resources reflected in the AA measure. With this reasoning, then, NAA was used in this study as a reflection of G, within the limitations implicit in its derivation.

The WAIS has been widely accepted as a reliable and valid test of intellectual functioning. As to reliability, Mattarazzo, noting in his recent review (1972) the relative paucity of retest reliability studies, reported recent test-retest correlations of .73 for Full Scale IQ, .70 for Verbal IQ, and .57 for Performance IQ over an interval of 13 years. In view of the functional changes likely to take place in a person over that period of time, when these subjects were between 29 and 42 years of age, the reported values perhaps suggest fair reliability for the measures involved. For these same IQ measures, highly reliable internal consistency was shown for the WAIS standardization sample (Wechsler, 1955) in odd-even coefficients of .97, .96, and .93, respectively. As to validity, typical values for concurrent validity are reflected in correlations of .75 for the WAIS and Otis, and of .78 between the WAIS and S-B, as reported by Guertin, Ladd, Frank, Rabin and Hiester (1966). The observation (Rabin, 1965) that the WAIS has been the individual measure of adult intelligence most used in diagnosis and research for many years attests to its wide acceptance as a reliable and valid test. While the WAIS itself has been established as an acceptable instrument, the derived AA and NAA variables as such have few, or for NAA no, known referents in the literature. As may be recalled, however, the NAA variable includes eight of the total 11 WAIS subtests on which the Full Scale IQ is based and the AA variable includes three of the five subtests on which the Performance IQ is based. In view of the relative similarity of content of the two variables with the IQs of established reliability and validity, the use of the two derived variables was thus judged suitable for purposes of research.

(c) The Halstead Impairment Index.- As originally derived by Halstead (1947) the Impairment Index was based on the 10 tests which most successfully discriminated brain-damaged subjects from control subjects in his study. As used at the Royal Ottawa Hospital, the index is changed somewhat and is based on scores derived from the following measures: the Halstead Category Test; the Tactual Performance Test (TPT), Total Time score; the TPT, Memory score; TPT, Location score; the Finger Tapping Test; the Speech Sounds Perception Test; the Seashore Rhythms Test; Sensory Deficit; Aphasia-Spatial Test; and the Trail Making Test. These measures will be described briefly below.

The Halstead Category Test, included in the index, uses a projection apparatus to present stimulus material on a milk-glass screen before which the subject is seated. Also in front of the subject is a row of four levers which he uses to register his response to the multiple choice form of stimulus presentation. The test comprises seven subtests of varying numbers of trials. Each trial consists of a set of four stimulus figures. For each trial the subject presses only one lever to indicate his response.

Each of the seven subtests has one main idea or principle (based on variables such as size, color, form, number, etc.) running through it. The testee's task is to identify or "abstract" the relevant principle which he must learn through attention to relevant similarities and differences among the stimuli and through positive (a pleasant chime) or negative (a harsh buzzer) reinforcement of correct or incorrect responses, respectively. The test has been described (Halstead, 1947; Reitan, 1955) as principally a measure of abstraction ability.

The Tactual Performance Test provides three subtest measures of the Impairment Index. The TPT utilizes a modification of the Seguin-Goddard formboard for the test in which a blindfolded subject is required to fit wooden blocks of different shapes into correspondingly shaped spaces in the formboard placed before him. Three trials--one with the dominant hand, one with the non-dominant hand, and one with both hands--are given, after which the board and blocks are removed, the subject's blindfold is taken off, and he is asked to draw a design of the board. Three scores--Total Time, Memory, and Location--are obtained, and each score contributes one-tenth to the total Impairment Index score. The TPT assesses the ability to coordinate kinesthetic and tactile cues with motor performance and also measures incidental memory (Reitan, 1955).

The Finger Tapping Test, as the name implies, is a test of the speed with which a subject can tap the index finger of each hand (dominant hand first) in a 10-second period over a number of trials. In the Impairment Index used in the present study the score for the dominant hand is used. The test appears to be a measure of pure motor speed.

The Seashore Rhythm Test is a subtest of the Seashore Test of Musical Talent in which a subject must differentiate between 30 pairs of rhythmic beats which are at times the same and at times different. Along with assessing the ability to perceive differing rhythmic sequences, the test also requires alertness and sustained attention to the task.

The Speech Sounds Perception Test consists of a multiple-choice presentation of 60 nonsense syllables (variants of the "ee" sound) which is played for the subject on a tape recorder adjusted for sound intensity to the subject's comfort. The subject's task is to select and underline the spoken syllable from among the alternatives printed on the test form. In addition to the maintenance of attention, this test requires adequate auditory perception and discrimination and the ability to relate auditory stimuli to corresponding visual stimuli.

The Sensory Deficit is a summary value derived from the number of errors obtained on bilateral tactile, visual, and auditory imperception, finger agnosia, and perception of numbers written to the fingertips.

The Aphasia-Spatial Test Deficit is a summary value derived from the number of aphasic and apractognostic symptoms obtained on the Wisconsin Aphasic Screening Test. The latter assesses expressive and receptive language functions related to both verbal and written language. Task requirements include, e.g., naming common objects, reading, writing, calculating, differentiating right from left, and identifying body parts.

The Trail Making Test consists of two parts, A and B. In each part the testee is presented with a white sheet of paper on which 25 circles are distributed. In Part A the circles are numbered from 1 to 25 and the subject must draw a line connecting the circles in numerical sequence as quickly as possible. In Part B some of the circles are lettered (A to L) and some are numbered (1 to 13), with the subject's task to connect the circles, alternating between numbers and letters, while proceeding in ascending sequence. While the test most conspicuously taps alertness and concentrated attention, according to Reitan (1958) it may also reflect several other kinds of functional impairment, e.g., aphasic problems or visual spatial difficulties, related to a variety of loci of brain lesions.

For each of the Impairment Index components briefly described above a cut-off score has been established in the applicable scoring system. For each of the 10 tests on which a person exceeds the criterion or cut-off score a score of .1 is attributed toward his total Impairment Index score, which thus has a maximum value of 1.0. For example, if a subject scores beyond the criterion on five of the 10 tests, he receives an Impairment Index score of .5. Extent of impairment as reflected in the index score is as follows: .0-.2, normal central nervous system functioning; .3-.4, borderline normal; .5-.6, mild cerebral dysfunction; .7-.8, moderate dysfunction; .9-1.0, severe impairment. In the present study, the subject's obtained index score was multiplied by 10 to eliminate decimals and was also reflected, as noted later.

Since its creation by Halstead, the Impairment Index has become a highly useful and valued tool in neuropsychological assessment. Reitan's (1955) conclusion from the results of his validation study of the Halstead battery was that "there is probably no other measure of the psychological effects of brain damage for which such striking evidence of validity could be cited" (p. 34). A recent study by Stuss (1974) confirmed earlier research results which found the Impairment Index almost as effective as the discriminant function in discriminating brain-damaged from control subjects. The Impairment Index would thus appear to be a measure of choice for assessment for presence of brain dysfunction.

2. The Subjects.

All of the subjects in the present study were persons who had been tested at the Neuropsychology Laboratory at the Royal Ottawa Hospital in Ottawa, Ontario. The sample comprised 62 adult males and 20 adult females, who were consecutively assessed at the laboratory during a time-limited period in which the PFT was included as part of the neuropsychological assessment routine. No other selection factor entered into the composition of the sample. In accordance with the criterion in use for the Halstead-Reitan battery employed at the laboratory, the term "adult" includes all persons 15 years of age and over. Most of the patients were out-patients referred from a variety of community sources--family physicians, medical specialists, or other community agencies. Some members of the sample had been referred from the in-patient service of the hospital. For the majority, the neuropsychological assessment for which they had been referred revealed or confirmed organic brain dysfunction. For a minority, the assessment ruled out organic impairment as an etiological factor in their various presenting complaints. These latter subjects were included in the study to provide a broad range of psychometric functioning, from normal to severely impaired.

Table 1 presents a breakdown of diagnostic categories for the total sample and for male and female groups separately. The diversity of diagnoses allowed for a variety of brain dysfunctions which would be reflected in a broad variety of patterns of psychometric functioning. The latter, in turn, should result in a lowering of the normally high total IQ - analytic ability correlation which has been a source of confounding in this area of differentiation research.

Table 2 presents the means, standard deviations, and ranges for age, education, RFT, Impairment Index, and WAIS Full Scale IQ and subtest scaled scores for the total sample and also for males and females separately. Subjects ranged in age from 15 to 60 years for the total sample. Education was similarly highly varied, showing a range of three to 25 years. Scores on the WAIS subtests indicate the extent to which the expected heterogeneity of psychometric functioning was achieved in this sample. RFT group means (male and female) are clearly in the field dependent range, as is typical in brain-damaged samples. Mean Impairment Index scores are at a level indicative of mild cerebral dysfunction. Sex differences favoring males are found on RFT scores. The only other sex differences of significance

Table 1

Distribution of Primary Diagnosis for Males, Females, and Total Sample

Diagnosis	Males N	Females N	Total N
Patients with brain damage			
Seizures			
Grand mal-major motor, idiopathic	9	2	11
Psychomotor-temporal lobe, idiopathic	3	1	4
Petit mal & Centrencephalic	1		1
Mixed or multiple, idiopathic	1	1	2
Head injuries	3		3
Cerebral vascular disease	1	1	2
Completed vascular accidents	5	1	6
AV-Malformations and aneurysms	1	3	4
Tumors	3	2	5
Atrophy of brain	1		1
Toxicity & alcoholism	1	1	2
Infectious	2	1	3
Hereditary & congenital	2		2
Hydrocephalus	1	1	2
Perinatal	2	1	3
Undiagnosed disease of the brain	2	1	3
Neurosurgery	1		1
Primary reading disabilities	1		1
Hyperactivity	1		1
Possible brain damage, learning difficulties	3	1	4
Inconclusive evidence, brain damage not ruled out	7	3	10
Not considered to have brain damge, specific language or perceptual-motor retardation	2		2
Patients without brain damage			
Psychopathology	7		7
Miscellaneous diseases, tension headaches	2		2
TOTAL	62	20	82

Table 2

Means, Standard Deviations, and Ranges for Age, Education, RFT, Impairment Index, Wechsler Adult Intelligence Scale (WAIS), Full Scale IQ (FSIQ), and WAIS Subtest Scale Scores for Males and Females, and for Total Sample with *t* Ratios for Sex Differences

Variable	Males (N=62)			Females (N=20)			*t*	Total		
	M	SD	Range	M	SD	Range	Ratio	M	SD	Range
Age	29.03	13.43	15-60	32.70	17.31	15-58	.87	29.92	14.45	15-60
Education	9.93	3.17	3-25	10.90	2.59	8-16	1.46	10.71	5.29	5-25
RFT	15.85	10.91	3-41[a]	24.31	12.85	8-47[a]	2.67**	17.85	11.87	3-47[a]
Impairment Index	4.91[b]	2.49	0-10	5.45[b]	2.61	1-10	.54	5.04[b]	2.53	0-10
WAIS FSIQ	98.40	14.02	61-131	100.90	11.38	86-121	.71	99.01	13.55	61-131
WAIS Subtests										
Information	9.64	2.85	3-14	10.30	2.34	4-14	1.04	9.80	2.73	3-14
Comprehension	9.92	3.50	4-19	10.50	3.15	5-17	.70	10.06	3.41	4-19
Arithmetic	10.03	3.36	3-17	10.25	2.02	7-14	.35	10.08	3.08	3-17
Similarities	9.50	2.71	3-16	10.60	2.30	6-15	1.77	9.77	2.64	3-16
Digit Span	9.27	3.46	2-19	9.65	3.17	6-19	.46	9.37	3.38	2-19
Vocabulary	9.61	3.10	4-17	10.95	2.86	6-17	1.79	9.94	3.08	4-17
Picture Completion	9.29	2.24	3-13	8.00	2.43	1-11	2.10*	8.98	2.34	1-13
Block Design	9.50	2.87	3-15	7.90	2.90	1-14	2.15*	9.11	2.94	1-15
Picture Arrangement	9.13	2.74	4-16	8.75	3.02	0-13	.50	9.04	2.80	0-16
Object Assembly	9.13	2.70	2-15	8.10	3.68	0-18	1.15	8.79	2.98	0-18
Digit Symbol	7.76	2.71	0-15	9.00	3.51	1-15	1.44	8.02	3.04	0-15

[a] Rounded to whole numbers for presentation in this table.
[b] Obtained scores multiplied by 10.
$^{*}p < .05$
$^{**}p < .001$

are found on the Picture Completion and Block Design subtests of the WAIS, both components of the composite analytic ability variable described earlier

3. Procedure.

The data on which this study was based were obtained as part of an extensive routine neuropsychological assessment of patients referred to the Neuropsychology Laboratory, Royal Ottawa Hospital. Testing was conducted by neuropsychological technicians highly trained in the standard administration and scoring of the various tests used. Routine procedure at the laboratory includes a checking of test results by a second technician. A similar check is also used in transferring results to coding sheets. The neuropsychological assessment involves a full day of testing for the individual, beginning at 8:15 a.m. and extending to about 4:00 p.m., with approximately an hour for lunch. The order of tests is flexible but is generally designed to minimize negative effects of fatigue and boredom. In keeping with this principle, the WAIS is administered early in the sequence. When the RFT is given it is usually the final procedure for the day.

Procedure for the RFT was as follows. After making sure that the curtain in front of the rod and frame was lowered to conceal the apparatus, the patient was brought into the testing room and helped into the chair. If needed for support, foam rubber padding was put in between the patient and the sides of the chair. Support straps were affixed, the headrest was adjusted, and the switch box for moving the rod was placed in the patient's right hand. He was then informed about what he was to do by means of the following instructions, identically worded for all subjects:

> The purpose of this test is to see how well you can establish the upright of a rod under varying conditions. By upright I mean a position of the rod directly up and down from the floor. We could describe a telephone pole as being upright in relation to the ground. While you will be adjusting the rod the room will be dark. The only thing you will see is a rod surrounded by a square frame. During this time I will be tilting the frame and the rod to either the right or the left and I will ask you to move the rod to an upright position--that is, straight up and down from the floor. You will be able to move the rod by adjusting the switch which is attached to the box you are holding in your right hand. By moving the switch you will be able to move the rod to the right or left so that it is straight up and down from the floor. As soon as you have the rod straight, tell me and then I will blacken the frame and rod, move it to a new position and have you straighten it again. You will notice at times, while the room is dark, some movement on the chair on which you are sitting. Also, the motor that moves the chair is a very noisy one, so be prepared for some noise. Most people get used to this sensation very quickly.

Answers to any questions the patient had were made by repeating pertinent parts of the instructions. Under no circumstances was the patient told that the chair was being tilted or was the purpose of the test explained further. After the examiner was satisfied that the patient understood the instructions, the screening curtain was raised exposing the rod and frame for the first trial. As noted in an earlier section of this chapter, the patient was given six trials while tilted left, followed by six trials while tilted right, and ending with six trials while seated upright. Between trials the curtain was lowered while the examiner re-positioned the rod and frame and also recorded the scores with the aid of a flashlight.

4. Statistical Analysis of the Data.

This section outlines the statistical methods used to analyze the data. The services of the Computer Center of the University of Ottawa were utilized for all computations and analyses.

In testing the reliability of the major measures, the RFT and the WAIS analytic ability and G variables, the following statistical techniques were employed. Odd-even coefficients were computed to estimate the internal consistency of RFT performance. Though the N of 20 for females was very small for a reliability measure, separate coefficients were obtained for male and females for comparison with prior research. To the obtained coefficients the Spearman-Brown formula (Garrett, 1958) was applied in order to estimate the reliability of the total test. For the AA and NAA reliability measures, for which no known counterpart in prior research seems to exist, test-retest reliability was obtained on a sample of 16 subjects. For this same sample Full Scale IQ test-retest reliability was also computed to provide a measure directly comparable to prior research, though Full Scale IQ was not directly used in the study. The retest sample also provided a test-retest coefficient for the Impairment Index. The test-retest reliability sample, though small for reliability measures, was random in comprising all subjects for whom retest data were available. Retesting took place from three months to one year following original testing.

The tests of the major and supplementary hypotheses were carried out by means of multiple regression procedures. For the variables used in the present study assumptions for the use of multiple regression appear to be satisfied, for research purposes, with respect to linearity. All variables except for age and sex are ability variables which it seems reasonable to assume are related to one another in a linear fashion (Ferguson, 1959; Garrett, 1958). Dummy, dichotomous coding of the sex variable allowed its use in combination with the other, continuous variables (Kerlinger, 1973; Cohen, 1968). As to age, which is known to be curvilinearly related to the RFT--criterion in this study--the age range in the present sample (15 - 60) starts at a level which eliminates one end of the curve, restricting the relationship to the rectilinear form.

Assumptions for normality and variance homogeneity for the dependent variable in this study are not adequately met, since the dependent variable is significantly skewed. According to McNemar (1969), "there are no general rules to follow in the case of variables using skewed distributions" (p. 214). Transformations are sometimes advocated when it is reasonable to assume that underlying distributions are normal (Garrett, 1958; Ghiselli, 1964; McNemar, 1969). However, the latter does not appear to be a reasonable assumption to make for the RFT, since there is reason to believe that its distribution in the normal population is, in fact, skewed. Witkin et al. (1954) reported skewed distributions for both male and female subjects in their early normative studies on normal adults and children. Along with the latter considerations, McNemar's (1969) warning that transformations are likely to change the form of regression from linear to curvilinear, or vice versa, suggested the possibility that, in using a transformation, one might exchange one problem for another rather than resolve the presenting difficulty in an uncomplicated way.

Some authors, in discussing the problem, suggest that concern for the effects of assumption violations need not preclude use of a skewed distribution of scores.

Ghiselli (1969) has stated that "in most instances" (p. 150) Pearson *r*s based on transformed scores compared with Pearson *r*s based on their untransformed counterparts will ordinarily be higher, but not more than about .02 to .05. Kerlinger and Pedhazur (1973) concluded that one can ordinarily go ahead with multiple regression without too much concern for assumptions, advising further that if assumptions do appear to be violated to treat the results with more caution than usual. Cohen's informative article (1968), which discusses the use of multiple regression as a general data analytic system for experimental and observational data, presents similar conclusions. In the light of a review (Cohen, 1965) of research on the problem, Cohen (1968) states, "As for the normality and variance homogeneity assumptions for Y, the robustness of the *F* test under conditions of such assumption failure is well attested to" (p. 436). With all the foregoing considerations in mind it appeared rather more appropriate for the present research purposes to use the skewed distribution of RFT scores than to transform them. In Cohen's (1968) view, a more serious problem lies in the size of sample used in regression studies. This is a relevant problem for the present study and will be discussed in greater detail further on in this section.

All multiple *R*s were computed using the Statistical Package for the Social Sciences (SPSS) multiple regression program available at the University of Ottawa Computing Center. *F* ratios were used to evaluate the significance of all multiple *R*s as well as to evaluate the significance of the decrement in multiple *R* relevant to the various null hypotheses. Significance of the various *F* ratios was determined by reference to the *F* table found in McNemar (1969).

For testing the significance of each multiple *R* the following formula was used (McNemar, 1969, p. 320):

$$F = \frac{R^2/m}{(1-R^2)/(N-m-1)} \quad \text{with} \quad \begin{matrix} df_1 = m \\ df_2 = (N-m-1) \end{matrix}$$

in which

R^2 = the multiple *R* squared

m = number of independent variables in the regression

N = total number of subjects

df_1 = degrees of freedom for numerator

df_2 = degrees of freedom for denominator.

F ratios for testing the significance of the decrement in multiple *R* in testing the various null hypotheses were derived from the following formula (McNemar, 1969, p. 321):

$$F = \frac{(R_1^2 - R_2^2)/(m_1 - m_2)}{(1 - R_1^2)/(N - m_1 - 1)} \text{ with } \begin{array}{l} df_1 = (m_1 - m_2) \\ df_2 = (N - m_1 - 1) \end{array}$$

in which

R_1^2 = multiple R^2 for regression with greater number of variables

R_2^2 = multiple R^2 with omission of selected variable(s) from R_1

m_1 = number of independent variables in regression for R_1

m_2 = number of independent variables in regression for R_2

N = total number of subjects

df_1 = degrees of freedom for numerator

df_2 = degrees of freedom for denominator.

In general, any increment (or decrement) in multiple *R* due to the addition (or omission) of a subset of variables in a given regression can be tested for the significance of the gain (or loss) by the above *F* formula (Cohen, 1968). As pointed out by McNemar (1969), this *F* ratio has special meaning when all but one of the m_1 variables in the regression on which R_1 is based are included in the regression on which R_2 is based. This in effect is the omission of one variable, and the *F* then is evaluating the significance of the given variable's omission (or inclusion) in the regression. In this case the *F* is really a test of the beta, or standardized partial regression coefficient for the relevant variable (McNemar, 1969, p. 321). One important aspect of this measure lies in the fact that *F* so evaluated is reflecting the significance of the given variable's contribution to the full regression which is over and above what is already provided by the other variables, including that contribution shared with the variable being assessed. Thus, with a given set of variables one may assess the contribution to criterion variance reduction or explanation which each independent variable makes above and beyond, or independently of, whatever joint contributions are present. The importance of this for the present study may be seen as it is recalled that confounding of the contributions of the major variables--analytic ability and general intelligence, or G, in their relationship to extent of differentiation--was the basis of the present research problem.

Specifically, then, in testing the major hypotheses of this study a three-variable multiple regression with the RFT as dependent or criterion variable was computed. AA and NAA, as defined earlier, served as independent variables and the effect of their separate omission from the multiple regression--testing null hypotheses 1 and 2--were assessed by the F tests described above. Similarly, supplementary hypotheses 3 and 4, relating to the role of organic impairment in the study, were tested by assessing the significance of the F ratio obtained with the omission of the Impairment Index from, respectively, (a) a multiple regression of the RFT on the Impairment Index and NAA, and (b) a multiple regression of the RFT on the Impairment Index and AA. Supplementary hypotheses 5 and 6, relating to the role of age and sex, respectively, were tested by assessing the significance of the F ratio obtained with the separate omission of each from a multiple regression of the RFT on a measure of intelligence (either AA or NAA), the Impairment Index, age, and sex.

As noted earlier in this section, the total number of subjects (N=82) in the present study is smaller than desirable for a multiple regression study. It was felt that cross-validation procedures might be of value in compensating to some extent the limitations which the size of N may present. To this end, cross-validation procedures were carried out for all multiple Rs obtained.

For cross-validation, a double cross-validation procedure as described by Guilford (1954) was used. By use of a table of random numbers the total sample was divided into randomly selected halves of 41 (31 males, 10 females) subjects each. All multiple regressions computed for the total group were computed for each subgroup, A and B, and the resulting multiple Rs for each subgroup were cross-validated on the other. In this procedure the B weights and constant from a given regression for subgroup A were applied to the corresponding scores for subgroup B, and vice versa, using the formula $X_1^1 = B_2X_2 + B_3X_3 \ldots B_nX_n + A$ (McNemar, 1969). Since raw scores were being used, regular regression coefficients, or B weights, rather than standardized regression coefficients, or beta weights, were used. Criterion scores predicted for each subgroup via these regressions were then correlated to the actual criterion scores for the relevant subgroup, providing the desired cross-validated *R*s for each regression. The latter were then transformed to *z* scores so that, for each regression, differences between subgroup cross-validated Rs could be tested by use of the formula (McNemar, 1969) for the standard error of the difference between two *z*s. Similar *z* difference tests were performed for the subgroup validation *R*s for each regression.

As may be seen the subgroup regressions also provided a form of replication (versus cross-validation) data for comparison with total group results, though this comparison must be mainly observational in nature. As pointed out by Zedeck (1971), there appears to be no established formula for directly comparing the validity coefficients of a subgroup with the validity coefficient of the total group of which it is a part. However, Dayhaw, in personal communication to McInnis (1974), suggested as a tentative measure a formula analogous with formulas dealing with part-whole differences of means or proportions (McInnis, 1974, p. 59):

$$\sigma_{R_s} = \frac{1 - R_t^2}{\sqrt{Ns - 1}} \sqrt{\frac{N_t - N_s}{N_t - 1}}$$

in which

R_t = multiple *R* for the total group

N_t = number in the total group

N_s = number in the subgroup.

While, as noted above, the latter is not an established standard error of difference formula, it was used to compare, in tentative fashion, all multiple *R*s obtained in testing the null hypotheses in the total group with (1) the corresponding subgroup multiple *R*s and (2) subgroup cross-validated *R*s.

To facilitate interpretation, scores for the RFT and the Impairment Index were reflected so that higher scores represented better performance on all the measures used in the study. In keeping with this consistency, sex was scored as 1 and 0 for males and females, respectively, recognizing the better performance generally found for males with respect to the criterion.

For all statistical analyses, a level of $p < .05$ was required for significance.

5. Additional Analysis of the Data.

While the focus of the present study was on the analytic ability measure as a *composite*, as operationally defined by Witkin, it was felt to be of theoretical interest and importance to examine the composite itself with regard to the role of its component members in the measure. To this end, the three WAIS subtests comprising the analytic ability measure (Block Design, Object Assembly, and Picture Completion) were entered as independent variables in a four-variable multiple regression with the RFT as criterion. The same procedure employed in testing the null hypotheses was employed in this phase of the study, i.e., the significance of the omission of each subtest from each regression (total and subgroups) was evaluated by means of the appropriate F ratio. Subgroup multiple Rs obtained in this regression were cross-validated as in prior regressions, and the difference between the z transformations of the cross-validated Rs was tested for significance.

CHAPTER III

PRESENTATION AND DISCUSSION OF RESULTS

The results of the research as described in the last chapter are presented and discussed in the present chapter. The initial section reports on the reliability of the measures used in the study. In the second section the results of the multiple regressions testing the main null hypotheses are presented, followed by a third section setting forth results for the supplementary hypotheses. Results of additional data analysis are presented in a fourth section. A fifth section presenting a discussion of the results concludes this chapter.

1. Reliability of the Measures.

Reliability estimates for internal consistency of the RFT were obtained separately for the total male sample (N=62) and for the 20 female subjects. Odd-even coefficients of .96 ($\underline{p} < .001$) for the male sample and .94 ($\underline{p} < .001$) for the female sample were obtained. Application of the Spearman-Brown correction formula (Garrett, 1958) to obtain a reliability estimate of the total test increased these coefficients to .98 and .97, respectively. Though the size of N for the female sample is obviously small for a reliability measure and must be considered with caution, the obtained coefficients compare favorably to those summarized by Witkin et al. (1954) and to those reported for the standardization groups (Witkin et al., 1962). In the latter summary, corrected odd-even coefficients ranged from .89 to .92. Similar values have been reported by Hellkamp (1967) and Yamada (1968), who obtained corrected odd-even coefficients of .92 and .90, respectively. Present values thus seem suitable for research purposes.

For the WAIS Full Scale IQ a test-retest reliability coefficient of .93 ($p < .01$) was obtained. While the small size of the retest sample (N = 16) points to the need for caution in interpreting all the present retest reliability coefficients, the results for the Full Scale IQ suggest a high degree of reliability for this measure, especially in view of the functional changes which might be expected to occur in re-examination of brain-damaged subjects. For the measures of analytic ability (AA) and G (NAA) test-retest reliability coefficients of .82 ($p < .01$) and .95 ($p < .01$), respectively, were obtained. Though no previous reliability data for these measures were obtained for comparisons, the size of coefficients in this type of sample would seem to indicate adequate reliability for these measures for the purposes of this research.

For the Impairment Index a repeated testing reliability coefficient of .79 ($p < .01$) was obtained. As with the AA and NAA measures, no available data were found for the measure of organicity for comparison with present results. However, the size of the coefficient would seem to suggest fair reliability for this measure, especially in view of the nature of the sample, as noted above. Thus within whatever limitations are imposed by sample size, as noted earlier, the reliability of the measures used in this study would appear to be adequate for the purposes of the present research.

2. Results for the Main Hypotheses.

Pearson intercorrelation matrices computed for the total and subgroup cross-validation samples are presented in Tables 3 and 4, respectively. The matrices, though not used for preselection of variables, comprise all variables used in the various regression analyses plus the Full Scale Intelligence Quotient which, while not required in any of the regressions is of important relevance to the present research question, especially as the former relates to the NAA measure as used in the present study. The correlation of .96 between the two measures in the total sample, and the similarly high correlations for them found in subgroup A (.96) and subgroup B (.96), would appear to support the rationale and justification for use of NAA as an approximate

Table 3

Means, Standard Deviations, and Pearson Intercorrelation Matrix for the Dependent Variable, All Independent Variables, and Full Scale Intelligence Quotient for the Total Sample (N=82)[a]

Variable	RFT	AA	NAA	IMPI	Age	Sex	FSIQ
Rod-and-Frame Test	-						
Analytic Ability	.65***	-					
Non-analytic Ability	.26**	.57***	-				
Impairment Index	.57***	.69***	.50***	-			
Age	-.34***	-.24*	.25*	-.44***	-		
Sex	.30**	.24*	-.13	.09	-.11	-	
Full Scale IQ	.33***	.68***	.96***	.52***	.26**	.08	-
Mean	17.85[b]	26.96	76.13	5.05[b]	29.92	.76	99.01
SD	11.87	6.95	17.11	2.53	14.45	.43	13.55

[a]In this and all following tables: (1) Some scores have been reflected so that higher scores *always* indicate better performance. (2) Values in multiple *R* columns indicate simple *r*s when omission of variable(s) reduce(s) regression to bivariate form.

[b]Before reflection.

$*p < .05$

$**p < .01$

$***p < .001$

Table 4

Means, Standard Deviations, and Pearson Intercorrelation Matrices for the Dependent Variable, All Independent Variables, and Full Scale Intelligence Quotient for Cross-Validation Subgroups A (N=41) and B (N=41)

Variable	RFT	AA	NAA	IMPI	Age	Sex	FSIQ
Subgroup A							
Rod-and-Frame Test	-						
Analytic Ability	.72***	-					
Non-analytic Ability	.14	.50***	-				
Impairment Index	.51***	.72***	.44**	-			
Age	-.34*	-.33*	.31*	-.46***	-		
Sex	.48***	.40**	.06	.25	-.03	-	
Full Scale IQ	.26*	.64***	.96***	.49***	.24	.13	-
Mean	17.22[a]	27.12	76.39	4.76[a]	28.34	.76	99.07
SD	12.34	7.56	17.65	2.40	14.42	.43	13.67
Subgroup B							
Rod-and-Frame Test	-						
Analytic Ability	.55***	-					
Non-analytic Ability	.40**	.65***	-				
Impairment Index	.63***	.68***	.56***	-			
Age	-.34*	-.14	.20	-.41**	-		
Sex	.10	.06	-.33*	-.05	-.19	-	
Full Scale IQ	.40*	.73***	.96***	.55***	.29*	-.29*	-
Mean	18.47[a]	26.80	75.88	5.32[a]	31.51	.76	98.95
SD	11.50	6.36	16.78	2.65	14.47	.44	13.60

[a]Before reflection.
*$p < .05$
**$p < .01$
***$p < .001$

measure of G, which the FSIQ has traditionally been held to reflect.

Means (*M*s) and standard deviations (*SD*s) of the different variables across groups appear to be quite similar, and the cross-validation subgroups seem roughly equivalent. Subgroup B is somewhat older and somewhat more field dependent than subgroup A but not significantly so in either case (t = 1.00 and .89, respectively). Comparison of the three matrices, however, shows differences for the two subgroups compared with one another and with the total group. For example, in subgroup A the Pearson r between AA and the RFT (.72) is considerably higher than that for subgroup B (.55) and is noticeably higher than that for the total sample (.65). Again, the Pearson correlation between NAA and the RFT in subgroup A is nonsignificant as contrasted with the significant correlation between the two variables in subgroup B (.40), which in turn is higher than the significant correlation of .26 found for these variables in the total sample. The opportunity is thus presented to check the various hypotheses in samples from the same population which, nevertheless, present fairly wide and obvious sampling fluctuations in the intercorrelations among the research variables of interest.

As expected, *M*s (range = 17.22-18.47) and *SD*s (range = 11.50-12.34) for the RFT for these mixed (male and female) brain-damaged samples are decidedly poorer than the values for normal adult males (*M* = 7.40; *SD* = 5.50) and females (*M* = 11.00; *SD* = 7.00) reported in Witkin et al. (1954) normative studies. Present values are, however, very similar to the mean of 17.58 and *SD* of 10.48 obtained for Goldstein et al.'s (1970) male brain-damaged sample. They are similar also, though rather less so, to the combined *M* of 15.46 and combined *SD* of 13.82 computed for data in Trites' (1969) male and female samples. (Table 5 presents a summary of these comparisons including separate sex results for the present sample.)

Using Wechsler's (1955) norms for the WAIS, the average score to be expected on the AA and NAA measures as constituted would be 30 and 80, respectively (scaled score of 10, times the number of subtests in the variable). The range of means for AA (26.80-27.12) and for NAA (75.88-76.39) in the present samples are thus seen to be roughly average or slightly lower and are consistent with the 98.95-99.07 range of Full Scale IQs reported for the three groups. As noted above, of significant importance in the tables are the very high correlations between Full Scale IQ and NAA, supporting the use of the latter as a measure of G. Level of organic impairment, as measured by the Impairment Index, is very

Table 5

Comparison of Means and Standard Deviations of RFT Scores in Selected Studies of Normal and Brain-Damaged Subjects

Study	Males			Females			Total		
	N	M	SD	N	M	SD	N	M	SD
Normal									
Witkin et al. (1954)	136	7.40	5.50	258	11.00	7.00	394	9.76[a]	6.64[a]
Brain-damaged									
Goldstein et al. (1970)	20	17.58	10.48	-	-	-	-	-	-
Trites (1969)	30	10.87	12.51	30	20.06	14.71	60	15.46[a]	13.82[a]
Present study	62	15.85	10.91	20	24.31	12.35	82	17.85	11.87

[a]Computed for this table from separate sex results.

similar for the three samples as evident in the narrow range (4.76 - 5.32) for the means, which reflect an average score of mild cerebral dysfunction for each group as determined by this index. The identical Ms and SDs on the sex variables across the groups are reflecting the three to one male-female ratio of the total sample, paralleled across groups by means of stratified random selection in the subgroups.

Table 6 presents selected statistical results of the multiple regression of the RFT on AA and NAA testing the main hypotheses of the study. The table presents the results in terms of multiple R, R^2, regular (B) and standardized (beta) partial regression coefficients, standard error of B, and the F ratio for the multiple R obtained. The obtained multiple R of .66 is significant as shown by the F ratio value of 30.01 ($p < .001$). This is consistent with the findings of prior research in which a significant relationship between extent of differentiation on the RFT and measures of intelligence, including the WAIS used here, has been quite consistently found. Results are consistent as well with the basic premise on which the present study is based.

The beta coefficient for Analytic Ability (.73) is of clearly greater magnitude than the beta weight for Non-Analytic Ability, which receives a slight negative weight

Table 6

Summary Table of Selected Statistics for Multiple Regression of RFT Scores on Analytic Ability (AA) and Non-Analytic Ability (NAA) Scores (N=82)

Independent Variable	B	SE_B	Beta	R	R^2	F_R	df
AA	1.25	0.18	0.73	.66	.43	30.01***	2/79
NAA	-0.10	0.07	-0.15				

***$p < .001$

(-.15). The beta values obtained indicate that, relatively speaking, AA is of greater importance to RFT performance than NAA in the present multiple regression. While the negative weight for NAA, which correlates low positive (.27) with the RFT, alerts one to the possibility of a "suppressant" effect for NAA in the present regression, the large standard error of the *B* coefficient for this variable also suggests a large error variance, or chance effect, in the weighting for the variable in this regression (Nie, Bent & Hull, 1970).

Table 7 presents the results of the above regression in terms of the null hypotheses testing the effect on multiple *R* of separate omission of the independent variables from the regression. As indicated by the *F* ratio of 50.41, the omission of AA from the multiple regression results in a highly significant ($p < .001$) drop in multiple *R*, while the omission of NAA does not affect the multiple *R* to any statistically significant degree ($F = 2.16$). As indicated in the "Loss in R^2" column, with the omission of AA there is a 36% decrease in the amount of RFT variance which can be accounted for when both variables are included in the regression, while the omission of NAA reduces the latter by only 1%. As indicated by the multiple R^2, the WAIS, as constituted by the two independent variables, can account for 43%, or roughly half, of the RFT variance in the present sample.

Table 7

Loss in Multiple R Due to Separate Omission of Independent Variables from Multiple Regression of RFT on Analytic Ability (AA) and Non-Analytic Ability (NAA) for Total Sample (N=82)

Independent Variable	R	R^2	Loss in R^2	$F_{R_{Loss}}$	df	p
AA + NAA	.66***	.43	-	-	-	-
Omitting						
AA	.26**	.07	.36	50.41	1/79	.001
NAA	.65***	.42	.01	2.16	1/79	n.s.

**$p < .01$
***$p < .001$

From the results of Table 7 it may be seen that the null hypothesis proposing a nonsignificant independent contribution to the proposed multiple regression must be rejected for the analytic ability variable. The corresponding null hypothesis for the G variable--NAA--cannot be rejected.

Tables 8 and 9 present the results of the replications of the above multiple regression procedures in the cross-validation subgroups. In Table 8 it may be seen that while the magnitude of multiple $\underline{R}$ for subgroup A (.76) is conspicuously higher numerically than that for subgroup B (.56), both multiple $\underline{R}$s are significantly different from zero, as indicated by their respective $\underline{F}$ ratios. In each regression, beta coefficients for AA are clearly larger than those for NAA. The latter, as in the total group, receives a negative weight in subgroup A, but a small positive weight in subgroup B. The change in sign of weight for NAA from one sample to the other is consistent with the large chance effects for this variable, suggested in the large standard error of the $\underline{B}$ coefficient relative to its size (Nie et al., 1970), as found in both subgroups and in the total sample. Results in the cross-validation subgroups are similar to those in the total group in indicating via beta coefficients the relatively more important role of AA than NAA in the regression.

Table 8

Summary Table of Selected Statistics for Multiple Regression of RFT Scores on Analytic Ability (AA) and Non-Analytic Ability (NAA) Scores for Subgroups A (N=41) and B (N=41)

Independent Variable	B	SE_B	Beta	R	R^2	F_R	df
Subgroup A							
AA	1.41	.20	.86	.76	.58	26.07***	2/38
NAA	-0.20	.09	-.29				
Subgroup B							
AA	0.92	.32	.51	.56	.31	8.52**	2/38
NAA	0.05	.12	.07				

**$p < .01$
***$p < .001$

Table 9

Loss in Multiple *R* Due to Separate Omission of Independent Variables from Multiple Regression of RFT on Analytic Ability (AA) and Non-Analytic Ability (NAA) for Subgroup A (N=41) and Subgroup B (N=41)

Independent Variable	*R*	R^2	Loss in R^2	$F_{R_{Loss}}$	*df*	*p*
Subgroup A						
AA + NAA	.76***	.58	-	-	-	-
Omitting						
AA	.14	.02	.56	50.35	1/38	.001
NAA	.72***	.52	.06	5.70	1/38	.05
Subgroup B						
AA + NAA	.56**	.31	-	-	-	-
Omitting						
AA	.40**	.16	.15	8.23	1/38	.01
NAA	.55***	.31	.00	0.14	1/38	n.s.

**$p < .01$
***$p < .001$

Table 9 presents the results of separate omission of the independent variables from the subgroup regresssions. Results in both subgroups are similar to results in the total group in showing a significant drop in multiple *R* when AA is omitted from the regression. The omission of NAA also results in a significant loss in multiple *R* in the regression for subgroup A, but there is no significant reduction in multiple *R* with the omission of this variable in the regression of subgroup B. In the regression for each subgroup the loss in amount of RFT variance which can be accounted for in the full regression is conspicuously (at least four times) greater with the omission of AA than for NAA.

Table 10 presents the results of a comparison of the subgroup multiple *R*s. Results show no significant difference between the two values. A comparison of the subgroup multiple *R*s against the multiple *R* for the total group is presented in Table 11. Both subgroup values differed from the multiple *R* for the total group to a significant degree ($p < .01$, subgroup A; $p < .05$, subgroup B).

Table 12 presents a comparison of the cross-validation multiple *R*s obtained when the *B* weights and constant obtained in one subgroup were applied to the corresponding scores of the other subgroup and the criterion scores predicted by this weighting were correlated with the

Table 10

Multiple *R*s, *z* Scores, Critical Ratio (*CR*), and Level of Statistical Significance for Comparison of Subgroup Multiple *R*s for Multiple Regression of RFT on Analytic Ability and Non-Analytic Ability

Group	N	*R*	*z*	*CR*	*p*
Subgroup A	41	.76	.996		
				1.59	n.s.
Subgroup B	41	.56	.633		

Table 11

Multiple *R*s, *z* Scores, Diff/σ_{R_s}, and Levels of Statistical Significance for Comparison of Subgroup Multiple *R*s with Multiple *R* for Total Group for Multiple Regression of RFT on Analytic Ability and Non-Analytic Ability

Group	N	*R*	*z*	Diff/σ_{R_s}	*p*
Total	82	.66	.793		
Subgroup A	41	.76	.996	3.18	.01
Subgroup B	41	.56	.633	2.50	.05

Table 12

Multiple Rs, z Scores, Critical Ratio (CR), and Level of Statistical Significance for Comparison of Cross-Validated Multiple Rs for Multiple Regression of RFT on Analytic Ability and Non-Analytic Ability

Group	N	R	z	CR	p
Cross-validation B to A	41	.69***	.848		
				1.31	n.s.
Cross-validation A to B	41	.50***	.549		

***$p < .001$

actual criterion scores of the relevant sample. Both cross-validation *R*s were significantly different from zero and there was no significant difference between the two values. When the latter measures were compared with the total group multiple *R* a significant difference was found with respect to subgroup B results, though not for the comparison with results for subgroup A. Total *R* comparisons with subgroup cross-validation *R*s are presented in Table 13.

3. Results for the Supplementary Hypotheses.

Results of the multiple regression procedures testing a hypothesized role for an intact-deterioration dimension of psychological functioning in relation to extent of differentiation are presented in Tables 14 and 15. Table 14 reports on the multiple regression of the RFT on NAA and the Impairment Index in terms of loss in multiple *R* resulting from the separate omission of the independent variables from the regression. Results showed no significant loss in multiple *R* with the omission of Non-Analytic Ability (F = .09), but the omission of the Impairment Index reduced the multiple *R* by a statistically significant amount (F = 30.78, $p < .001$). With no significant or noticeable contribution by NAA, the significant multiple *R* of .57 ($p < .001$) indicates a fairly

Table 13

Multiple $\underline{R}$s, $\underline{z}$ Scores, Diff/σ_{R_s}, and Levels of Statistical Significance for Comparison of Cross-Validated Multiple $\underline{R}$s with Multiple $\underline{R}$ for Total Group for Multiple Regression of RFT on Analytic Ability and Non-Analytic Ability

Group	N	$\underline{R}$	$\underline{z}$	Diff/σ_{R_s}	$\underline{p}$
Total	82	.66	.793		
Cross-validation B to A	41	.69	.848	.86	n.s.
Cross-validation A to B	41	.50	.549	3.82	.001

Table 14

Loss in Multiple R Due to Separate Omission of Independent Variables from Multiple Regression of RFT on Non-Analytic Ability (NAA) and Impairment Index (IMPI) for Total Group (N=82)

Independent Variable	R	R^2	Loss in R^2	$F_{R_{Loss}}$	df	p
NAA + IMPI	.57***	.33	-	-	-	-
Omitting						
NAA	.57***	.33	.00	.09	1/79	n.s.
IMPI	.26**	.07	.26	30.78	1/79	.001

$^{**}p < .01$
$^{***}p < .001$

Table 15

Loss in Multiple R Due to Separate Omission of Independent Variables from Multiple Regression of RFT on Analytic Ability (AA) and Impairment Index (IMPI) for Total Group (N=82)

Independent Variable	R	R^2	Loss in R^2	$F_{R_{Loss}}$	df	p
AA + IMPI	.67***	.45	-	-	-	-
Omitting						
AA	.57***	.33	.12	16.93	1/79	.001
IMPI	.65***	.42	.03	4.50	1/79	.05

***$p < .001$

strong relationship between the Impairment Index and the RFT. This is consistent with the mean field dependent functioning in brain-damaged groups generally found in earlier research. The null hypothesis for the role of the Impairment Index in this regression must be rejected.

Table 15 presents the results of the multiple regression of the RFT on AA and the Impairment Index in similar terms as in the previous table. The obtained multiple R of .67 is statistically significant. The significant F ratios resulting from the separate omission of each variable from the regression indicate that both variables contribute significantly to the multiple regression independently of their joint contribution. The relative sizes of these values indicate that AA is more important to RFT performance than the Impairment Index in the present regression, contributing a greater independent share to RFT variance explanation. The latter may be more clearly seen in the "Loss in R^2" column which shows that the omission of AA results in a 12% drop in the amount of RFT variance which can be accounted for with both variables in regression, while the corresponding drop with the omission of the Impairment Index is only 3%. However, the significance of the latter requires rejection of the null hypothesis with respect to the Impairment Index in this regression.

Tables 16 and 17 present replications of the above multiple regressions in the two cross-validation subgroups, A and B. As may be seen in Table 16, the omission of NAA made no significant difference in the multiple regression for either subgroup, as shown by the appropriate F ratios, while in both subgroups the omission of the Impairment Index resulted in a significant drop in multiple R. In terms of RFT variance which the full regression can account for, the omission of NAA results in almost no change in either subgroup. By contrast, the omission of the Impairment Index decreases the amount of explained variance by 25% and 24% in subgroups A and B, respectively.

As indicated in Table 17, when compared to the analytic ability variable, the Impairment Index shows no significant contribution to the multiple regression of the RFT in subgroup A. In subgroup B, however, the relative importance of the two variables is reversed, with the Impairment Index playing a significant and more important role (F = 8.13) and AA making a lesser and nonsignificant (F = 1.90) contribution to the full regression.

Subgroup multiple Rs did not differ beyond sampling fluctuation for either regression, i.e., with either AA or NAA entered as independent variable with the Impairment Index. Similar comparisons of subgroup and total values

Table 16

Loss in Multiple R Due to Separate Omission of Independent Variables from Multiple Regression of RFT on Non-Analytic Ability (NAA) and Impairment Index (IMPI) for Subgroup A (N=41) and Subgroup B (N=41)

Independent Variable	R	R^2	Loss in R^2	$F_{R_{Loss}}$	df	p
Subgroup A						
NAA + IMPI	.52**	.27	-	-	-	-
Omitting						
NAA	.51***	.26	.01	.48	1/38	n.s.
IMPI	.14	.02	.25	13.27	1/38	.001
Subgroup B						
NAA + IMPI	.64***	.40	-	-	-	-
Omitting						
NAA	.63***	.40	.00	.19	1/38	n.s.
IMPI	.40**	.16	.24	24.46	1/38	.001

**$p < .01$
***$p < .001$

Table 17

Loss in Multiple R Due to Separate Omission of Independent Variables from Multiple Regression of RFT on Analytic Ability (AA) and Impairment Index (IMPI) for Subgroup A (N=41) and Subgroup B (N=41)

Independent Variable	R	R^2	Loss in R^2	$F_{R_{Loss}}$	df	p
Subgroup A						
AA + IMPI	.72***	.52	-	-	-	-
Omitting						
AA	.51***	.26	.26	19.66	1/38	.001
IMPI	.72***	.52	.00	.00	1/38	n.s.
Subgroup B						
AA + IMPI	.66***	.43	-	-	-	-
Omitting						
AA	.63***	.40	.03	1.90	1/38	n.s.
IMPI	.55***	.30	.13	8.13	1/38	.01

***$p < .001$

showed no significant differences with respect to either subgroup for either regression. When comparisons were made with respect to cross-validated multiple Rs calculated using regression weights and constants obtained in the regressions for one subgroup on the corresponding scores of the other subgroup, no significant differences were found for the results for either regression. Total values did not differ from cross-validated Rs for either regression for subgroup A, nor from the cross-validated value for subgroup B with respect to the regression with NAA. There was, however, a significant difference found between the multiple R for the total group and the cross-validated R for subgroup B with respect to the regression with AA. Results of the various multiple R comparisons are presented in Tables 18, 19, 20, and 21.

Table 22 presents the results of assessment of the role of age and sex in the present study. In Table 22 it may be seen that, independently of each other and of level of analytic ability and degree of organic impairment, neither age nor sex contributes significantly to the multiple regression of the four variables on the RFT. The hypothesis of no significant contribution to multiple R for age and sex cannot be rejected. The four variables taken together can account for almost half the variation in RFT scores in the present sample.

Table 18

Multiple *R*s, *z* Scores, Critical Ratios (*CR*), and Levels of Statistical Significance for Comparison of Subgroup Multiple *R*s for Multiple Regressions of RFT on Impairment Index (IMPI) and Intelligence Variables (NAA; AA)

Independent Variables in Regression	Group	N	*R*	*z*	*CR*	*p*
NAA + IMPI	Subgroup A	41	.52	.577	.78	n.s.
	Subgroup B	41	.64	.758		
AA + IMPI	Subgroup A	-	.72	.908	.52	n.s.
	Subgroup B	-	.66	.793		

Table 19

Multiple Rs, z Scores, Diff/σ_{R_s}, and Levels of Statistical Significance for Comparison of Subgroup Multiple Rs with Multiple Rs for Total Group for Multiple Regressions of RFT on Impairment Index (IMPI) and Intelligence Variables (NAA; AA)

Independent Variables in Regression	Group	N	R	z	Diff/σ_{R_s}	p
	Total	82	.57	.648		
NAA + IMPI	Subgroup A	41	.52	.577	.98	n.s.
	Subgroup B	41	.64	.758	1.27	n.s.
	Total	-	.67	.811		
AA + IMPI	Subgroup A	-	.72	.908	1.51	n.s.
	Subgroup B	-	.66	.793	.40	n.s.

Table 20

Multiple *R*s, *z* Scores, Critical Ratios (*CR*), and Levels of Statistical Significance for Comparison of Cross-Validated Multiple *R*s for Multiple Regressions of RFT on Impairment Index (IMPI) and Intelligence Variables (NAA; AA)

Independent Variables in Regression	Group	N	*R*	*z*	*CR*	*p*
NAA+IMPI	Cross-validation B to A	41	.50***	.549	.84	n.s.
	Cross-validation A to B	41	.63***	.741		
AA+IMPI	Cross-validation B to A	-	.64***	.758	.61	n.s.
	Cross-validation A to B	-	.55***	.618		

***$p < .001$

Table 21

Multiple *R*s, *z* Scores, Diff/σ_{R_s}, and Levels of Statistical Significance for Comparison of Cross-Validated Multiple *R*s with Multiple *R* for Total Group for Multiple Regressions of RFT on Impairment Index (IMPI) and Intelligence Variables (NAA; AA)

Independent Variables in Regression	Group	N	*R*	*z*	Diff/σ_{R_s}	*p*
NAA + IMPI	Total	82	.57	.648		
	Cross-validation B to A	41	.50	.549	1.55	n.s.
	Cross-validation A to B	41	.63	.741	1.45	n.s.
AA + IMPI	Total	-	.67	.811		
	Cross-validation B to A	-	.64	.758	.83	n.s.
	Cross-validation A to B	-	.55	.618	3.02	.01

Table 22

Loss in Multiple R Due to Separate Omission of Independent Variables from Multiple Regression of RFT on Analytic Ability (AA), Impairment Index (IMPI), Age, and Sex for Total Group (N=82)

Independent Variable	R	R^2	Loss in R^2	$F_{R_{Loss}}$	df	p
AA+IMPI+Age+Sex	.70***	.49	-	-	-	-
Omitting						
Analytic Ability	.63***	.40	.09	13.90	1/77	.001
Impairment Index	.69***	.47	.02	2.60	1/77	n.s.
Age	.69***	.47	.02	2.05	1/77	n.s.
Sex	.68***	.46	.03	3.46	1/77	n.s.

***$p < .001$

Replications of the above assessment in the subgroups, presented in Table 23, show some dissimilarities from results in the total group. In subgroup A the effects of the sex variable reach the level of statistical significance ($F = 4.34$, $p < .05$). In subgroup B, consistent with earlier results, the roles of AA and the Impairment Index are reversed, but the nonsignificant results for age and sex are replicated as in the total sample.

Comparisons of subgroup validation and cross-validation multiple *R*s, and of those *R*s with total multiple *R*, are presented in Tables 24, 25, 26, and 27. Comparison of subgroup multiple *R*s showed that the two values did not differ by more than sampling fluctuation (*CR* = .79). Comparison of total versus subgroup multiple *R*s showed a significant difference between total and subgroup A results, but only chance differences between total and subgroup B results. When the subgroup cross-validation *R*s were compared, the *CR* of .41 obtained indicated that the two values did not differ significantly. When the latter were compared with total multiple *R*, a significant difference was found only between the total multiple *R* and the cross-validation *R* for subgroup B.

Table 23

Loss in Multiple R Due to Separate Omission of Independent Variables from Multiple Regression of RFT on Analytic Ability (AA), Impairment Index (IMPI), Age, and Sex for Subgroup A (N=41) and Subgroup B (N=41)

Independent Variable	R	R^2	Loss in R^2	$F_{R_{Loss}}$	df	p
Subgroup A						
AA+IMPI+Age+Sex	.76***	.58	-	-	-	-
Omitting						
Analytic Ability	.65***	.42	.16	13.73	1/36	.001
Impairment Index	.76***	.58	.00	.11	1/36	n.s.
Age	.75***	.56	.02	1.59	1/36	n.s.
Sex	.73***	.53	.05	4.34	1/36	.05
Subgroup B						
AA+IMPI+Age+Sex	.67***	.45	-	-	-	-
Omitting						
Analytic Ability	.65***	.42	.03	1.94	1/36	n.s.
Impairment Index	.62***	.38	.07	4.78	1/36	.05
Age	.66***	.44	.01	.66	1/36	n.s.
Sex	.67***	.45	.00	.40	1/36	n.s.

***$p < .001$

Table 24

Multiple *R*s, *z* Scores, Critical Ratio (*CR*), and Level of Statistical Significance for Comparison of Subgroup Multiple *R*s for Multiple Regression of RFT on Analytic Ability, Impairment Index, Age, and Sex

Group	N	*R*	*z*	*CR*	*p*
Subgroup A	41	.76	.996		
				.79	n.s.
Subgroup B	41	.67	.811		

Table 25

Multiple *R*s, *z* Scores, Diff/σ_{R_s}, and Levels of Statistical Significance for Comparison of Subgroup Multiple *R*s with Multiple *R* for Total Group for Multiple Regression of RFT on Analytic Ability, Impairment Index, Age, and Sex

Group	N	*R*	*z*	Diff/σ_{R_s}	*p*
Total	82	.70	.867		
Subgroup A	41	.76	.996	2.31	.05
Subgroup B	41	.67	.811	.86	n.s.

Table 26

Multiple *R*s, *z* Scores, Critical Ratio (*CR*), and Level of Statistical Significance for Comparison of Cross-Validated *R*s for Multiple Regression of RFT on Analytic Ability, Impairment Index, Age, and Sex

Group	N	*R*	*z*	*CR*	*p*
Cross-validation B to A	41	.66***	.793		
				.41	n.s.
Cross-validation A to B	41	.61***	.709		

***$p < .001$

Table 27

Multiple *R*s, *z* Scores, Diff/σ_{R_s}, and Levels of Statistical Significance for Comparison of Cross-Validated Multiple *R*s with Multiple *R* for Total Group for Multiple Regression of RFT on Analytic Ability, Impairment Index, Age, and Sex

Group	N	*R*	*z*	Diff/σ_{R_s}	*p*
Total	82	.70	.867		
Cross-validation B to A	41	.66	.793	1.11	n.s.
Cross-validation A to B	41	.61	.709	2.72	.01

4. Additional Analysis of the Data.

To test the individual role of its components in the composite AA measure, the Block Design (BD), Object Assembly (OA), and Picture Completion (PC) subtests of the WAIS were entered as separate independent variables in multiple regressions of the RFT computed for total and subgroup samples. Results of testing the effect on multiple R which occurs with the separate omission of the subtests from the relevant regressions are presented in Table 28 for the total group, and in Tables 29 and 30 for the subgroups. For all three groups BD is clearly the subtest of greatest relative importance, as shown by the relative sizes of the F ratios for the three subtests. In both the total group and in subgroup A, the BD and OA subtests each contribute significantly to RFT variance explanation independently of its association with one another and with the PC subtest. While none of the subtests independently contributes to the regression in subgroup B, the test on the omission of BD (F = 4.00) approaches the $p < .05$ level of significance ($F(1,37) = 4.11$). The PC subtest provides no significant contribution to any of the computed regressions apart from its association with the other two variables. As is evident in the "Loss in R^2" columns, PC independently contributes only a small amount to RFT variance explanation

Table 28

Loss in Multiple R Due to Separate Omission of Independent Variables from Multiple Regression of RFT on Block Design, Object Assembly, and Picture Completion Subtest Scores for Total Group (N=82)

Independent Variable	R	R^2	Loss in R^2	$F_{R_{Loss}}$	df	p
Block Design Object Assembly Picture Completion	.67***	.44	-	-	-	-
Omitting						
Block Design	.58***	.34	.10	14.72	1/78	.001
Object Assembly	.63***	.40	.04	5.90	1/78	.05
Picture Completion	.66***	.44	.00	.17	1/78	n.s.

***$p < .001$

Table 29

Loss in Multiple R Due to Separate Omission of Independent Variables from Multiple Regression of RFT on Block Design, Object Assembly, and Picture Completion Subtest Scores for Subgroup A (N=41)

Independent Variable	R	R^2	Loss in R^2	$F_{R_{Loss}}$	df	p
Block Design Object Assembly Picture Completion	.76***	.58	-	-	-	-
Omitting						
Block Design	.67***	.45	.13	12.01	1/37	.01
Object Assembly	.72***	.52	.06	5.84	1/37	.05
Picture Completion	.76***	.58	.00	.30	1/37	n.s.

***$p < .001$

Table 30

Loss in Multiple R Due to Separate Omission of Independent Variables from Multiple Regression of RFT on Block Design, Object Assembly, and Picture Completion Subtest Scores for Subgroup B (N=41)

Independent Variable	R	R^2	Loss in R^2	$F_{R_{Loss}}$	df	p
Block Design Object Assembly Picture Completion	.56**	.31	-	-	-	-
Omitting						
Block Design	.49**	.24	.07	4.00	1/37	n.s.
Object Assembly	.54**	.30	.02	.97	1/37	n.s.
Picture Completion	.54**	.30	.02	1.00	1/37	n.s.

**$p < .01$

in subgroup B and nothing of even measurable value in the remaining two groups.

Comparison of the subgroup cross-validation Rs, as presented in Table 31, shows no more than chance differences between the two measures and minimal lowering of the latter from the corresponding validation Rs.

5. Discussion.

The results of the statistical analyses reported in the previous sections of this chapter will be discussed in the present section. The major part of the discussion will focus on the results of the total group, touching on the subgroup results only incidentally since their main function in the present research was to provide a check on the reliability of the results for the total group. Before proceeding to the major discussion, however, a brief discussion of the subgroup results and their implications must be presented.

The following results for the random subgroups provided support for confidence in the reliability of the multiple regressions for the total group. (1) In the first three multiple regressions, both subgroups showed the same rank order of beta regression weights for the relevant variables as was found in the corresponding regression for the total group, with one exception (the subgroup B regression

Table 31

Multiple *R*s, *z* Scores, Critical Ratio (*CR*), and Level of Statistical Significance for Comparison of Subgroup Cross-Validated Multiple *R*s for Multiple Regression of RFT on Block Design, Object Assembly, and Picture Completion Subtest Scores

Group	N	*R*	*z*	*CR*	*p*
Cross-validation B to A	41	.73***	.929		
				1.48	n.s.
Cross-validation A to B	41	.53***	.590		

***$p < .001$

with AA, to be discussed below). In the final regression differences in ranking of variables among the three groups were seen, but differences were minor, with the exception, again, of subgroup B results. (2) In no regression did subgroup results, tested by comparison of multiple *R*s, differ by more than sampling fluctuation. (3) No significant differences were found between cross-validation *R*s obtained across subgroups for any regression. (4) Cross-validation *R*s showed relatively small "drops" from the corresponding subgroup multiple *R*, with the largest difference showing a drop of from .66 to .55 in the regression with AA and the Impairment Index in subgroup B. Six of 10 such differences showed "drops" in multiple *R* of .06 or less, indicating that the beta weights obtained in the multiple regressions for either subgroup are quite stable and satisfactory in predicting criterion scores in the other subgroup.

As indicated above, results for subgroup B in the regression with AA and the Impairment Index as independent variables differed conspicuously from results in the total group and in subgroup A. For the same regression, results in subgroup A replicated those of the total sample in showing a major role for AA and a minor role for the Impairment Index, though the latter reached the level of statistical significance ($p < .05$) in the total group results. However, in subgroup B, the Impairment Index carries the weight of the regression, with AA providing no contribution of significance to the regression independently of the Impairment Index. While this, at first glance, might suggest some unreliability in the weighting of the analytic ability variable, closer examination of the data suggests a different interpretation. Guilford (1954) points out that when the correlation between two predictors is high, indicating that they have common factors, the one that correlates with the criterion less, even though the difference is small, is likely to acquire a zero weight when both are permitted to enter a regression equation separately; in another sample if the two validity coefficients were reversed even slightly in order of size, beta weights in the new sample will be similarly reversed. In other words, the predictor with the chance higher validity coefficient sufficiently "accounts for" the factor(s) common to the two predictors with respect to the criterion so that the predictor with the smaller validity coefficient may become superfluous. This appears to be the case with the organic impairment and analytic ability variables in the present study. Inspection of the intercorrelation matrices for the three samples in Tables 3 and 4 reveals quite substantial Pearson correlations between the two variables in each group, ranging from .68 to .72. Also, their validity coefficients are quite similar, ranging from .51 to .68 in the case of the Impairment Index and from .55 to .72 for AA. In all cases, the correlation between the two predictors is seen to be higher than the correlation between either and the criterion. These results seem to indicate that AA and the Impairment Index are measuring the same thing to a considerable degree. Thus, the reversal of beta weights seen in subgroup B, in which the Impairment Index has the higher validity coefficient, would appear to be reflecting the ability of the two variables to substitute for one another, in large measure, as they relate to the RFT. Thus, rather than any unreliability per se of the beta weights for the predictors, the reversal of weights, as discussed, would appear to present no real discrepancy from the confirmatory trends of the checking procedures as discussed above.

The results which raised most questions on the reliability of the total group results arose from the statistical comparison of total versus subgroup multiple Rs. Several significant differences were found between total multiple R and corresponding subgroup multiple and cross-validated Rs. However, there is reason to suspect that the proposed formula, used in the absence of an established formula (see p. 94), may be inappropriate with the present sample because of limitations of sample size and size of correlations obtained (Guilford, 1954; McNemar, 1962).

According to McNemar, the early formula for the standard error of a multiple $\underline{R}$ $((1-\underline{R}^2) \div \sqrt{N})$, which is included in the formula under discussion, came into being before much was known about the sampling distribution of $\underline{R}$. McNemar thus suggests that the formula is not safe to use except when samples are very large (unlike the present sample), and even then its use may be questionable. These considerations cast doubt on the validity of the total versus subgroup comparisons under consideration. While the significant differences found between total and subgroup results may thus suggest some unreliability in the total results, warranting caution in their interpretation, on the whole the checking procedures in this study using established formulae, generally provide support for confidence in the reliability of results in the total group. The checks used generally suggest that total group results are not unduly influenced by chance factors and are instead reflecting meaningful and relatively stable characteristics of the relationship of the variables under consideration. In the following discussion reference to the subgroup results will be included only when necessary for elaboration or clarification of total group results.

When the two WAIS variables derived to reflect analytic ability and general intelligence, respectively, were entered as independent variables in a multiple regression of the criterion measure of extent of differentiation, the null hypotheses related to the significance of their respective contributions to the multiple _R_ was rejected in the case of the analytic ability measure, but could not be rejected with respect to the measure representing G, or general intelligence. The results of testing the major hypotheses of this study thus support Witkin's contention that analytic ability, and not general intelligence, carries the weight of the significant, positive correlation consistently found between composite measures of intelligence--the WAIS in this study--and measures of extent of differentiation. No support was found for Zigler's (1962a) alternate contention that G, or general intelligence, is the basis of the intelligence-differentiation correlation--a contention which posed a serious challenge to the theory of psychological differentiation.

Witkin et al. (1962) supported their position on this question with research data from factor analytic studies of data for children (Goodenough & Karp, 1961) and adults. Goodenough and Karp found that their "intellectual index" (comprising the three Wechsler subtests of the analytic ability measure used in the present study) correlated more highly with their measures of field dependence than did their "verbal index" (Vocabulary, Information, and Comprehension subtests) or "attention-concentration index"

(Arithmetic, Digit Span, and Coding subtests), with all "indexes" being derived on the basis of subtest factor loading. It was just these studies, however, which Zigler (1962b) challenged on the grounds that the various correlations being compared failed to take account of the common G variance shared by all the Wechsler subtests. He pointed out that in consequence of this failure the different correlations between the various Wechsler indices and the field dependence measures were less clearly or meaningfully interpreted than was apparent. Moreover, he proposed that the Witkin results could equally well support the view that G, or the general intelligence factor, was the variable of relevance in the correlations under discussion.

Zigler's critical objection to the Witkin studies would not seem to apply to the present research. As may be recalled, the confounding of G and subtest factors, which Zigler pointed out, was the problem which prompted the selection of a brain-damaged sample for the present study. As more fully discussed earlier (p. 58), the normally high part/whole correlation between total IQ (G) and subtest factors, and the confounding thus resulting, would be reduced in a brain-damaged sample which is heterogeneous as to loci of organic impairment. Along with the reduction in confounding expected via sample selection alone, the WAIS measures of analytic ability and general intelligence were so derived that they did not relate to one another in part/whole fashion, and each comprised separate WAIS subtests. Furthermore, the multiple regression and statistical procedures testing the research hypotheses were specifically focused on measuring that component of the variables in question, analytic ability (AA) or G (NAA) which is independent of--or above and beyond--whatever the two variables contribute jointly to extent of differentiation (RFT) explanation through shared variance. It seems reasonable to assume that any significant G contribution which is over and above the G contributed jointly by the two variables should be manifested through the variable with the higher G loading. As may be recalled, the NAA variable was specifically intended to serve this function, in fact, to serve as a substitute measure of G. Whether the latter intent was reasonably accomplished should, of course, be questioned. However, the very high correlations (total group, .96; subgroup A, .96; subgroup b, .96) between NAA and Full Scale IQ,which traditionally has been considered and accepted as a reasonable measure of general intelligence or G, provide considerable statistical support for the logical justification for using NAA as an approximate measure of G as described earlier in this paper (see p. 71). The much lower correlations between AA and Full Scale IQ (total group, .68; subgroup A, .64; subgroup B, .73) further support the view that of the two variables NAA is the more highly loaded with G. The failure, then, of NAA to contribute anything beyond a chance (or, as in subgroup A, a statistically significant but suppressant [$F = 5.70$, $p < .05$]) effect, indicates that G, insofar as it is manifested through the non-analytic variable, has little relevance for RFT performance independently of its association with AA. As to the latter, its independent contribution ($F = 50.41$, $p < .001$) to the regression--which constitutes almost all (42%) of the total WAIS contribution (43%)--is reflecting specifically that non-G factor which distinguishes the variable from the rest of the WAIS. This factor--loaded regularly by Block Design and Object Assembly--though variously named, has been consistently found, according to Cohen (1958), in factor analytic studies of the Wechsler scales in children and adults. It has been labeled "analytic ability" by Witkin et al. who see it as the underlying factor in the extent of differentiation dimension, as discussed at length earlier.

The major role of analytic ability in relation to extent of differentiation was repeated throughout the multiple regression procedures testing the supplementary hypotheses. In the limited test of the Goldstein et al. (1970) hypothesis that extent of differentiation might be reflecting an intact-deterioration dimension of psychological functioning, support for the hypothesis was found, but with qualifications which again point to AA as the underlying variable of major relevance. That level of organic impairment is significantly reflected in extent of differentiation is clearly indicated in the multiple regression of the RFT on the Impairment Index and NAA (Table 14). There the organic measure is seen to play the major and highly significant ($F = 30.78$, $p < .001$) contributing role, while the G measure adds nothing of significance ($F = .09$, ns) to the regression. This support for the proposal of Goldstein et al. (1970) is consistent with the results of prior research which consistently has indicated that, as a group, brain-damaged subjects tend to function in the field dependent range on measures of extent of differentiation (Bailey, Hustmyer & Kristofferson, 1961; Goldstein et al., 1970; Trites, 1969).

While the foregoing results confirm the significant role of organic impairment in RFT performance, the results of the regression with AA and the Impairment Index suggest further that kind, rather than amount, of impairment may be the more important aspect of organic impairment extent of differentiation correlations. In the regression cited, the Impairment Index plays a conspicuously different role than it did in the prior regression with NAA, and shows a proportionally small though statistically significant ($F = 4.50$, $p < .05$) contribution apart from its association with AA (F = 16.93, $p < .001$). Moreover, the significance it does achieve disappears when the effects of age and sex are taken into consideration in a later regression. As the results have demonstrated, when only knowledge of a measure of general intelligence is available, knowledge of degree of organic impairment is of substantial and highly significant usefulness in predicting RFT performance (Table 14), but when level of analytic ability is known, information provided by the Impairment Index becomes almost superfluous, adding only a small, though statistically significant improvement in RFT prediction. These results suggest that the Impairment Index and the AA measure as used here are largely measuring the same underlying factor(s). Further support for this view was more fully elaborated in the discussion of the results of the checking procedures with which the present section began.

While earlier research has clearly demonstrated the value of the Impairment Index in measuring extent of brain damage (Halstead, 1947; Reitan, 1955; Stuss, 1974), the measure does not appear thus far to have been identified as reflecting a more specifically delineated kind of impairment such as present results seem to suggest, although there is past research (Goldstein et al., 1971) to support this possibility.

In a factor analytic study of cognitive, motor, and perceptual functioning of alcoholics, Goldstein et al. (1971) found that the Halstead measures they used (most of which comprise the present Impairment Index) generally loaded on factors with strong loadings from the Block Design, Object Assembly, and Picture Completion subtests of the WAIS, with little in the way of common factor loadings with the rest of the WAIS subtests. In the same study, however, the only tests which loaded on the same factor as did the RFT were the WAIS Object Assembly subtest and the Trail Making Test. In a recent test of the Goldstein hypothesis published while the present results were being written, Neuringer, Goldstein and Gallagher (1975) found significant correlations between the RFT and the impairment ratings on the Speech Perception, Tactual Performance-Time, and Tactual Performance-Location components of the Impairment Index. In the study of "normal" college females, correlations between the RFT and the rest of the constituent measures of the index were nonsignificant, including the correlation with the Trail Making Test, contrary to the results in the earlier study cited above.

The interrelationships just described need clarification and would appear to provide a fruitful area of research which should be of significant import for research on brain damage per se (with respect to the WAIS-Impairment Index relationships) as well as for research on brain damage as it relates to extent of differentiation. Insofar as the present research focus is concerned, results obtained in this study support the Witkin position that analytic ability, as herein defined, is a basic underlying factor in RFT performance, even with respect to the influence of organic impairment.

No significant role was found for either age or sex in the present results. There was no significant increase in field dependence with advancing age found in the present results. While some studies (Comalli, 1965; Schwartz & Karp, 1967) have shown a decline in field independence in later life, the decline has been most obvious beyond age 60, the upper age limit in this study. It may thus be that the ceiling age in the present sample was sufficiently low to prevent any strong manifestation of any trends relative to increasing age-field dependence correlation, though within-sample (Tables 3 and 4) simple Pearson *r*s with the criterion were significant.

While sex differences have been a frequent finding in differentiation research (Witkin, 1962), there have been studies (DeKoninck & Crabbe-Decleve, 1971; Jackson, Messick & Myers, 1964; Bieri, 1960) in which no significant sex differences in field dependence were found, and in one recent study (Constantinople, 1974), a reversal of the usual sex differences was obtained. The failure of sex differences to be significantly manifested in present results is thus not unusual. Though data for subgroup A (Table 23) did show a proportionally small (5%) but significant ($p < .05$) contribution by sex to RFT variance explanation, the size of the standard error of the B coefficient relative to the weight itself casts doubt on the reliability of the weighting of the variable in the regression. As with age (though, as indicated, neither age nor sex played a significant role in the multiple correlations), significant bivariate correlations (Tables 3 and 4) between sex and extent of differentiation, in favor of males, were found (total group, $r = .30$, $p < .01$; subgroup A, $r = .48$, $p < .001$), but not consistently (subgroup B, $r = .10$, ns).

Of most importance to the discussion of age and sex effects in the results of this study is the recognition of the role of the AA variable in the research design. Presumably, age and sex effects in differentiation research are reflecting underlying differences in "analytic ability" between (in the present age range) younger versus older subjects and between males and females, respectively. With the effects of level of analytic ability being evaluated in the present study via its reflection in the AA measure, evaluation of significant analytic ability variation via sex and age variables would appear to become superfluous. With this recognition an explanation is offered for the apparent discrepancy in finding significant relationships between the age and sex variables and extent of differentiation in the bivariate correlations, which reflect but do not specify the influence of analytic ability, and the failure to find significant effects for age and sex in the multiple regressions, in which the effects of analytic ability were specifically and independently evaluated. These results again point to the major role of "analytic ability" as an underlying variable of importance in understanding extent of differentiation. Nevertheless, that factors entering into RFT performance extend beyond those included in the variables of the present study is evident in the observation that the amount of RFT variance attributable to AA alone (42%), or together with the remaining research variables (49%), still leaves over half the variation in RFT scores in the present study unexplained.

While the major role of analytic ability in the present research results seems fairly clearly shown, the interpretation of the demonstrated relationships remains an unresolved issue. Some workers may readily acknowledge the relationships as set forth by Witkin and confirmed by this study, but prefer the interpretation of analytic ability as a special aspect of intellectual functioning, e.g., perceptual accuracy (Schooler & Silverman, 1969), selectiveness of attention (Gardner, 1962), spatial ability

(Sherman, 1967)--without further relevance as an index of a pervasive cognitive style. As may be seen, the latter view is a reflection of the major criticism of "overgeneralization" which met the presentation of both the field dependence hypothesis and the hypothesis of psychological differentiation, and which was the basis of Zigler's strong objection resulting in the general intelligence-analytic ability debate of the present study.

While it would seem difficult to continue to defend Zigler's contention that general intelligence is the basis of the perception-personality relationships found in differentiation research in the light of the present results, the latter do not offer any data which can definitely assist in the clarification of the special ability versus cognitive style problem which, in itself, is beyond the scope of the present study. However, the results of the additional analysis of the data, which focused on the analytic ability composite, may be of speculative interest for the problem.

When the composite analytic ability measure was examined for the independent contribution of its individual components (Block Design [BD], Object Assembly [OA], and Picture Completion [PC]) to the multiple regression of the RFT, it was found that, as the analytic ability composite had carried the weight of the WAIS-RFT correlation, the BD subtest carried the weight of the analytic ability-RFT correlation. Of the three component subtests, BD was consistently the relatively most important element throughout the multiple regressions calculated for the total and subgroup samples, showing a significant contribution to the multiple $\underline{R}$ independently of its association with OA and PC in results for the total group ($\underline{F}$ = 14.72, $\underline{p} < .001$) and for subgroup A ($\underline{F}$ = 12.01, $\underline{p} < .01$). In results for subgroup B, none of the subtests showed an independent contribution of significance, but of the three measures, only the contribution of BD approached ($\underline{F}$ = 4.00) the $\underline{p} < .05$ level of statistical significance ($\underline{F}(1,37)$ = 4.11). While OA also contributed significantly above and beyond its association with the other two subtests (in total and subgroup A results), PC in no case showed more than a negligible contribution to RFT variance reduction apart from its association with BD and OA, suggesting that the inclusion of PC in the analytic ability composite may be superfluous or unwarranted.

While the observed results with the PC measure were not expected on the basis of Witkin's hypothesis, they may not be surprising in view of the varying relationships which this measure has shown in a variety of investigations over the years. As pointed out in the first chapter, even within the Witkin work this subtest has correlated significantly with the WAIS Comprehension subtest--a component of their "verbal index" (Witkin et al., 1962, p. 74). This was contrary to expectations and inconsistent with other data which related PC to the components of the "analytic index" (1962, p. 74). Cohen (1957) found PC loading a common factor with different subtests across his four adult groups, divided as to age, with results for one of them even showing PC to define a specific factor. This subtest seems to be an ambiguous measure and may not reliably reflect analytic ability. Logical support for the present finding may be seen in the observation that of the three subtests included in the AA measure as used here, PC would appear to be the least clearly defensible as a measure of the ability to overcome an embedding context, which is thought to be the basic characteristic of analytic ability (Witkin et al., 1962).

As to the preeminent role which the BD subtest plays in the AA measure, the results are quite consistent with the observation that of the three relevant variables, BD, which requires the analysis and synthesis of a visual pattern (Wechsler, 1958), can most clearly be seen as requiring the ability to overcome an embedding context. This, as just noted, has been identified as the chief requirement for success on the RFT or other differentiation tasks.

Since the weighting of the analytic ability measure seems predominantly associated with just one (BD) of the WAIS subtests, the results just discussed may provide some weight on the side of the arguments for the "special ability" interpretation of extent of differentiation research results. However, the results related to the role of organic impairment might suggest the contrary, i.e., a broader role for "analytic ability." As may be recalled, in the present study the Impairment Index and AA were found to have a large communality and to be, at least in relation to the RFT, largely measures of the same underlying factor(s). In view of the apparently broad variety of tasks, even across modalities, comprising the Impairment Index, the special ability interpretation thus seems questionable. The problem remains for further research to clarify. As noted earlier, Goldstein et al. (1971) have conducted one factor analytic study on alcoholics which included the relevant WAIS and Impairment Index variables along with the RFT. Results, it may be recalled, showed that the RFT loaded a relatively independent factor which also was loaded significantly by only OA (of the 11 WAIS subtests) and the Trail Making Test (of the 10 Impairment Index components), suggesting a much more limited association between the RFT and either the WAIS or the Impairment Index than was suggested in the present study. The points and inconsistencies discussed above indicate the need for further research.

The reader interested in pursuing the special ability-cognitive style problem more fully is referred to the thorough and informative discussions of the question presented by Kagan, Moss and Siegel (1963) and by Wachtel (1968, 1972).

As is obvious, the present study has not directly addressed nor shed any light on the special ability-cognitive style problem just discussed. However, the rationale for using a brain-damaged group in this study may be of use in considering the issue. For example, the present sample was selected specifically because brain damage may be quite selective in its effects on intellectual functioning and can result in impairment of quite specific functions while leaving others unaffected. Thus, as expected, some of the subjects of the sample were seen to be functioning very effectively intellectually apart from an obvious and quite specific impairment on the measure of analytic ability. If these subjects had manifested no evidence of poor differentiation in social aspects of their functioning or on appropriate personality assessment procedures, it would seem clear that the "special ability" hypothesis would be strongly supported.

With respect to the methodological issue directly related to the present problem, the results of this study, having shown that general intelligence is not a variable of significance in relation to extent of differentiation, support the view that control for IQ--verbal or total--

is not necessary in differentiation studies. Witkin's (1963) long-held and firm conviction on the latter point in the face of the continued and vigorous theoretical and research debate reported in the review of the literature was somewhat puzzling to the writer before viewing the raw data of the present study (Appendix 1). It was very obvious in this widely heterogeneous group, on the basis of the raw data alone, that many subjects of relatively lower levels of Full Scale IQ equalled or surpassed subjects of sometimes much higher total IQs on both AA and RFT measures. Witkin's extensive experience with the measures in samples ranging intellectually from the retarded (Witkin, 1966) upwards likely provided him with compelling data of a similar nature which forced conviction which the conflicting evidence of others could not offset.

It must be pointed out that the intelligence-differentiation relationships indicated in the present study apply only to differentiation as measured by the RFT. While the RFT is the prototypic measure of perceptual differentiation, the current debate (Arbuthnot, 1972) on the validity of the equivalence of various measures of extent of differentiation precludes the extension of these findings to measures other than the RFT. In view of the preferred role which other more simply administered differentiation measures have in this area, replication of the present study with, e.g., the EFT would appear to be a useful research goal.

Cautions are obviously in order in applying the results and conclusions of the present study. The brain-damaged status of the sample studied precludes generalization of this study's findings to "normal" populations, or to populations which differ in any significant way from the present sample. Caution is needed with respect to brain-damaged samples as well, however, since--despite the generally supportive, though indirect, results on the reliability of the findings provided by the subgroup cross-validation procedures--the size of N (82) in the present study is considered relatively small for multiple regression procedures. Replication with a larger sample would offset this particular limitation.

In retrospect, then, the results obtained in the present study gave clear support for Witkin's position with respect to the general intelligence-psychological differentiation controversy in finding that, in this brain-damaged sample, analytic ability "carried the weight" of the multiple correlation of the RFT on the two WAIS variables, with general intelligence being irrelevant to the regression independently of analytic ability. In view of the atypical (brain-damaged) nature of the sample, however, replication of the present study, or similarly clear findings in other appropriate research, in a normal sample will be necessary before the intelligence-differentiation controversy may be considered fully resolved in favor of the Witkin position. With respect to Goldstein et al.'s hypothesis of an intact-deterioration dimension of psychological functioning as the basis of the differentiation dimension, results indicated that kind of impairment--specifically impairment in analytic ability, primarily--rather than degree or amount per se is the variable of relevance in the organic impairment-differentiation relationship. Further research is needed to resolve questions raised in the present study (the role of Picture Completion in analytic ability) and inconsistencies in research data cited (inconsistent factor loadings of the RFT and associated variables). Research is also needed to extend present results to other differentiation measures and, most importantly, to normal groups.

SUMMARY AND CONCLUSIONS

The present study represented an attempt to contribute to the resolution of a long-standing controversy over the basis of the well-established, significant relationship between composite measures of intelligence and measures of extent of differentiation. Witkin and his co-workers have contended that the total IQ-differentiation correlation is "carried by" those portions of overall intelligence measures--and only those portions--which specifically reflect analytic ability, defined as the ability to overcome an embedding context. On the other hand, critics of the latter position propose that it is the _general_ factor (G), or overall intelligence, rather than any more circumscribed intellectual ability which is reflected in the correlation in question, contending, therefore, that psychological differentiation is basically a manifestation of general intelligence.

The present study proposed to assess, by multiple regression procedures, the relative importance of general intelligence versus analytic ability as these relate to extent of differentiation in a random sample of 62 male and 20 female brain-damaged subjects. Selection of a brain-damaged sample was based on the expectation that heterogeneity of intellectual impairment (e.g., some subjects impaired on analytic ability, some not so impaired) would result in a lowering of the normally high, part/whole correlation between general intelligence and analytic ability which has been a source of confounding in prior research. In addition to the main research goal just stated, a minor test of the hypothesis that an intact-deterioration dimension of psychological functioning might underlie the differentiation dimension was proposed. A consideration of the role of age and sex in the results was also included. In the multiple regressions studied, the RFT served as the criterion measure of extent of differentiation. The analytic ability and G measures were operationally defined and derived from a division of the WAIS subtests. Together the two derived measures constituted the total WAIS. The Halstead-Wisconsin Impairment Index served as the measure of organic impairment.

For the major goals of the study, null hypotheses proposed that there is no significant loss in multiple $\underline{R}$ when the measure of analytic ability or the measure of general intelligence is omitted from a multiple regression in which the two measures served as independent variables with the criterion extent of differentiation measure. For the supplementary aims of the study, null hypotheses proposed that there is no significant loss in multiple $\underline{R}$ when the measure of organic impairment is omitted from multiple regressions in which the organic measure is paired as independent variable with (a) the measure of analytic ability and (b) the measure of general intelligence. Null hypotheses proposed for other supplementary aims stated that there is no significant loss in multiple $\underline{R}$ when age or sex is omitted from a multiple regression which includes both as independent variables along with the measure of organic impairment and one of the intelligence measures.

The $\underline{F}$ ratio for the difference between two multiple $\underline{R}$s was used to test the significance of the omission of a given variable from the relevant regression, thereby assessing its contribution to the regression in addition to, or independently of, the other variables in the regression, including any joint contribution(s) shared by the tested variable.

For the main hypotheses, the obtained results required rejection of the null hypothesis with respect to the analytic ability variable, but that for general intelligence could not be rejected. Analytic ability contributed to RFT variance explanation substantially and significantly independently of general intelligence, while the latter added nothing of significant relevance to the regression independently of analytic ability. The results clearly supported Witkin's position on the IQ-differentiation controversy, at least as these relationships were manifested in this brain-damaged sample.

Supplementary null hypotheses related to the role of organic impairment were both rejected, with results indicating a significant role for degree of organic impairment in relation to extent of differentiation. However, qualifications on the hypothesis that extent of differentiation might be reflecting an intact-deterioration of psychological functioning were indicated, since the role of the organic measure varied considerably depending on which intelligence measure it was paired with in regression. In the regression with G, the Impairment Index played the major and highly significant role, while general intelligence played no significant role. However, in the regression with analytic ability, the latter was found to be the major variable of significance, with the Impairment Index adding only a relatively small, though statistically significant, contribution to the multiple regression. Along with other supporting data, these results suggested considerable communality between the analytic ability and organic impairment measure, and further suggested that impairment in <u>kind</u>, i.e., in the area of analytic ability, rather than in <u>amount</u> of overall impairment, may be the variable of major relevance in the organic-differentiation correlation.

Age and sex showed no significant role in the present results. It was suggested that since usual age and sex differences in extent of differentiation are presumably reflecting age and sex differences in analytic ability, the addition of the two variables was superfluous in a multiple regression which included a direct measure of analytic ability.

Suggestions and indications for further research were pointed out. Most significant of the latter, in terms of the present main research problem, is the need for replication of present results, or similar findings with other appropriate methods, in the normal population, since the atypical (brain-damaged) nature of the sample precludes generalization of present results and conclusions to normal groups of subjects. Cautions were also indicated in generalizing present results to other brain-damaged groups in view of the limitations in sample size for a regression study, though cross-validation data generally provided support for some confidence in the results.

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APPENDIX 1

RAW SCORES FOR DEPENDENT AND INDEPENDENT VARIABLES AND FULL SCALE IQ

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RAW SCORES FOR DEPENDENT AND INDEPENDENT VARIABLES AND FULL SCALE IQ

	Independent Variables					Dependent Variable	
Subject	Sex	Age	IMPI	AA	NAA	RFT	FSIQ
Subgroup A							
1	0	38	6	23	74	29.72	92
2	0	54	8	21	84	33.83	104
3	0	56	10	2	68	34.56	86
4	0	15	5	20	67	47.61	90
5	0	18	2	40	99	10.33	119
6	0	53	8	21	82	26.61	96
7	0	17	5	24	76	9.06	98
8	0	18	4	21	69	45.17	90
9	0	17	7	25	58	14.12	88
10	0	19	3	22	78	24.00	96
11	1	60	9	20	91	39.44	111
12	1	23	5	32	94	4.50	109
13	1	15	4	38	79	5.78	108
14	1	33	5	25	69	11.94	88
15	1	20	2	34	69	3.11	96
16	1	16	1	31	83	6.89	106
17	1	39	4	25	56	10.11	85
18	1	15	4	28	69	19.17	96
19	1	21	0	36	100	5.94	115
20	1	34	2	41	121	5.56	131
21	1	18	1	42	85	5.11	112
22	1	20	2	29	95	9.56	104
23	1	43	7	22	87	31.33	102
24	1	25	5	26	58	7.28	85
25	1	60	5	29	96	25.78	119

Subject	Independent Variables Sex	Age	IMPI	AA	NAA	Dependent Variable RFT	FSIQ
26	1	16	5	32	51	6.06	88
27	1	17	3	29	79	6.94	103
28	1	16	7	19	43	23.17	75
29	1	29	7	14	46	35.56	70
30	1	20	2	35	83	6.22	105
31	1	42	5	37	103	10.17	120
32	1	41	7	29	76	7.94	99
33	1	15	2	28	77	21.72	101
34	1	17	4	29	88	6.50	108
35	1	55	4	28	105	18.94	124
36	1	19	7	24	45	11.17	78
37	1	23	8	27	47	9.39	79
38	1	36	5	22	84	26.78	97
39	1	25	7	26	63	14.67	87
40	1	17	6	27	74	26.83	99
41	1	40	2	30	81	7.39	103
Subgroup B							
1	0	16	5	25	62	12.17	90
2	0	58	4	31	97	12.56	121
3	0	47	4	26	92	17.06	111
4	0	50	10	18	83	24.72	101
5	0	57	8	20	101	39.61	117
6	0	48	5	30	90	37.89	112
7	0	17	4	28	78	8.00	102
8	0	25	2	29	84	12.44	102
9	0	19	8	19	65	30.78	86

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Subject	Independent Variables Sex	Age	IMPI	AA	NAA	Dependent Variable RFT	FSIQ
10	0	26	1	35	104	10.28	117
11	1	55	9	21	57	27.39	91
12	1	51	5	33	106	7.56	124
13	1	15	6	28	66	7.44	94
14	1	16	4	29	92	7.44	110
15	1	17	3	32	75	5.28	102
16	1	56	10	19	63	34.78	94
17	1	18	5	34	76	5.72	102
18	1	34	6	31	93	24.22	108
19	1	19	1	27	94	13.56	108
20	1	23	3	26	80	7.39	98
21	1	17	6	27	65	37.11	93
22	1	29	3	33	88	4.33	106
23	1	18	5	25	59	11.56	86
24	1	42	8	30	60	17.17	90
25	1	55	4	27	79	10.28	108
26	1	47	5	29	83	15.39	108
27	1	15	0	28	74	8.39	99
28	1	17	2	38	90	7.22	115
29	1	29	4	35	83	7.94	105
30	1	25	5	30	56	33.00	86
31	1	28	9	25	66	19.28	88
32	1	18	6	18	51	38.17	78
33	1	25	6	25	76	29.33	94
34	1	36	9	10	43	22.67	68
35	1	42	7	25	60	41.28	87
36	1	28	9	25	64	22.06	87

Subject	Independent Variables Sex	Age	IMPI	AA	NAA	Dependent Variable RFT	FSIQ
37	1	25	10	8	37	28.39	61
38	1	42	5	34	91	11.56	111
39	1	46	7	27	62	29.50	94
40	1	20	2	34	96	7.33	112
41	1	21	3	25	70	9.17	91