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## A Comparative Study of Cerebral Palsied and Normal Adults on Two Forms of Raven's Progressive Matrices

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A COMPARATIVE STUDY OF CEREBRAL PALSIED AND NORMAL ADULTS  
ON TWO FORMS OF RAVEN'S PROGRESSIVE MATRICES

by

Vernon Sloan Tracht

A Dissertation Submitted to the Faculty of the Graduate School  
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## CHAPTER I

### INTRODUCTION

In the preceding decade since the present writer finished his Master's thesis on a topic pertaining to cerebral palsy (48), interest in this neuromuscular disability has become much greater and more widespread, both here in this country and abroad. Likewise the amount of literature published on the subject, as reflected not only in professional journals but also in popular magazine and newspaper articles, has increased many-fold. Indeed, today it has become commonplace to find it given prominence in the daily papers, such as the two following dramatically captioned excerpts reveal:

#### Plan Big U.S. War on Cerebral Palsy

The Public Health Service...announced a sweeping multi-million-dollar program investigating the causes of cerebral palsy, mental retardation and the various forms of blindness and deafness....

#### Cerebral Palsy Rises As No. 1 U.S. Crippler

Cerebral palsy will soon be the nation's No. 1 crippler, So say officials of the American Academy for Cerebral Palsy, meeting here....With the Sauk vaccine promising to eliminate paralytic polio, they predict that more and more attention will be focused on CP. (10)

These press releases may be said to mark the climax of a trend which began some twenty-five or thirty years ago with the advent, among several pioneers, of Carlson (8) and his efforts at habilitating himself as well as others who

were similarly afflicted. During this relatively short period of time, the Easter Seal Society (46), through its loan library service and publications (38), has been a valuable source of information and material concerning cerebral palsy. Symptomatic of this whole period of intensified interest has also been the founding in 1949 and the subsequent rapid growth throughout the country of the United Cerebral Palsy Associations (42), a voluntary health organization dedicated to providing services for those with this handicapping condition and to eventually finding solutions, through extensive research, to the various problems connected with it.

From the standpoint of a broader historical perspective, it is well to note that the condition currently referred to as cerebral palsy was first recognized and described medically almost one hundred years ago by William Little, an English physician, in 1861 (33). Actually, he concerned himself with what is now known as only one type of cerebral palsy—namely, spastic diplegia, which is usually characterized by a very severe degree of motor involvement. On the basis of his observations, it was generally believed for over half a century that mental impairment always accompanied it, whereas present-day knowledge indicates that mental functioning is not necessarily affected adversely. Somewhat later, two physicians who became famous in their respective fields, Sir William Osler (35) and Sigmund Freud (19), contributed further observations, the former being the first to use the term "the cerebral palsies." In thus applying the plural connotation, he rightly surmised that the condition had a number of forms and that therefore it could be so designated.

As a matter of fact, however, one may go much further back in history and

find reference to what can probably be regarded as the ancient equivalent of cerebral palsy. Mention is made in the New Testament of the Bible — specifically in Luke 5:18 — of the man with a palsy, who was cured of it by his faith in Christ. It is open to question, of course, whether this particular type of palsy dated from birth and was therefore the kind under discussion here. Nevertheless, it is interesting to speculate that such was the case. Another instance from historical record of what appears to be cerebral palsy is found in the biography of a lesser known religious personage of the early Middle Ages — namely, Saint Herman the Cripple. He was born nearly a thousand years ago in Germany, in the year 1013 to be exact, a descendant of a great family-line of noblemen and crusaders. But he was so severely handicapped from birth that he could not walk or stand or even sit without the aid of a special chair which was made for him; and in addition he had much difficulty in speaking and in writing. Yet he is described as pleasant, friendly, easy to talk to; always cheerful and laughing, never criticising, and loved by everybody. He learned mathematics, Greek, Latin, Arabic, astronomy and music; wrote a treatise on the astrolabe, an instrument used to determine the altitudes of heavenly bodies; and made astrolabes, clocks and musical instruments, despite his crippled hands. It is believed that he composed two of the great hymns of Christendom, Salve Regina and the Alma Redemptoris, both of which are still sung today throughout the world. The honor and glory of being the patron saint of all physically handicapped persons would most likely fall upon Saint Herman the Cripple, regardless of whether his affliction was actually cerebral palsy. (25)

Still another apparent instance of this disorder can be found in history,

as immortalized in the dramatic literature of Shakespeare through the medium of his tragedy of Richard the Third. In the opening lines of the play, the Duke of Gloucester, who shortly becomes King Richard by resorting to treachery and murder, soliloquizes about his physical condition, thus:

I, that am curtailed of this fair proportion,  
Cheated of feature by dissembling nature,  
Deformed, unfinished, sent before my time  
Into this breathing world, scarce half made up,  
And that so lamely and unfashionable  
That dogs bark at me as I halt by them;  
Why, I, in this weak piping time of peace,  
Have no delight to pass away the time,  
Unless to see my shadow in the sun  
And descant on mine own deformity. (34)

Again, one must stress the fact that the evidence is suggestive rather than certain, and therefore still a matter of speculation, as to whether the persons involved in these three instances from the distant past had cerebral palsy.

Nevertheless, there can be little room for doubt but that handicapping conditions of this type have been known to mankind throughout the ages, even though they have been studied and described in medical terms only within fairly recent times.

In order to round out this introductory section, it would be well to fully define cerebral palsy and to give some basic facts and figures concerning the subject in general. Since it is a complex disorder, the definitions regarding it have tended to be either too broad, and therefore encompass more than is warranted by our present state of knowledge, or too narrow to cover the field adequately. Indeed there are still a few physicians who prefer not to employ this all-inclusive term; instead they continue to use the traditional method of categorizing the symptoms more specifically as to type and degree of

involvement. Be that as it may, the following composite definition and description gives a comprehensive picture in a few paragraphs, as quoted from several leading authorities:

Cerebral palsy is a term which has come into common usage recently... once synonymous with Little's Disease, a spastic paralysis resulting from birth trauma, it has grown to include a diversified group of neurologic conditions whose common bond is abnormal neuromotor function resulting from brain damage. In its usual sense...cerebral palsy not only indicates cerebral pathology but also describes a group of handicapped children. They are an important medical problem; and they represent two important goals in medical practice; prevention and habilitation. To the pediatrician, cerebral palsy may first mean an infant who is a difficult feeding problem; to the orthopedic surgeon, cerebral palsy may mean spastic adductors that need correction and limbs that need stabilization; to the neurologist and neuro-surgeon, cerebral palsy may mean cortical atrophy, convulsions or ablation of a damaged portion of a cerebral hemisphere. The psychiatrist may see in cerebral palsy behavior and mentality that are atypical, while the psychologist may see a child whose intelligence and personality are difficult to evaluate. The therapists may visualize a cerebral palsied child as legs that must be moved reciprocally, fingers that must attain prehension, or a tongue that must be taught to glide over vowels and consonants. The social worker may be interested in cerebral palsy only as it relates to family, economic and social problems, while the special teacher or recreation expert may understand cerebral palsy only as a problem in learning, retaining and socializing. Parents see cerebral palsy as a deep sorrow, and the cerebral palsied may think of himself as an "inadequate one."...cerebral palsy is all of these things, but they must be considered as a whole, not separately. Only in this way can the problems of the cerebral palsied child and his parents be best solved by the professional workers in the field. (12, pp. 21-22)

Since practically all expressions of human behavior are hinged upon the motor system, any interference with these expressions, from stammering to complete diplegia, could theoretically be included in the category of cerebral palsy. The term, however, is, at least traditionally, limited to conditions which go back to the beginning of life or early infancy... (3, p. 221).

Some investigators believe that cerebral palsy should be included as one group of the broader category...known as "the brain-injured" ....This broader group includes children whose cerebral lesions cause mental retardation, defects in perception and concept formation, sensory defects, personality disorders, or epilepsy



whether or not there is accompanying motor dysfunction. The child with cerebral palsy may have any of the above handicaps in addition to his primary neuromuscular disability, and he frequently has more than one of them. (7, pp. 4-5)

Generally...the brain damage which is reflected as cerebral palsy takes place before, at, or just after birth; it involves the part of the brain which controls body movement. Lack of oxygen supply to the brain appears to be a frequent factor in its production. This anoxia, of course, can come about in diverse ways and can play a part in the damage produced by poisoning, infections, physical injury or other agencies. Usually more than one part of the brain is affected so that in addition to lack of motor control, there may be seizures..., interference with intellectual ability, difficulties in sensation and perception, and impairment of sight and hearing. (6)

Thus, it is readily apparent from these quotations that cerebral palsy is not only a complex but can also be a multiple type of handicap; in fact, the condition is at one and the same time as highly complicated and as little understood as the human brain itself.

This situation is well illustrated by the attempts which have been made in the last eight or ten years to develop an adequate system of classification, beginning with that devised by Phelps and Fay (18, p. 182) which comprised six sub-groups, including the two most frequently found —namely, the spastic and athetoid types. As Denhoff has pointed out, the ideal system

would include anatomic, etiologic, and clinical data. However, in current clinical practice, classification is based on clinical findings. This includes type, location and degree of handicap as well as associated handicaps. The reason is that so far there has been inconclusive correlation between anatomic and clinical findings. (12, p. 23)

The comparatively small amount of knowledge we possess about this disorder is therefore limited by our knowledge about the brain; and, conversely, the tremendous amount we have yet to learn ultimately depends upon our success in finding out how the brain functions and how it reacts to and recovers from a

variety of situations which produce damage. Parenthetically, it should be stated here that the present discussion will be concerned with only that definition of cerebral palsy where the motor dysfunction is paramount and the other handicaps of cerebral origin, if present, are secondary to it.

The question is often raised, what characteristics do persons with cerebral palsy have in common? Actually, they are very seldom alike. One may be so severely handicapped physically as to be practically helpless and yet have average or better than average intelligence, while another may be only mildly affected physically but have a severe degree of mental retardation; some may have visual or auditory impairment or may be unable to recognize what they see or hear; still others may have difficulty in speaking or cannot speak intelligibly at all. Thus, the range and the various combinations of handicapping conditions found in cerebral palsy are seemingly infinite, the disorder generally interfering with the ability to do any motor tasks in varying degrees — such as walking, dressing, eating or speaking — and affecting in many instances the ability not only to learn, from the purely academic standpoint, but also to achieve independence and self-sufficiency from the social maturity standpoint. (6, p. 2)

Although there is no compulsory registration of cases of cerebral palsy as yet, it has been estimated by Altman that there are somewhere between 300 and 350 cases of all ages per 100,000 population, or approximately 550,000 in the United States as a whole. He states that the confusion revolving around this problem of prevalence is due to the lack of a clear definition of the disorder and the paucity of data about it. (1, p. 4) The latest figures published by the Board of Education relating to Chicago's special schools for crippled

children reveal that the cerebral palsied outnumber those of any other diagnostic category, being 33.3% of the total enrollment (47). Regardless of what the final figures are in this question of prevalence, however, cerebral palsy is a serious problem of national scope and probably has become the major crippling condition among children in this country. Furthermore, it must not be forgotten that these nation-wide figures represent thousands of human beings — adults as well as children — whose lives, and those of their parents, have been deeply affected by this serious handicap.

As time goes on, it becomes increasingly apparent that cerebral palsy is not exclusively a medical problem, although medical science plays a very significant role in the over-all picture; nor is it entirely a therapeutic, a psychological or even a social service problem, important though these are individually and collectively in the now popular team approach to the disability. First and foremost, it is a family problem, with many serious emotional, social, and economic ramifications. Regardless of how deeply concerned the professional workers are in dealing with the general welfare of those who are afflicted and with questions of diagnosis, classification, etiology, treatment and prevention, they certainly are not the ones who experience the full impact of cerebral palsy. It is felt primarily by the family — mother and father, and perhaps indirectly and to a lesser extent, any brothers and sisters who make up the immediate family circle. There is the responsibility and burden of caring for a child with this handicap, whether he is mildly, moderately or severely involved.

Obviously, too, the parents of a child with cerebral palsy, in addition to the anxiety and disappointment which they feel over his failure to develop

normally, are faced with the external, social pressure of non-conformity — all because they have a child who is strikingly different. Many parents, when first told that their child is afflicted, experience feelings of guilt that one or the other of them may have been at fault through an imagined hereditary defect. Frequently, also, maladjustment occurs between the parents because of their conflicting attitudes regarding the handling of the handicapped child, or of the other children and members of the family in relation to him.

The needs of the cerebral palsied are not unlike those of other children, except that they are accentuated perhaps by the physical handicap — needs for parental affection, for recognition, for achievement, for development of independence and for satisfying social relationships. Of special importance to the adolescent and the adult is the need to belong to a group, to be gainfully employed upon finishing school, if at all possible, and to have opportunities for developing a sense of personal worth. In line with this, it is well to mention that emotional problems may in some instances be as disabling as the physical handicap itself, making it necessary to provide psychological counseling and guidance for the afflicted person and also his parents.

The need for providing long-term treatment or, in the case of the very severely handicapped, custodial care often results in financial sacrifices which can place a heavy economic burden on all members of the family. Many families of such handicapped persons do not have the resources to absorb these costs, all of which again illustrates the fact that was brought out earlier: cerebral palsy begins as an acute family problem and in due time, sooner or later, becomes a social problem of serious proportions. (9)

The question of what constitutes proper and effective treatment has

recently commanded the attention of leading specialists in the field. In fact, there is today a certain trend in their thinking to the effect that perhaps a so-called plateau has now been reached. Thus, the willingness of the government to back greater research efforts, as indicated in the previously-mentioned news item announcing that large sums of money were being allocated for this purpose, might be said to reflect an awareness among professional and lay people alike that serious limitations exist in our current methods of attacking the problems which cerebral palsy presents.

This present tendency to reappraise the whole situation is reflected in the philosophy and aims which are set forth as a guide to post-graduate courses in cerebral palsy recently offered by the College of Physicians and Surgeons of Columbia University to doctors, nurses and others in fields related to medicine, as follows:

The treatment of cerebral palsy is in a period of transition. In the past, a period of neglect was succeeded by one of over-optimism and over-emphasis on physical treatment, often to the detriment of patient and family. At present, a number of contradictory approaches are advocated, and often long-term therapeutic goals are not clearly visualized. Furthermore, the benefits of more widespread use of therapy have been less than many had hoped.

Therefore, many workers in this complex field are aware of a need for a thoughtful appraisal of present day medical management. There is a growing feeling that what is needed...is not necessarily more and more therapy but a better understanding of the role that the various kinds of treatment can play in the guidance of the cerebral palsied person toward his eventual place in adult society. Although answers are still fragmentary and tentative, it is this healthy questioning attitude which will eventually lead to whatever solutions are possible.

With such widespread interest being aroused and more research being done, it should be only a matter of time until answers are found to some of the

fundamental questions still puzzling the specialists in the medical and treatment areas from which this quotation was drawn.

Insofar as the psychological aspects are concerned, on the contrary, the point has not been reached yet where careful reappraisal is necessary, since hardly enough research has been done to require it. Nevertheless, considerable progress has been made, as Holden (26, p. 92) indicates when he calls attention to "a significant increase" in the number of journal articles related to cerebral palsy appearing between 1947 and 1952 compared to the period 1931 through 1946, and there is reason to believe that the pace has not slackened since 1952. Commenting on the need for more experimental studies in cerebral palsy, Garnezy stated in 1953 that several "problem areas" still remained to be investigated:

Typical of such ignored areas are the fields of learning, motivation, perception, personality development and personality evaluation. This neglect is a potentially serious one since the resolution of many vexing problems centering about effective rehabilitation may be dependent upon the utilization of knowledge gained through empirical investigations in these fields. (20, p. 349).

Surprisingly, even in the relatively short period of time since this was written these heretofore largely untouched areas have come under increasing investigation.

It is the hope of the present writer that the following pages, which describe and discuss a research study concerned with only one of these areas of the many-sided problem, may prove to be a contribution, however small, to the growing body of psychological knowledge about cerebral palsy.

## CHAPTER II

### REVIEW OF THE RELATED LITERATURE

Considerable attention has been centered for some time now on the problem of perception in the so-called brain-injured child, undoubtedly because perceptual and thinking difficulties constitute the principal barrier to educational progress and adjustment for such a child, as Berger (4, p. 46) has rightly stated. The pioneer work of Strauss and his associates, Lehtinen, Werner and others (45) (31) (50), is well known. It has been adequately summarized and incorporated in the two-volume series (44) (43) which is now complete after an interval of eight years between the publication of the first and second volumes, and it is still the object of lively arguments, both pro and con, in many a professional circle. Briefly, Strauss and Lehtinen, in the first of these books on the subject, define the "brain-injured child" as one who "before, during, or after birth has received an injury to or suffered an infection of the brain," as a consequence of which "defects of the neuromotor system may be present or absent;" furthermore, he may exhibit "disturbances in perception, thinking, and emotional behavior, either separately or in combination." (44. p. 4). Actually, however, although they generalize their findings regarding the presence of perceptual and thinking distortion to include cerebral palsied children, all of their clinical case material is illustrative of only "exogenous" types of mentally deficient children without gross motor handicaps -- that is, brain-injured children without physically

crippling sequelae.

The experimental evidence, which they cite from the earlier work of Werner and Strauss (50), involved the use of a tachistoscopically presented picture test featuring marred figures, and of a marble board test in contrasting normal with exogenous and endogenous children. The results indicated a markedly different mode of response in the exogenous children that suggested a failure to discriminate between foreground and background, which the authors summarized as follows:

...a foreground-background disturbance in the visual perceptual field is a handicap to brain-injured children in all learning processes involving visual perception....It may be assumed...that the perceptual disturbances... are in certain situations caused by "forced responsiveness" to the background. (44, pp. 44-46)

Additional studies by Werner and Thuma (51) (52), dealing with experiments in apparent motion and critical flicker frequency as applied to exogenous and endogenous mentally deficient children matched for M.A. and I.Q., are referred to in both volumes mentioned above. Their results are more clearly summarized in the second volume by Strauss and Kephart, to the effect that the brain-injured, as contrasted to the non-injured children,

...were found defective in perception of apparent motion, though able to perceive real motion;  
 ...experience simultaneity at a slower rate of succession of stimuli;  
 ...rarely see motion with tachistoscopic exposure of single figures;  
 ...[are less sensitive to] the influence of one tachistoscopically exposed figure on one exposed immediately thereafter...  
 ...were lower at each brightness level [of] critical flicker frequencies... (43 pp. 147-148)

Such findings were regarded as indicating that tests of apparent motion and critical flicker frequency might have greater diagnostic value than other techniques previously used.



One of the principal purposes of this second volume by Strauss and Kephart, as set forth in the preface, was to enlarge the concept associated with the clinical syndrome of exogeneity in brain-injured, mentally deficient children "to include the clinical syndrome of the brain-injured child who is not mentally defective, but who in spite of 'normalcy in I.Q.' as tested is still 'defective'". It is, however, largely a collection of some new clinical observations, interestingly interspersed with earlier experimental findings and new theoretical approaches in neurology and psychiatry, the avowed aim being that it "may lead not only to theoretical understanding of brain injury in children but...to a more effective treatment of so-called 'normal' brain-injured children — they may be diagnosed as 'cerebral palsy' or as 'behavior problem...'" (43 ix), But again, as in the first volume, there is little or no evidence, either clinical or experimental, that the cerebral palsied child per se was considered more than a possible subject for future research.

Dolphin and Cruickshank (13) (14) (15) were the first to utilize a population of truly cerebral palsied children in testing the major hypotheses of Strauss and his co-workers concerning perceptual and thinking disorders in brain-injured children. Specifically, these authors carried out a series of experiments to discover whether generalizations could justifiably be made from one group of brain-injured defective children without appreciable motor handicaps, to another group of brain-injured but non-defective children with definitely crippling neuromuscular symptoms diagnosed as cerebral palsy. Duplicating as closely as possible the test materials of the Werner and Strauss studies and matching two groups of children individually on the basis

of sex, chronological age and mental age, they found significant differences between thirty cerebral palsied children and a like number of physically normal children in visio-motor activity; in thinking, reasoning and concept formation; and in figure-background relationships.

Concerning the results of the figure-background test, they had this to say

The statistical differences in the cerebral palsy and normal groups...showed that the cerebral palsy children were inferior to normal children in distinguishing the figure from the background.... In part this difference might be due to the phenomena of forced responsiveness to extraneous stimuli which has been found characteristic of organic pathology. Further the presence of meticulousity also characteristic of individuals with cortical damage may account for the fact that when the cerebral palsy children were able to differentiate the figure they also felt compelled to include the background in their descriptions. The pathology of figure-background relation in the cerebral palsy child has significant implications for educators and for educational methodology. (15, p. 231)

Likewise, in discussing the differences in conceptual thinking which were obtained on a picture object test, they reported

The cerebral palsy group selected a significantly greater number of objects. However, there were also qualitative differences between the two groups. The cerebral palsy group made more selection of objects based on secondary qualities of the objects, chose a larger number of uncommon objects, dramatized the pictures in their selection of objects, extended the pictures into time and space, frequently rejected an object after having initially selected it, and in some cases were unable to organize the picture into a meaningful whole. (14, p. 392)

Thus, with respect to these important psychological functions, the results of Dolphin and Cruickshank verified their hypothesis to the effect that cerebral palsied children may be expected to function similarly to mentally defective brain-injured children who manifest no gross motor involvement. In addition, their subjects tended to exhibit certain characteristics --- such as distractibility, perseveration, dissociation and disinhibition --- which other

investigators, for example, Halstead (24) and Goldstein and Scheerer (21), had observed in adults with organic brain disorders of one kind or another.

An extensive follow-up of the Dolphin and Cruickshank studies has been undertaken through a combined research project by Cruickshank in Syracuse and Bice in New Jersey to answer the criticism leveled at the former studies, to the effect that such sweeping conclusions were not warranted on the basis of so relatively few children. Although still in progress, this project has released certain preliminary data which has been reported in one chapter of the comprehensive book on cerebral palsy edited by Cruickshank and Raus (11 pp. 158-159). Using improved test materials and scoring methods, they have compared the performance of 246 cerebral palsied children with that of 45 non-handicapped children and have obtained a highly significant difference, indicating a poorer performance on the part of the latter in figure-ground relationships and corroboration of at least this aspect of the previous work by Dolphin and Cruickshank.

Berko (5 p. 3) has reported failure or decidedly poor performance in placing the appropriate blocks in the Seguin Form-board with about 300 cerebral palsied children, all of whom had sufficient physical coordination and mental capacity to accomplish this task easily. Having considered these clinical observations as good evidence of defective visual perception, this investigator matched 20 such children with a similar number having mild articulatory difficulties but no known neurological disorders, and found a significant difference between the groups in their Seguin Formboard performances, the group with cerebral palsy being the lower of the two. He raises the same question which others have asked, namely, whether such obtained differences can be

attributed to factors other than visual perception. The answer would seem to be, of course, that more research is needed to settle this question and many more like it which are equally challenging in this complex field. As Cardwell has ably stated:

Whether or not these visuomotor problems are common among the cerebral palsied and whether they are more closely associated with one type of cerebral palsy than another are not yet known.... Though a certain number in the cerebral palsied group are unquestionably affected by conceptual difficulties, as they are by defects in perception, such characteristics must not be attributed to all cerebral palsied. Results of further investigation are awaited to reveal more data on the nature and extent of this problem. (7, pp. 357-358)

In concluding this review of related literature which has briefly summarized those pertinent research findings that are regarded as bearing most directly upon the present experimental project, it would be well to mention the admonition of Holden that research in cerebral palsy should be evaluated separately from research in brain injury generally, even though the "problem of cerebral palsy is ordinarily thought of as belonging in the larger field of brain injury and continues to be subsumed under that broader heading:"

...research in the effects of brain injury has been mainly with adults. There arises the important question of the relationship of genetic development and the effects of brain damage on the growing organism....in adults, the localization of the damage is often known, but in the human organism damaged before, at, or slightly after birth, such localization is by no means definite.... research in brain damage in adults has often involved a specific dysfunction such as memory loss, aphasia, distractibility of attention, etc., whereas in the early damaged individual the results of cortical insult may not be circumscribed but widespread, affecting not only the functioning of specific muscles but many and varied sensorimotor, intellectual and personality characteristics as well. (26, p. 92)

In a word, the point that Holden makes is that the adults, who have been the objects of much research, are those whose brain injuries have been incurred

later in life after normal development has taken place. Therefore, the problems raised by their mental functioning, personality characteristics and behavior are not comparable in most respects to those of cerebral palsied adults who have had to develop with the original damage "stamped in", as it were, from the time of birth. Obviously, the impact of these subtle factors, plus the not-so-hidden factor of the physically handicapping condition itself, is such that generalizations from brain-injured adults to cerebral palsied adults are probably more questionable and less justified than generalizations from brain-injured children to cerebral palsied children. And yet the two kinds of adults are often treated as though they were similar in all pathological manifestations.

An exhaustive survey several years ago of the literature related to the psychological consequences of brain injuries by Klebanoff, Singer and Wilensky (28) listed no references among its 307-title bibliography which pertained to studies on cerebral palsied persons as such. It is possible that they were lost or submerged somehow in the confusion over terminology which apparently pervades the field of brain injury generally. However, the fact remains that, outside of the need for clarification in this area of terminology, there is a need for more basic psychological research in cerebral palsy, especially with adults who are thus afflicted, in contrast to those whose damage to the brain was sustained later in life.

## CHAPTER III

### STATEMENT OF THE PROBLEM

Generally speaking, the aim of this study is to investigate the possibility that cerebral palsied adults exhibit disturbances in visual perception and in the ability to think abstractly which would interfere with their performances on tasks requiring these psychological processes. Reference has already been made to several studies which indicate that similarly afflicted children have such disturbances; but as yet none have been attempted on adults, so far as the writer is aware. In the present study no comparison is made between cerebral palsied children and adults with respect to their performances on tasks involving these functions. However, if adults show a pattern of behavior analogous to that of the children, certain inferences could be made concerning the cerebral palsied as a group, independently of their age.

From its inception, this study has been regarded as preliminary and exploratory in nature, by reason of the complexity of the problems related to brain damage in general. The writer hopes that, whatever results are achieved, it will serve to stimulate more research by suggesting other methods of attacking this question of whether perceptual and thinking disturbances, which allegedly affect cerebral palsied children, are also present in the adults.

#### Hypotheses

The following hypotheses will be investigated:

- I. If cerebral palsied and normal adults differ in visual

perception and abstract thinking, their performances on two forms of the same test should be significantly different.

- II. If cerebral palsied adults have disturbances in visual perception and abstract thinking, then, among themselves, their performances on two forms of the same test should be significantly different, in favor of the form which helps them counteract the effects of such presumed disturbances.

Both hypotheses are based on the following assumptions: first, that the presence of gross disturbances in visual perception and abstract thinking can be demonstrated by comparing the scores on two forms of the same test, in one of which the perceptual and thinking components are made to play a more important part than in the other; and second that the cerebral palsied adults need the benefit of an enlarged, more concrete and three-dimensional block form, with its manipulative pieces --- all of which features accentuate the perceptual and thinking components --- in order to offset the detrimental effects of these presumed disturbances.

As a consequence, in Hypothesis I, cerebral palsied adults would be expected to score significantly lower than normal adults on the booklet form of the testing instrument and to score equal to them on the block form. In Hypothesis II, cerebral palsied adults, among themselves, would be expected to score significantly higher on the block form as compared to the booklet form.

The two forms of the same test used in this research are the original booklet form of Raven's Progressive Matrices (1938) and a specially constructed wooden block form. A detailed description of them follows in the next chapter.

## CHAPTER IV

### PROCEDURE

#### The Measuring Instrument

The Progressive Matrices (1938 edition) of J. C. Raven, a British psychologist, was chosen as the most appropriate test to use in the present research study for two important reasons. First, it combines in one measuring instrument a test known to have strong perceptual elements as well as a "capacity for intellectual activity," to quote the author — these psychological processes being of major concern in this investigation. Second, it is particularly applicable to handicapped persons, especially those with cerebral palsy who so often have great difficulty in expressing themselves, either verbally or by gesture, and may react unfavorably in test situations generally. These points will be discussed more fully later in this section. Parenthetically, another and more personal reason could be given, namely, that the present writer was the first to introduce the test into the field of cerebral palsy, as described in a journal article which appeared nine years ago (49), and he has been much interested in it since then, having used various forms experimentally with both cerebral palsied children and adults. Originally imported from England, where it is among the most widely used non-verbal measures of intelligence and the object of pioneering research by Rimoldi (39) in Argentina over a decade ago, the test has attracted growing attention in recent years in this country — as the work of Levine and Iscoe



(32), Green and Ewert (22), and Barratt (2), to mention only a few, indicates.

Raven himself has described the 1938 edition of the

Progressive Matrices as

...a test of a person's capacity at the time of the test to apprehend meaningless figures presented for his observation, see the relation between them, conceive the nature of the figure completing each system of relations presented, and, by so doing, develop a systematic method of reasoning. The scale consists of 60 problems divided into five sets of 12. In each set the first problem is as nearly as possible self-evident. The problems which follow become progressively difficult. The order ... provides the standard training in the method of working. The five sets provide five opportunities for grasping the method and five progressive assessments of a person's capacity for intellectual activity.... The scale is intended to cover the whole range of intellectual development from the time a child is able to grasp the idea of finding a missing piece to complete a pattern, and to be sufficiently long to assess a person's maximum capacity to form comparisons and reason by analogy without being unduly exhausting or unwieldy. The scores obtained by adults tend to cluster in the upper half of the scale, but there are enough difficult problems to differentiate satisfactorily between them....It is often useful to describe the scale as a test of observation or clear thinking. Each problem in the scale is really the "mother" or "source" of a system of thought -- hence the name Progressive Matrices. The scale has a re-test reliability varying, with age from 0.83 to 0.93. It correlates 0.86 with the Terman-Binet test, and has been found to have a G saturation of 0.82. (36 pp. 1-2)

A further analysis of the test reveals that it can be applied to individuals of various ages, from six years on. The difficulty of the items increases somewhat irregularly but steadily within each set and throughout the whole scale. The scoring is simple, each item answered correctly being given one point toward a possible total score of 60. The nature of the test makes it independent of various educational, environmental or cultural backgrounds. Both Spearman (41) and Raven (37) have indicated that this test was designed according to the former's "noegenetic" principles and is regarded as a good

measure of "g", the general factor in intelligence.

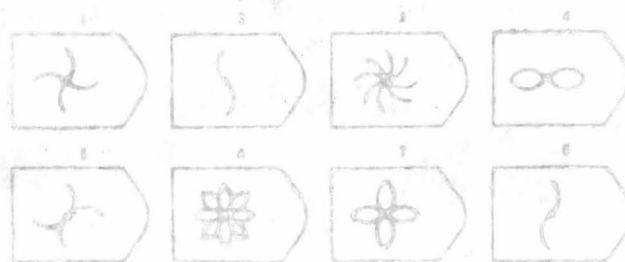
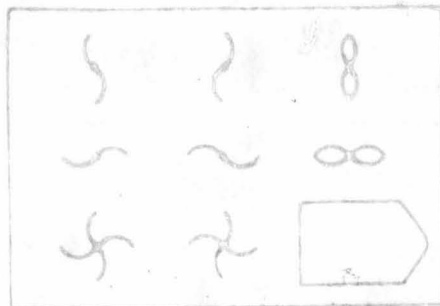
A factorial study of the test was done by Rimoldi (40), who included it in a larger battery composed chiefly of performance tests. Having used each set as a separate test for the purposes of correlation, he found the following factors were important psychological variables; one which was common to all five sets he interpreted as probably similar to Thurstone's "Induction" and to Spearman's "Analytical Activity," since their solution requires finding the rule or principle governing each set; another, common to the first three sets, he termed "the perception of relations necessary for the construction of a whole." It is apparent from this and other studies of the test's composition that perceptual ability plays an important part in at least the first two or three sets. An analysis of wrong answers given by test subjects suggests that they had experienced a faulty perception of figure-ground relations in attempting to solve the various items. The last two sets increasingly demand of the subjects the use of abstract thought if the correct solutions are to be found. (40)

The principal advantage of using the Progressive Matrices for testing persons with cerebral palsy is that an absolute minimum of motor response is necessary. If the subject is wholly unable to verbally select his choices for completing the various patterns, he may be able to point, however unsteadily, to the missing part in each instance. If unable to execute either of these alternatives, he can still resort to nodding the head or moving an arm or a leg in a gross fashion in order to indicate the desired choice when questioned. In other words, no refined muscular coordination is required. Because cerebral palsied persons generally seem to be prone to emotional upset

or blocking, a test with a time limit usually has an adverse effect, as reflected in the increase of random muscular activity and other symptoms of anxiety. The mere awareness of being timed may be sufficient for the subject to develop such a state of tension that he is either unable to finish or does not do his best. The Raven test, being untimed, having very simple instructions, and permitting relative freedom in the mode of expression, promotes a more favorable test situation for the cerebral palsied than can be achieved with most other tests. Parenthetically, it must be added, however, that the time taken to complete the test was noted for each subject, although no indication was given him to this effect.

For purposes of the present research, a block form of the Progressive Matrices was constructed, by photographing all 60 items of the booklet form, enlarging each from its original size of 3 by  $4\frac{1}{2}$  inches to  $4\frac{1}{2}$  by  $6\frac{1}{2}$  inches, and mounting each pattern and extra pieces on one-half inch plywood. Then each of the test items was placed on a separate 11 by  $13\frac{1}{2}$  inch board, in such a way that the upper half of each pattern and the pieces belonging to it extended one-quarter inch above the surface of the large board, thus giving all parts of the item a three-dimensional appearance. The "missing" part of each pattern was, of course, cut out; and each of its separate pieces could be put into the vacant space, if the subject chose to do so in his search for the "correct" piece to complete the pattern. Figure 1, which illustrates how one of the test items appears in the booklet form, may help those readers who are unfamiliar with the test to visualize what was entailed in this transformation to the block form:

FIGURE 1



The directions for administering the booklet form of the test were retained as given by the author in the Guide to Using Progressive Matrices (1938), except for a few minor word substitutions to accommodate the American idiom of speaking — for example, using "piece" instead of "bit" and "just right" instead of "quite right." In administering the block form, however, certain changes and additions were necessary in order to carry out the purpose on contrasting the subject's performance on both forms and to render assistance to the handicapped subjects when they needed help in putting the chosen pieces in the missing part of each pattern. Since one of the primary aims of the research was to discover whether the subjects gained any advantage in the block form by being able to manipulate the pieces at will and to see how the chosen

ones looked after being put into the missing part of the pattern, additional instructions were given beyond those required in the booklet. A comparison of the two sets of instructions follows, the first being those used for the booklet form and the second those for the block form:

Booklet Form -- The examiner opens the book to the first item, A 1, and says:

"Look at this (pointing). It is a pattern with a piece taken out. Each of these pieces below (pointing) is the right shape to fit the space, but they do not all complete the pattern."

Examiner explains why numbers 1, 2 and 3 are wrong and why number 6 is nearly right, then says:

"Point to the piece which is just right."

If the subject does not point to the right piece, the examiner continues his explanation until the nature of the problem to be solved is clearly grasped.

The examiner explains that on every page there is a pattern with a part left out and says:

"All you have to do is to point each time to the piece which is the right one to complete the pattern."

Turning to item A. 2, he continues:

"They are simple at the beginning but get harder as you go along. If you pay attention to the way the easy ones go, you will find the later ones less difficult. Just point to the piece which completes the pattern. You may continue at your own pace. See how many you can get right. You may have as much time as you like. There is no need to hurry, but be careful. Remember that each time only one piece is just right."

Block Form - The examiner presents the board on which the first item, A. 1, is attached, and says:

"Look at this (pointing). It is a pattern with a piece taken out. Each of these pieces below (pointing) is the right shape to fit the space, but they do not all complete the pattern."

Examiner explains why numbers 1, 2 and 3 are wrong, and why number 6 is nearly right, then says:

"Now you select the piece which is just right and put it in the space where the pattern is not complete." If the subject is not able to do this because of his handicap, the examiner places the selected piece for him. If the subject does not select the right piece, the examiner continues his explanation of the first item, A 1, until the nature of the problem is clearly grasped.

The examiner explains that on every board that follows there is a part left out, and says:

"All you have to do is select the piece which is the right one to complete the pattern."

Presenting the board upon which the second item, A. 1, is attached, the examiner continues:

"They are simple at the beginning but get harder as you go along. If you pay attention to the way the easy ones go, you will find the later ones less difficult. Just select the piece which completes the pattern. You may continue at your own pace. Tell me when you are ready for the next board. See how many you can get right. You may have as much time as you like. There is no need to hurry, but be careful. Remember, too, that if you are not satisfied with the piece you select after you put it in the missing part of the pattern and see how it looks, you may change it if you wish---like this (demonstrates)."

The scoring method in the case of the booklet form was the same as that of Raven, namely, the subject's score is the total number of test items or patterns he solves correctly, there being no time limit. If he should point to more than one piece, his final choice is the one that is counted right or wrong. In his shorter children's edition of the Progressive Matrices, printed in color and published in 1947, Raven gives directions and norms for a block form, in addition to those for the booklet form. Its scoring method for the block form differed from that for the booklet form in that the first, rather

than the last choice, was the one which counted, regardless of changes which the subject might have made thereafter. In the present study the block form was scored both ways, namely, taking the subject's first choice regardless of any subsequent ones, and taking his final choice irrespective of how many earlier ones he made. When it was later determined that there was no statistically significant difference between these two methods (cf. RESULTS, Table 2), the latter method of counting only the final choice was adopted in order to more readily show any possible difference between the booklet and the block forms, since there proved to be a slightly higher average score in favor of the second method of scoring the block form.

#### The Subjects

An experimental group of 32 cerebral palsied persons, including 19 males and 13 females, with an age range from 19 to 42, was matched for age, amount of education and I.Q. with a control group of 28 normal persons, including 16 males and 12 females, with an age range from 18 to 52. The Verbal Scale of the Wechsler-Bellevue Intelligence Scale was administered to all subjects to determine their I.Q. ratings in this matching process. The results of this matching process, indicating means and standard deviations for the two groups, are shown in Table 1. There were no significant differences between the means of the two groups in these three categories.

TABLE 1

COMPARISON OF MEANS AND STANDARD DEVIATIONS FOR  
THE EXPERIMENTAL AND CONTROL GROUPS IN  
AGE, AMOUNT OF EDUCATION AND I. Q.

	Experimental		Control	
	Mean	S.D.	Mean	S.D.
Age	29.2	6.0	30.5	10.0
Education	12.2	2.4	11.8	2.4
I.Q.	106.8	14.7	106.0	14.9
	N-32		N-28	

With few exceptions, the persons finally selected to comprise the experimental group were among about 40 who volunteered from the Adult Cerebral Palsy Club of Chicago. Since these subjects were not selected at random, the group as constituted must be regarded as an "incidental sample", according to Guilford's definition (23, p. 180). All at one time or another during their lives had been diagnosed as having cerebral palsy, or as the old terminology had it, "spastic paralysis;" furthermore, all had had the condition since the time of birth or early infancy (several were excluded from participating in the project because their disability was incurred later in childhood). It would have been very desirable but unfortunately it was not feasible to give them a medical checkup by a specialist in the field to determine what type of cerebral palsy they had. Under the circumstances, only a very rough estimate



could be made by the writer, based on his own observation and clinical experience; consequently, he classified each subject according to at least the two most prominent types, spastic and athetoid, and to the degree of physical involvement. The following criteria for estimating the latter were devised by the writer, with a few minor changes, for a previous research project and represent a rough framework for judgement, with the realization that no hard and fast rules exist and that some overlapping occurs in any functional scheme of this kind:

Mild — Subjects can walk unaided, with or without crutches or a cane, can travel alone on public transportation facilities, and can dress and feed themselves with little or no assistance.

Moderate — Subjects can usually walk unaided, with or without crutches or a cane, but may have considerable difficulty and thus may not be able to (or have not developed confidence to try to) travel alone on public transportation facilities. With few exceptions, subjects usually need considerable help in dressing and/or in feeding themselves.

Severe — Subjects cannot walk without assistance (if at all) nor travel alone on public transportation facilities. With few exceptions subjects are almost completely (if not totally) dependent upon others for meeting essential needs.

Of the 32 cerebral palsied subjects, 10 were classified as spastic and 18 as athetoid; 4 were regarded as having somewhat mixed and ill-defined characteristics and were therefore left unclassified as to type. With respect to the degree of handicap, 16 were judged "mild," 10 were "moderate" and 6 "severe." A further analysis of the composition of the experimental group reveals that, of the 32 subjects, 11 were employed in business or industry, 7 were self-employed and thereby earned at least a partial livelihood, 12 were unemployed (10 of these being considered unemployable), and 2 were housewives.

The persons comprising the control group came from various walks of life:

all but one of the 28 in this group were employed, although 8 of these were seeking some kind of aid from the County Welfare Department; some of those who were employed were continuing their education by going to night school. As in the case of the experimental group, this also was an "incidental sample."

It was not possible to formally test any of the subjects, either in the experimental or in the control group, as far as their visual acuity was concerned; however, it was determined before the testing that each one had adequate vision, with or without glasses, to see the test material and to realize what had to be done to solve the problems. Of the 32 in the experimental group, 12 wore glasses; and of the 28 in the control group 10 wore them.

The test situation was intentionally kept as informal as possible for the cerebral palsied subjects so that they could relax and be free from the tension and anxiety which can so easily affect adversely the performances of such persons when under physical and mental stress. The whole affair was treated more as a challenging game in which one was expected to do one's best; and since most of the subjects were known to the investigator, he was able to develop good test rapport and elicit their full cooperation.

In order to minimize the possibility of a practice effect, the experimental and control groups were divided into two sub-groups, each with 16 and 14 subjects respectively. Thereupon, one sub-group from each of the larger groups was given the booklet form of the Progressive Matrices, followed approximately four months later by a re-test on the block form; the other sub-group was given the block form first, followed by the booklet form after a similar elapse of time. Several subjects were "lost" through illness or other

circumstances as a result of using this rotation method; but the procedure was necessary, nevertheless, with this type of an experiment.

### Statistical Treatment of the Data

In determining the significance of the differences of the means in the major comparative aspects of the study, the method of the analysis of variance was chosen, primarily because the data could be handled easier and more simply by this technique. Edwards has written as follows concerning it:

The very great value of the analysis of variance and the test of significance based on the F distribution is not in its application to the problem of 2 sample means, but in problems where the differences among a set of several means are to be evaluated. Such problems occur frequently in research, particularly in the exploratory stages of an investigation. (17, p. 185)

Along the same line, Kogan has commented:

Perhaps the main usefulness of this design is to serve as an extension of the  $t$  test to more than two groups. Not only does the analysis of variance evade the practical problem of carrying out a laborious number of  $t$  tests when there are many experimental comparisons to be made, but it can be argued that the over-all  $F$  test leads to more dependable inference about the possible differences among means. (29, p. 3)

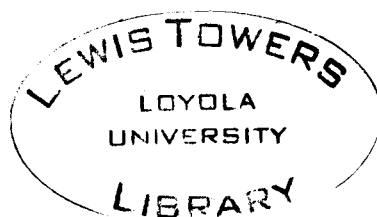
These quotations afforded ample justification for employing a method which has gained widespread use in psychological research in recent years.

A second opportunity for applying the analysis of variance technique developed subsequent to the completion of the first, when the latter demonstrated no positive results with respect to the major hypothesis and other comparative aspects related to it. Thus, a consideration of the hitherto neglected element of time which the various subjects needed to finish each form of the Raven test revealed a striking difference between the means of the two groups; whereupon a determination of the possible significance of these

findings necessitated this additional computation. It was believed advisable to use only the time taken on the booklet form, since that was regarded as a better reflection of the time factor in the thinking process required to solve the test problems. In contrast, the time taken on the block form would obviously have reflected more than this, especially for the handicapped subjects, because of the purely motor element connected with handling the numerous blocks.

One or two supplementary aspects of the over-all study necessitated statistical procedures other than those mentioned above. For example, a t test was needed to determine whether there was any significant difference between the means representing the two possible ways of scoring the block form of the Raven test. In addition, the correlation coefficients between the Wechsler-Bellevue Verbal Scale and the two forms of the Raven test were computed in an effort to estimate the effect of matching the experimental and control groups for I.Q. on one type of intelligence test and then comparing the same groups by utilizing another type of intelligence test.

All of these results are given in the chapter which follows.



## CHAPTER V

### RESULTS

As stated in the previous chapter (cf. PROCEDURE) two preliminary steps were taken, from the standpoint of statistical procedure, the first being to determine whether there was a significant difference between the two methods of scoring the block form of the Raven test, namely, scoring according to either the subject's initial choice or his final choice. The results are given in Table 2, showing the means and other statistics for the two block forms in the

TABLE 2

MEANS AND OTHER STATISTICS IN THE COMPARISON OF THE TWO METHODS OF SCORING  
THE BLOCK FORM OF THE RAVEN TEST IN THE EXPERIMENTAL AND CONTROL GROUPS

	Experimental		Control	
	block <sub>1</sub>	block <sub>2</sub>	block <sub>1</sub>	block <sub>2</sub>
Statistic				
N	32	32	28	28
M	37.8	40.4	38.1	39.9
S.D.	10.4	10.6	12.8	13.2
S.E. <sub>M</sub>	3.4	3.5	5.9	6.2
S.E. <sub>d<sub>M</sub></sub>	2.7		3.5	
D <sub>M</sub>	2.6		1.8	
t	1.0		.5	

experimental and the control groups separately. The t test of significance revealed no difference between the scoring methods in either of the two groups at the 5% level. Since both groups averaged slightly higher on the basis of the second method of scoring the block form, it was adopted in order to give the subjects the benefit of even this advantage when comparing their performances on the block form and the booklet form in the main aspect of the study. The second of these steps --- one which is preliminary in the sense that it relates to the original matching of the groups, yet anticipates the forthcoming discussion of their results --- involves the correlation between the Wechsler-Bellevue Verbal Scale and the Raven test, the results of which are given in Table 3.

TABLE 3

CORRELATION COEFFICIENTS OF THE TWO FORMS OF RAVEN'S  
PROGRESSIVE MATRICES WITH THE VERBAL SCALE OF  
THE WECHSLER-BELLEVUE FOR THE EXPERIMENTAL,  
THE CONTROL AND THE COMBINED GROUPS

		Experimental		Control		Combined	
		Booklet	Block	Booklet	Block	Booklet	Block
N		32	32	28	28	60	60
r		.74	.72	.82	.82	.78	.77

It will be noted from the above table that the correlation coefficients between the two forms of the Raven test and the Verbal Scale of the Wechsler-Bellevue for the combined experimental and control groups are .78 in the case

of the booklet form and .77 for the block form. Both of these correlations were found to be significant at the 1% level of confidence.

Turning now to the main portion of this study which was subjected to an analysis of variance, it is to be noted that three principal variables are involved — namely, 1) the type of individuals comprising the experimental and control groups (cerebral palsied versus normal persons), 2) the type of test used (booklet form versus block form), and 3) the order of presentation of these two forms (first presentations versus second presentations). Table 4 summarizes the results of this procedure:

TABLE 4  
ANALYSIS OF VARIANCE FOR THE TEST SCORES

Type	Description of Variable	Sum of Squares	Degrees of Freedom	Mean Square	F	Levels of Confidence	
						5%	1%
I	Experimental vs Control	0	1	0	0	3.93	6.87
II	Booklet vs Block	1.22	1	1.22	0.009	3.93	6.87
III	First vs. Second Presentations	1.22	1	1.22	0.009	3.93	6.87
I-II	Interaction	7.42	1	7.42	0.05	3.93	6.87
II-III	Interaction	137.35	1	137.35	0.98	3.93	6.87
I-III	Interaction	162.29	1	162.29	1.16	3.93	6.87
I-II-III	Interaction	19.67	1	19.67	0.14	3.93	6.87
Within		15730.04	112	140.45			
Total		16059.20	119				

It is evident from an inspection of the "F" column in Table 4 that the groups under consideration in this study are not sufficiently different from one another to justify the rejection of the Null hypothesis. In other words, there are no significant differences at either the 5% or the 1% levels of confidence in terms of the aforementioned three principal variables, as indicated by Roman numerals I, II and III in Table 4, nor with respect to the secondary interactions, expressed as I - II, II - III, I - III and I - II - III in the same table.

In terms of Hypothesis I, as set forth in the earlier section entitled STATEMENT OF THE PROBLEM, and contrary to it, the results in Table 4 show that the two groups, comprised of cerebral palsied and normal adults, did not score significantly different from one another on either form of the Raven test. Moreover, it did not make any difference to either group whether the booklet or the block form was administered first, when each group was subdivided; nor was there any evidence in either group of an appreciable practice effect after an elapse of four months between the giving of one form and another.

The summary of the analysis of variance given in Table 4 likewise reveals the extent to which both Hypothesis I and Hypothesis II were unsubstantiated. Thus, the cerebral palsied group did not score significantly lower than the normal group on the booklet form, whereas they were expected to do so; the fact that the former did score equal to the latter on the block form, as was expected, was of no consequence whatsoever in the light of the over-all problem. The results also failed to support the expectation that the cerebral palsied persons, among themselves, would score significantly higher on the block form because of its presumed advantage for them over the booklet form.



All of these various findings are graphically portrayed in Figures 1, 2, 3 and 4, in which the total Raven test results are broken down into the five component sets of the Progressive Matrices. The titles on these different graphs are self-explanatory, illustrating as they do the comparison between the two principal groups in relation to the booklet and block forms, as well as the several comparisons between the booklet and block forms with respect to the two principal groups and the four sub-groups. Particular attention is called to Figure 4 and the accompanying data given in Table 5, which shows the mean scores of the two principal groups on each of the six sets of the Raven test, since they point up the fact that neither group benefited by one test form or the other.

FIGURE 3

FIGURE 2  
Comparison of scores

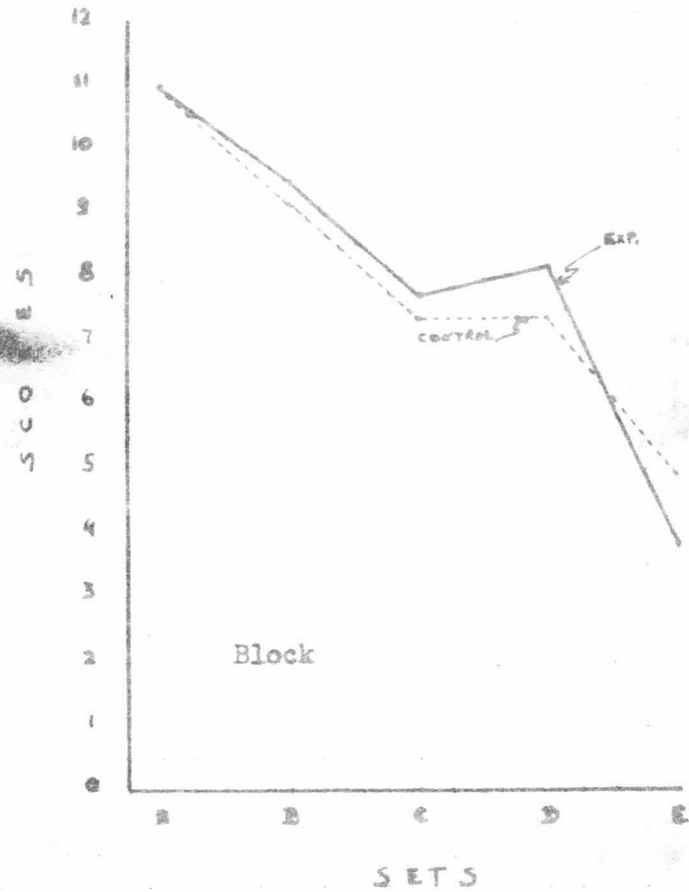
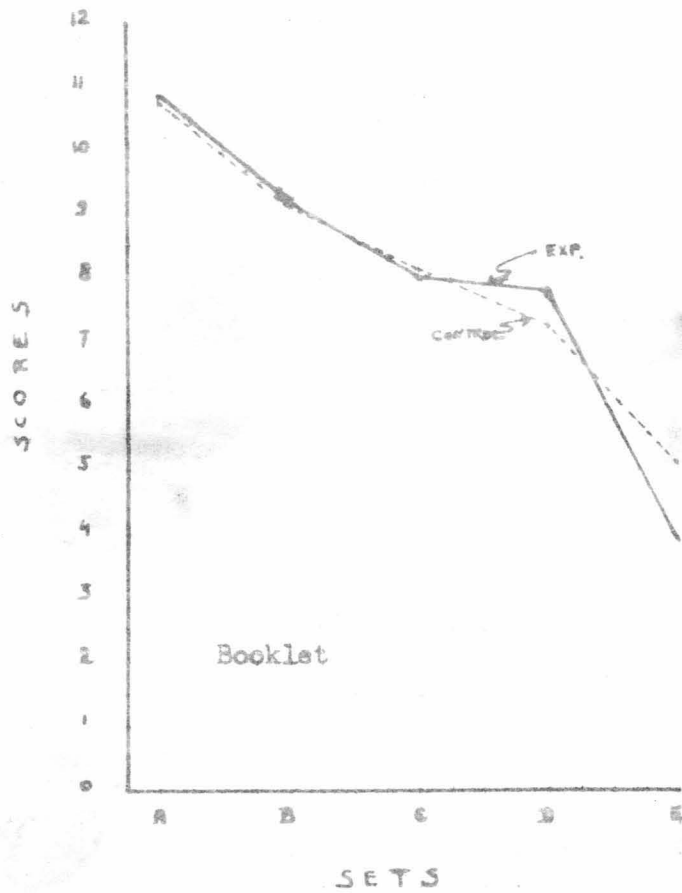


FIGURE 3

Comparison of scores

Experimental group

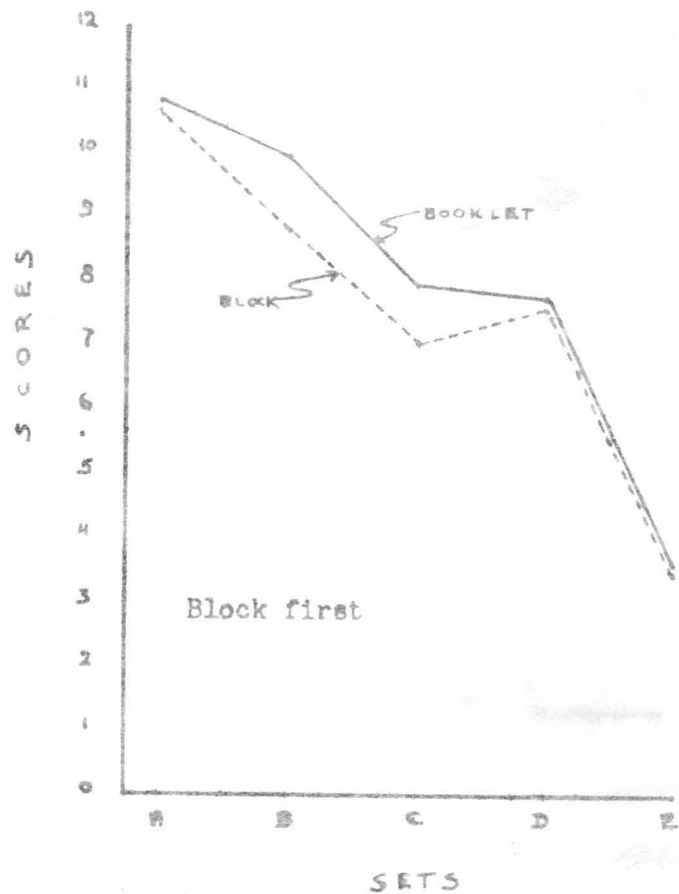
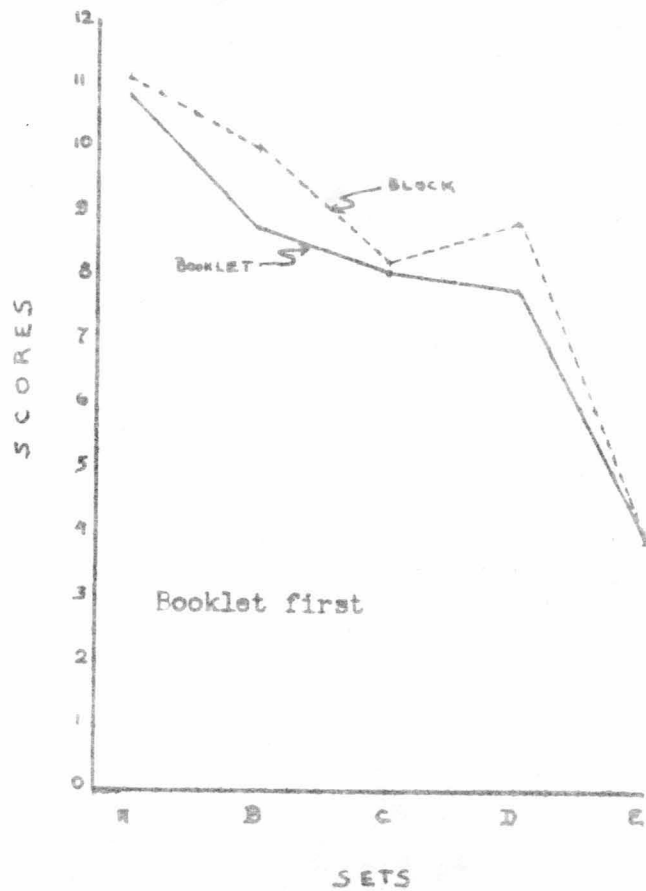


FIGURE 4

Comparison of scores

Control group

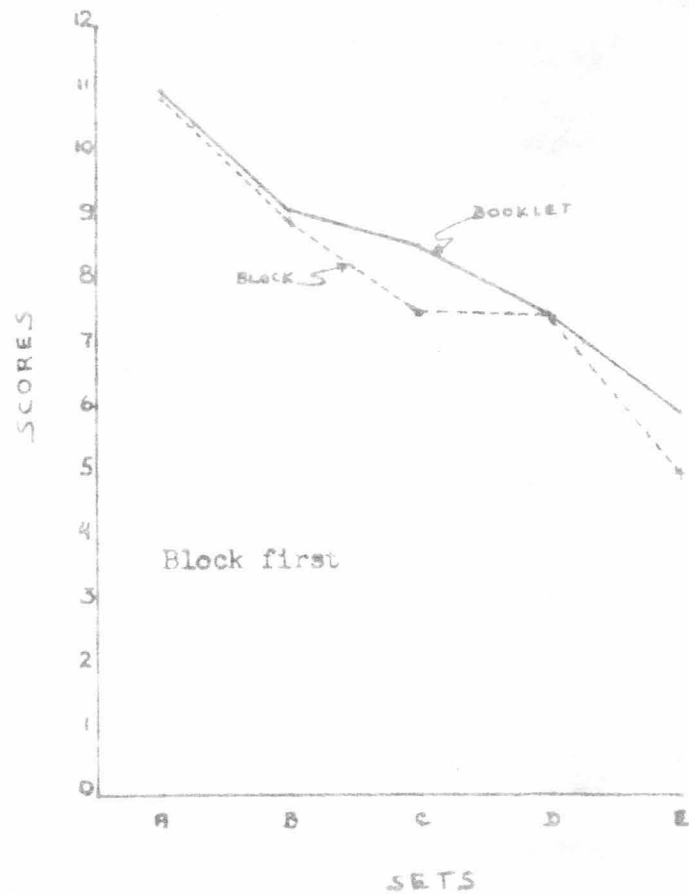
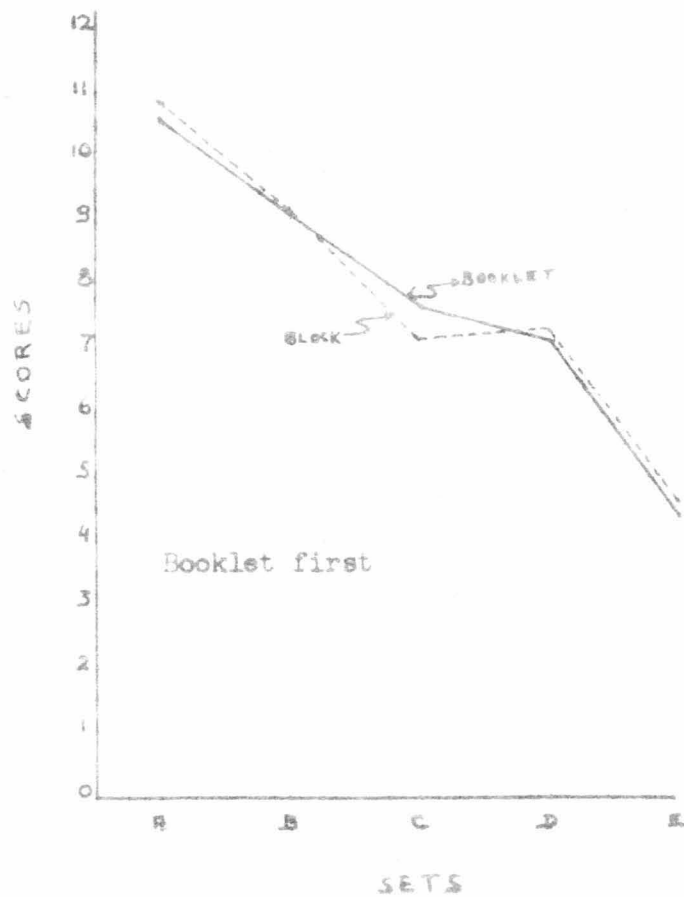


FIGURE 5  
Comparison of scores

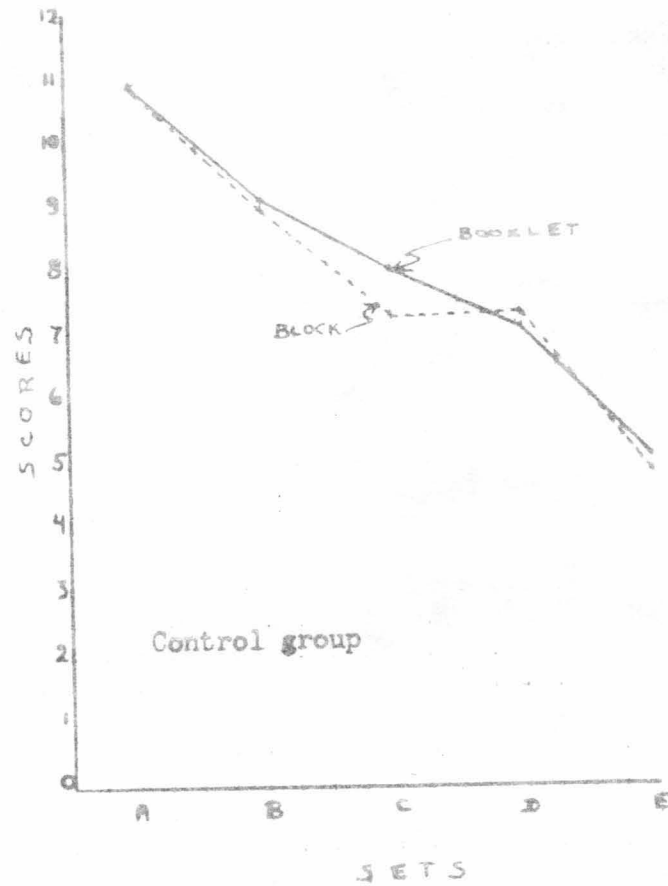
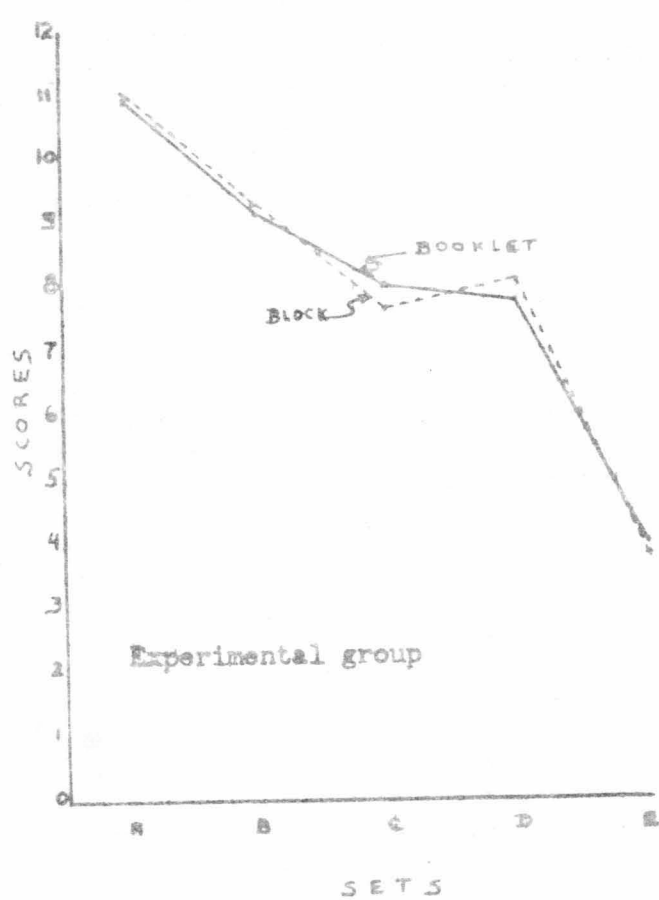


TABLE 5

MEANS FOR THE TOTAL EXPERIMENTAL AND THE TOTAL CONTROL  
GROUPS IN BOTH FORMS OF THE SIX SETS OF THE RAVEN  
PROGRESSIVE MATRICES

Sets	Experimental		Control	
	Booklet	Block	Booklet	Block
A	10.85	10.98	10.80	10.97
B	9.33	9.46	9.16	9.07
C	8.03	7.60	8.10	7.38
D	7.72	8.21	7.27	7.42
E	3.94	3.72	5.11	4.83
	N = 32		N = 28	

When a re-examination of the original data was made in the light of these negative findings, it was discovered that the time factor, which had not been considered pertinent to the main portion of the study, might indeed assume sufficient importance to warrant further investigation. Calculation of the average time taken by the subjects to complete the booklet and the block forms revealed wide group differences, as shown in Table 6. Hence it was decided to apply the analysis of variance method to this problem involving time. Only the booklet form was used as the basis of comparison between the experimental and control groups, because it was felt that the time element on the block form was unduly exaggerated by the need to manipulate the various

TABLE 6

A COMPARISON OF MEANS BETWEEN THE EXPERIMENTAL AND THE CONTROL GROUPS IN TIME TAKEN, AS GIVEN IN MINUTES, TO COMPLETE THE TWO FORMS OF THE RAVEN TEST

	Experimental		Control	
	Booklet	Block	Booklet	Block
N	32	32	28	28
M	52.8	76.6	28.6	27.8

pieces of the block form, whether done by the examiner or the subject, in contrast to the much simpler task of merely turning the pages of the booklet form. Such of course, would be more likely to affect the time taken by the handicapped subjects as against that of the normal ones, due to the difficulty of the former in handling objects.

The results of the analysis of variance covering this question of time are summarized in Table 7. By way of explanation it must be said that a square root transformation of the original scores, as measured by elapsed time in minutes, was considered advisable, since Bartlett's test for homogeneity of variability on the original data revealed a significant difference between the experimental and the control groups; therefore, the figures in the table reflect this method of transforming scores to bring about equality of variability between groups. Parenthetically, it should be added, however, that an analysis of variance using the original scores revealed essentially the same results, indicating that such a laborious transformation of scores was largely a precautionary procedure rather than a necessary one.

TABLE 7  
ANALYSIS OF VARIANCE FOR THE TIME SCORES

Type	Description of Variable	Sum of Squares	Degrees of Freedom	Mean Square	F	Levels of Confidence	
						5%	1%
I	Experimental vs. Control	55.859	1	55.859	29.681	4.02	7.16
II	First vs. Second Presentations	3.051	1	3.051	1.621	4.02	7.16
I-II	Interaction	3.360	1	3.360	1.785	4.02	7.16
Within		105.396	56	1.882			
Total		167.666	59				

An examination of Table 7, particularly the "F" column in relation to the columns indicating 5% and 1% levels of confidence, discloses a very significant difference between the experimental and the control groups, representing cerebral palsied as compared with normal persons, in the matter of time needed to complete the booklet form of the Raven test. Moreover, supporting this striking contrast is the fact that no significant difference is shown in regard to the order of presentation, that is, whether the booklet was administered first or second in relation to the block form. (The latter form, of course, did not enter into the calculations involved in this particular problem of time, for the reasons stated previously.)

Although it has little if any bearing on the over-all study, an



an interesting sidelight is provided by the results in Table 8, which gives the stated preference of the subjects in both the experimental and the control groups either for the booklet form or for the block form, or for neither one.

TABLE 8  
PREFERENCES EXPRESSED BY SUBJECTS  
FOR ONE FORM OR ANOTHER OF THE RAVEN TEST

	Booklet	Block	Neither
Experimental	7	17	8
Control	6	18	4
Totals	13	35	12

Thus, despite the fact that both groups showed no significant differences in their performances on the booklet form as compared to the block form, more than twice as many in each group still preferred the latter to the former; and many of the subjects who selected the latter, elaborated upon their choice by stating they felt certain that they had done better on the block form.

The principal findings in this section, that is, those which are the most pertinent to the major aspects of the present study, will be discussed in the following chapter.

## CHAPTER VI

### DISCUSSION OF THE RESULTS

The finding of no significant differences with respect to both Hypotheses I and II could raise some questions concerning certain aspects of the research. In the first place the subjects comprising the experimental group may have represented a biased sampling of the population. It would seem likely that sampling errors might be somewhat higher in number in the case of the cerebral palsied group as compared to the normal group, primarily for the following reasons: 1) cerebral palsy being a somewhat loosely and arbitrarily defined handicapping condition, covering several types and degrees of brain injury with crippling neuromuscular effects, it is very difficult to secure a purely random sample of such a population; 2) the subjects of this study were volunteers rather than having been selected at random. Therefore, when circumstances such as these are present, the experimenter has to be satisfied with what Guilford (23, p. 180) has termed the "incidental sample" because it is the most available, especially since "...conditions of sampling are never ideal." In the second place the Progressive Matrices may not have been a sufficiently sensitive test for distinguishing between the groups on the basis of presumed differences in visual perception and/or in abstract thinking. Thus, even though a factorial analysis of the test has indicated that it contains strong elements of visual perception as well as other elements involved in abstract thought, these elements could be so submerged in the

over-all "intellectual activity" component that any marked deviations in them would not be brought to light. However, the important fact to remember here is, while the Progressive Matrices as such was the measuring instrument, the booklet and block forms represented the real method by which these differences --- if they were to exist --- would be demonstrated. In other words, the block form --- by having certain characteristics not present in the booklet form, such as increased size, concreteness, three dimensionality and mobility of parts in completing each pattern --- was presumed to aid the cerebral palsied group in solving test problems that are known to be heavily loaded in perceptual and thinking factors. Therefore, the validity of the method of discovering possible disturbances in these factors depends upon two forms of the Raven test --- not upon the Raven test per se.

Another question, which is related to the preceding one concerning the appropriateness of the Progressive Matrices, centers around the possibility that the method of matching the experimental and control groups may have inadvertently set the stage, so to speak, for the negative findings which were subsequently obtained. It will be recalled that the two groups were equated with respect to chronological age, amount of education and I.Q. --- the latter being determined by the verbal scale of the Wechsler-Bellevue. The significantly high correlations between their performances on this verbal scale and the two forms of the Raven test, as shown in the previous section entitled RESULTS, might indicate that the usefulness of the Raven test as the measuring instrument may have been somewhat diminished by being too closely linked to the matching instrument. One answer to this would be that, although both the matching and the measuring instruments are regarded as intelligence tests, the

Progressive Matrices may still be singling out and emphasizing different aspects of intelligence than the verbal scale of the Wechsler-Bellevue.

However, probably the best answer which can be given to such questions about the adequacy of the method of measurement is to say that these questions relate to the first of the two original assumptions upon which Hypotheses I and II of this study were based. In this connection, therefore, the present writer is confident that the method of utilizing two forms of the Raven test served the purpose for which it was intended --- although he recognizes that others may disagree on this point --- and that consequently certain valid inferences can be made from this research.

Since the obtained results did not substantiate either Hypothesis I or II, as given in the earlier chapter entitled STATEMENT OF THE PROBLEM, the most conservative interpretation would be to say that at least some cerebral palsied adults do not differ significantly from normal adults in their performances on test problems involving visual perception and abstract thinking. By way of further elaboration, it can be stated that at least some cerebral palsied adults do not appear to have disturbances in visual perception and abstract thinking which could be said to interfere with their success on test problems containing these psychological components. The strongest support for this last assertion is found in the evidence that the cerebral palsied adults, among themselves, did not differ significantly in their scores on the block form as compared to the booklet form and that therefore they showed no benefit from the use of the block form, with its expected advantage to those who have these disturbances. Hence, the contention by certain experts in the field that "a concrete rather than an abstract thinking approach, must play a large

part in the educational training program for cerebral palsied children" (27, p. 97) does not seem applicable to the adults who participated in the present investigation, judging from these findings.

It should be noted in the preceding paragraph that the phrase "at least some" has been underscored. This has been deliberately done, because the writer feels that broad, sweeping generalizations concerning all cerebral palsied — when based upon data from a few experimental studies of such children — are risky and unjustified, if not highly misleading, in view of the incomplete state of our current knowledge of brain functions. The present study is no exception, and its findings on the basis of a small sample certainly do not warrant the unqualified statement that all cerebral palsied adults show a surprising lack of disturbances in visual perception and thinking. It is therefore considered safer to say that some do not, whereas others may well exhibit them, especially since the effects of brain damage are extremely diverse and inconsistent at best!

Many workers in the field seem to fall into the questionable habit of referring to the "brain-injured child" or the "brain-injured adult" as though each one possessed characteristics and identifying marks which were typical of a whole class of persons with a certain diagnosis. Wortis has challenged the assertion by Strauss and Lehtinen (14) that neither the nature nor the extent of a brain injury is of great concern, since the clinical manifestations are the same and since all brain lesions result in a similar type of disordered behavior among brain-injured children. He has wisely cautioned that

...it would be very rash indeed to declare that any lesion, diffuse or discrete, regardless of degree or localization, would tend to produce the same pattern of behavior....There is, in short, I believe, no "brain-injured child," but only a variety of brain-injured children whose problems are quite varied and whose condition calls for far more refined analysis than some of the current generalizations on the brain-injured child provide. (53, pp. 205-206)

These remarks are just as pertinent to cerebral palsied children; and yet Dolphin and Cruickshank (16, p. 4), in discussing the educational implications of their findings, which were reported earlier in the section headed REVIEW OF RELATED LITERATURE, tend to do exactly what Wortis warns against and to generalize too freely from the small sample to the total population, thus:

The perceptive process of the child with cerebral palsy is now known to be characterized by (a) inability to withstand the impact of stimuli, (b) difficulty in discriminating background from foreground stimuli, (c) perseveration, (d) dissociation, and (e) motor disinhibition. (16, p. 4)

Obviously, a more careful approach in this matter would be to recognize, as Cardwell (7, p. 358) does, that some cerebral palsied children undoubtedly manifest these perceptual and thinking difficulties while others apparently do not; therefore one is not justified in attributing such characteristics to all cerebral palsied.

The convictions of Wortis with respect to brain-injured children and of Cardwell concerning cerebral palsied children seem equally applicable to cerebral palsied adults. Hence, there is no typical "cerebral palsied adult"; instead there are many such persons whose problems are admittedly varied and complex, but not identical.

To reiterate, then, in line with this cautious approach to the problem of the effects of brain damage, it is safe to say that, on the basis of this small sampling of the total population, at least some cerebral palsied adults

--- when age, amount of education and verbal I.Q. are held constant --- exhibit no significant deviation from the norm in visual perceptual and thinking, insofar as these processes can be measured by two forms of Raven's Progressive Matrices.

Any attempt to account for this phenomenon is, of course, largely a matter of speculation. One possible explanation would be that in the process of maturation cerebral palsied persons might either spontaneously outgrow such disorders or more likely learn to compensate for them somehow, assuming that Dolphin and Cruickshank are correct in claiming that most if not all cerebral palsied children show signs of perceptual and thinking "pathology". Lehtinen, in a chapter of the volume on the brain-injured child edited by Strauss and Kephart, as quoted earlier, maintains that this appears to happen with mentally deficient brain-injured children in regard to one commonly seen symptom:

We have observed that with increasing maturity the disrupting effect of distractibility decreases. We can presume that the organism through maturation and learning has achieved... more facility in perceiving the relationship of external stimuli to his circumstances of the moment. (30, pp. 173-174)

With respect to the physical handicap itself, it is apparent that many intelligent, well-motivated cerebral palsied persons have been able to compensate for the lack of or damage to braincells governing motor activity --- that is to say, they have learned, by training and conscious effort, to utilize the undamaged motor cells and alternate neural pathways of the brain, in order to carry out as many muscular activities as are still potentially possible, regardless of how crudely or incoordinately performed. By the same token it would seem conceivable for those who have the necessary potential to

also learn to offset the disruptive effect of any presumed perceptual and thinking disturbances, again assuming that they had such disturbances to begin with. It will be recalled in this connection that the cerebral palsied adults comprising the experimental group averaged 12.2 years of formal education, which is the equivalent of having finished high school, and averaged 106.8 in verbal I.Q.; hence they would be expected to have these potentials for doing so. Perhaps, then, the cerebral palsied adults who were selected for this study happened to be those who had already compensated for such presumed disturbances and therefore, when given sufficient time, could equal the normal adults in their average performance on the test problems.

Another possible explanation would be that the cerebral palsied adults in this particular sample never had these perceptual and thinking disturbances, therefore could not learn to "compensate" for some hypothetical difficulties. Unfortunately, not enough is known on the subject to be able to say which of these two possible explanations, if indeed either one, is the more plausible. Certainly more longitudinal studies of brain-injured persons in general and cerebral palsied persons in particular are needed to keep pace with our rapidly growing knowledge of brain functioning. As mentioned before, the most conservative interpretation seems to be the only one which can be adopted for the present, until more extensive knowledge has been acquired — namely, that at least some cerebral palsied adults, when given sufficient time, do not differ significantly from normal adults in their average performance on certain test problems involving visual perception and abstract thinking.

The expression "when given sufficient time," which has been used in each of the summarizing statements of the last two paragraphs, calls attention to



the fact that the element of time must not be overlooked in this discussion, although it was not foreseen as an important aspect in the original formulation of the problem. Indeed, it was more or less accidentally uncovered when a re-examination of the data was made in the light of the negative findings, as explained in the preceding chapter. Having thus discovered a very significant difference between the cerebral palsied group and the normal group in the time taken to complete the booklet form of the Progressive Matrices, as the results given in Table 7 reveal, the writer is frank to admit that these findings apparently do little more than open the way to further speculation which may or may not eventually help to solve the basic questions raised by this study. He realizes that the problem of time introduces a dimension in research with cerebral palsied persons which has not received adequate consideration in the past, and which unfortunately can only be touched upon briefly here.

In this connection, then, it is worth noting that a number of the tests used by Strauss and his associates on brain-injured children and by Dolphin and Cruickshank on cerebral palsied children were timed tests. The time limits within which these subjects operated were arbitrarily set; thus some of the obtained differences from the norm in perception and thinking were secured within the framework of time as a penalizing factor. More use of untimed tests on groups of cerebral palsied persons of various ages and intellectual levels might shed new light on the problem from the standpoint of a cross-sectional as well as a longitudinal approach.

Another interesting point which can be raised is that the time element could represent a very important part of the compensatory process alluded to above. Again by way of speculation, it could be surmised that intelligent

cerebral palsied persons are constantly attempting to offset the tension and anxiety to which they are subjected by the hypersensitivity of the nervous system itself, as well as by the personal-social problems of adjustment. The "pressure of time" only accentuates the disruptive effects of these organic and functional factors and also increases the dilemma of those who are trying to compensate for them. It is therefore conceivable, in the writer's opinion, that such disruptive effects, including the pressure of time, could cause functional disturbances of perception and thinking --- not the "pathological" organic ones claimed by some investigators. What the assurance of unlimited time may do is to assist cerebral palsied persons in the compensatory process of relaxing sufficiently to be relatively free from tension and anxiety and to achieve a better degree of concentration, thereby enabling them to perform equal to normal persons in a problem-solving situation. In doing so, however, they may take twice as much time, as shown by the results of the present study.

Let it be re-emphasized in concluding this discussion that these are speculations prompted by the discovery that time is an important factor to consider in evaluating the test performances of cerebral palsied children and adults. It is hoped that they will lead to further research into this area, as well as other related ones, in this challenging field.

## CHAPTER VII

### SUMMARY AND CONCLUSIONS

To investigate the possibility that cerebral palsied adults exhibit disturbances in visual perception and abstract thinking which would be revealed in their performances on two forms of a non-verbal intelligence test having these components, a booklet and a block form of Raven's Progressive Matrices were administered to an experimental group of 32 cerebral palsied subjects, including 19 males and 13 females, ranging in age from 19 to 42, and a control group of 28 normal subjects, including 16 males and 12 females, ranging in age from 18 to 52. These groups were matched for age, amount of education and I.Q., no significant differences having been found between the means of the two groups in these three categories. Of the 32 cerebral palsied subjects 10 were classified as spastic and 18 as athetoid; 4 were regarded as having somewhat mixed and ill-defined characteristics and were therefore left unclassified as to type. With respect to degree of handicap, according to certain specified standards of appraisal, 16 were judged mild, 10 were moderate and 6 were severe. To minimize the possibility of a practice effect, the two groups were divided into two sub-groups each and the method of rotating them were employed. Thus, one sub-group in each larger group was given the booklet form, followed four months later by a re-test on the block form; the other was given the block form with a re-test on the booklet form after the same elapse of time.

On the basis of these presumed disturbances in the cerebral palsied subjects, two hypotheses were advanced centering around the expectation that, using two forms of the Raven test as the measuring instrument, significant differences would be found not only between the cerebral palsied and the normal subjects but also among the cerebral palsied subjects themselves. Both hypotheses rested on two assumptions: first, that the presence of such disturbances can be demonstrated by comparing the scores on the two forms, in one of which (the block form) the perceptual and thinking components are accentuated so as to play a more important part than in the other (the booklet form); and second, that the cerebral palsied subjects need the benefit of the enlarged, more concrete and three-dimensional block form, with its manipulative pieces — all of which features bring out more clearly the perceptual and thinking elements — in order to offset the detrimental effect of these disturbances.

The analysis of variance method was used to determine the significance of the differences in the major comparative aspects of the study. This method was also used in a supplementary study of the time needed by the two groups of subjects to complete the booklet form of the Raven test, since the time element was found to play an important part in their respective performances. The investigation of time was limited to the booklet form because it was regarded as better able to reflect the time factor operating in the perceptual and thought processes required to solve the test problems.

The following conclusions are drawn from the results which were obtained in this study:

1. Contrary to expectation, no significant differences were found between a group of cerebral palsied adults and a group of normal adults on either the booklet or the block form of Raven's Progressive Matrices. Thus, comparison of their performances on these two forms failed to reveal the presence of disturbances in visual perception and abstract thinking in the handicapped group.
2. When each group was sub-divided, it made no significant difference whether the booklet or the block form was administered first; nor was there any evidence in either group of a practice effect after an elapse of four months between the giving of one form and another.
3. Contrary to expectation, among the cerebral palsied adults themselves, no significant difference was found between their performances on the booklet and the block form. This would indicate that the block form, with its characteristic features which were expected to offset their presumed disturbances in visual perception and abstract thinking, was of no advantage to them over the booklet form.
4. As was to be expected, among the normal adults themselves, no significant difference was found between their performances on the booklet and the block form.
5. A very significant difference at the 1% level of confidence was found between the two groups in time taken to complete the booklet form of Raven's Progressive Matrices. This would strongly indicate that the time element is an important factor to consider in evaluating the over-all findings of this study and the test results of cerebral palsied persons in general, whether children or adults. It would seem to be of sufficient importance to warrant further serious investigation in any similar studies of such persons.

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APPROVAL SHEET

The dissertation submitted by Vernon Sloan Tracht has been read and approved by five members of the Department of Psychology.

The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the dissertation is now given final approval with reference to content, form, and mechanical accuracy.

The dissertation is therefore accepted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy.

Jan 15, 1951  
Date

Vincent V. Henry  
Signature of Adviser