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ABSTRACT

Presented is a report on a cross-sectional and longitudinal study concerned with the course of intellectual development in 210 children (6-12 years old) educationally designated as brain damaged (learning disabled and/or behavior problems) and assigned to special school placement. The report is divided into four sections which focus on introductory information, stability and change, patterns of abilities, and growth and prediction. Fourteen chapters cover the following topics: subjects, test procedures, and methods; intelligence, achievement, and other variables--a summary for 4 years; longitudinal study of the Wechsler Intelligence Scale for Children (WISC); related literature; relationships of mental abilities, neurological signs, and academic achievement; age-specific relationships of neurological signs and intellectual status; a graphic view of patterns of intellectual functioning; consecutive factor analyses of the WISC for 4 years--R analysis of test variables; factor analysis of the WISC--Q analyses of person variables; Primary Mental Abilities Test patterns of mental ability--a regression analysis; patterns of ability and behavioral status on a classroom-specific basis; predictive value of IQ scores for growth in academic achievement; and prediction of reading abilities. The document also contains 134 tables and 26 figures. (SBH)

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COGNITIVE DEVELOPMENT IN CHILDREN WITH BRAIN DAMAGE

by

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It is often said that the orientation of a teaching faculty toward research directly reflects the attitudes of the administration. It is also no secret that busy teachers do not always find it easy to sympathize with the goals of research when it does not readily promise

practical answers to practical questions. It is, therefore, an extraordinary tribute to the teachers in this school that they and their administration demonstrated such consistently friendly attitudes toward the various research assistants who were required to interrupt classrooms for testing purposes at all hours of the school day.

The large number of teachers makes it impossible to list them by name, but they are no less appreciated because of this limitation. In fact, there could have been no study without their cooperation.

A number of research assistants participated in different phases of the project. However, it was primarily Sheila Carlos Squillace who provided the responsible assistance that was necessary for the proper recording, treatment, collation and coding of the data. Thanks go to Shavee Altman who attended to the myriad secretarial duties in a reliable and highly effective manner.

I wish to acknowledge the constant and never-failing professional support of my wife, Juliet Bortner, who worked in a variety of capacities during the course of this study. In addition to actively participating in and supervising the data collection, she established the kind of interpersonal contacts with the children, teachers and administrators which made it possible for us to return year after year without incurring resistance. She provided the continuity that permitted such a large amount of data to be organized. Her many skills as a psychologist permitted her to play an important and continuous role in the decision-making processes at all stages of the project.

At different points and around different issues different individuals emerged in important roles. Dr. Sam Korn supplied the invaluable advice which led to the formulation of the format of Tables 1 to 65. The great value of these tables is that they present basic data in a manner which makes it feasible for other investigators to re-work the data and to pursue questions of their own choosing.

Drs. Serena and Joseph Reswick played an important role in the preparation and interpretation of the data for Chapter 4. Dr. David J. Franks was a student intern at Yeshiva University at the time of this study. Based on a portion of this project's data, and under the sponsorship of Dr. Edward Meyen at the University of Missouri-Columbia he completed a doctoral dissertation. Chapters 5 and 6 are both a revision and a condensation of aspects of his dissertation.

Dr. Margaret Hertzig was the physician who administered the clinical neurological examinations to all the children, thus making it possible to compile the data reported in Chapter 7. Dr. Leon Smith acted as technical and methodological consultant to a number of studies completed in this project. These included studies reported in Chapters 9, 11, 12 and 13. His advice and his calm were equally invaluable. He was assisted by Gregory Schimoler who played an important role in computerizing portions of the data. Dr. Robert Cooper was a research associate for the project at that point in time when the principal investigator became interested in Q Factor Analysis. Chapter 10 is the outcome of this interest and contains Dr. Cooper's contribution to a complex statistical analysis which benefitted from the advice of several statisticians and programmers including Mendel Hoffman and Dr. Patricia Cohen.

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In the background, during the conduct of this study, there was always the advice of Dr. Herbert G. Birch. Although he did not live to participate in the final analyses of the data, his views influenced this report insofar as they are so inextricably interwoven with those of the principal investigator as to be inseparable from them.

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Scholar continued throughout the period of the conduct of this project, and their support is gratefully acknowledged.

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1976 Morton Bortner, Ph.D.

TABLE OF CONTENTS

Section IV: Growth and Prediction

LIST OF TABLES

LIST OF FIGURES

Figure Page

Section I: Introduction

Chapter 1. Statement of Problem

The present study is concerned with the course of development of intellectual functioning in brain damaged children. The method of study is both cross-sectional and longitudinal.

Children with certain kinds of behavioral disturbances and learning disorders have increasingly been categorized both in clinical and educational situations as "brain damaged," "perceptually impaired," "hyperkinetic," and by a variety of other euphemistic labels. Clements (1966) in summarizing the literature for a special joint commission on cerebral dysfunction has pointed out that in published reports one can find a wide variety of names for what are presumably similar groups of children and that approximately 100 symptoms and symptom complexes are attributed to them. Simultaneous with the development of clinical and educational classifications parental special interest groups have emerged and educational theories have evolved. These ideas and events have resulted in the establishment of an educational category of brain injury, the formation of special classes and even of special schools for such children. In addition, a diversified set of curricula for such special groups are currently available and are the object of discussion and controversy. Clearly, no uniform teaching procedures have been universally accepted.

Despite this growth of special classes and despite the widespread recognition that children classified as brain damaged constitute a most heterogeneous aggregation (Birch, 1964; Bortner, 1968), little effort has yet been made to divide this group into more meaningful educational categories. Until such sub-division is made the assessment of effective curricula is impossible, and our educational planning will be obscured by conflicting reports on the success or failure of different methods of instruction always special but never demonstrably pertinent or appropriate to the learning styles or potentials of the children to whom they happen to be applied.

It is necessary, in order to arrive at rational curricula, to have a clearer understanding of the course of cognitive growth in children with neurological impairment. It is also necessary to have more clearly defined objectives regarding the kinds of alteration in developmental course the instructional intervention is designed to help. To do this requires depicting the course of cognitive growth in neurologically impaired children.

In the present research a first step is taken in delineating a basis for meaningful educational classification by analyzing one set of abilities central to learning, i.e. intellectual competence described in terms of patterning and growth. It is hoped that this analysis will contribute to a useful basis for pertinent sub-division of the children who have been globally classified as brain damaged.

Despite the over-inclusive nature of the deficits described for brain damaged children and the lack of agreement in the literature on all points, there is good agreement on several issues which are clearly basic to the educational process. Attention and concentration are frequently impaired, motoric rhythm is disrupted and intellectual functioning is inadequate and uneven. The present study is concerned with this last area.

Growth of Intelligence

Developmental psychology has given a significant amount of attention to the question of how intelligence grows in normal children. The Berkely Growth Studies determined growth of intelligence through longitudinal study of children in the age range 1 month through 18 years. A partial listing of the publications that stemmed from this project is found in Bayley and Jones (1941).

Many other investigators have demonstrated interest in this problem area and their names are a good indicator of the merits of the research area: Shuttleworth (1939), Freeman and Flory (1937), Goodenough and Maurer (1942), and Escalona and Heider (1959). Unfortunately, comparable studies on the growth of intelligence in children with neurological impairment do not exist. The present research is an approach to this neglected area.

It is important to note that none of the standard texts on exceptional children, e.g., Dunn (1973), or Kirk (1962), which contain chapters on retarded and neurologically impaired children contain any information on the growth of intelligence in these children. A few studies have appeared which showed interest in the intellectual growth of retarded, neurologically impaired children. Baumann et al. (1962) reported a follow-up of children aged 5-12 evaluated psychologically, physically, psychiatrically and neurologically. However, only 19 children were available for intensive re-evaluation. In Drillen's study (1961) re-testing was done with children 2-5 years of age, but the emphasis was on the detection of difficulties associated with prematurity. Knobloch and Pasamanick (1960) were interested in the predictability of abnormality at early age levels, and found Gesell testing at one month predictive of abnormality at 10 months of age and these in turn to be predictive of intellectual function at three years of age. Several studies (Denhof, Holden and Silver, 1956; Meyer and Crothers, 1953) were concerned with the validity of a variety of forecasts and have reported these for intellectual status as being reasonably accurate. Unlike the findings for normal children, studies of neurologically impaired children do demonstrate the predictive value of testing in earlier years for later performance (Knobloch and Pasamanick, 1960).

In all these studies the emphasis was on the reliability of total test-retest or the prognostic value of an IQ at a given point in time in the child's development. Intellectual status as a global entity was viewed in relation to other gross measures such as physical growth or neurological status. No attention was given to aspects of intellectual function. The present report will deal with these issues in the section entitled "Growth and Prediction."

Variability and Consistency

It is important to know something of the variability and consistency of a group's intellectual functioning in order to plan educationally for them. Wide ranging variability in function for a group at a given age level will clearly require a somewhat different teaching approach than would be the case for a group which evidences greater homogeneity and a narrow range of ability. Similarly, if we know that a given child maintains his status over the years relative to his peer group on a particular intellectual function, then special emphasis can be planned to offset known (and consistently maintained) deficits. If instead, inconsistency is observed, and the deficits of today become the relative strengths of tomorrow, a different, more flexible (and more complex) instructional program will need to be planned.

Consistency of intellectual status through time in normal children was reported by Bayley (1949) as being high. Correlations between repeats of the same test averaged .89 and correlations between different tests averaged .87. Stability of total test scores in longitudinally studied samples of normal children have been found to depend on three variables: the age of the child at the first testing, the interval between tests and the intelligence level of the child (Bayley, 1949; Ebert and Simmons, 1943; Honzik, 1938; McNemar, 1942).

The consistency of intellectual functioning in neurologically impaired children remains unknown. This problem may be re-stated as follows: What happens to the relative position of a child within his peer group both in terms of general intelligence test scores and in terms of specific aspects of intellectual functioning? The present report will deal with these issues in the section entitled "Stability & Change."

Patterns of Ability

It is important to document the pattern of the child's abilities in conjunction with his general level of functioning. No statement of level alone can ever fully describe the relative strengths and weaknesses of a child's intellectual functioning. Moreover, it is evident that within groups placed together because of homogeneity of general intellectual level there are wide disparities in individual abilities. Only a knowledge of the pattern of abilities that characterizes the child can adequately prepare the teacher for the job of devising appropriate instructional procedures. Hence, a knowledge of patterns of ability leads ultimately to more rational educational planning.

Intelligence is not a unitary and homogeneous entity, but is instead composed of a variety of abilities (Bayley, 1949; Conrad et al., 1944; Hofstaetter, 1954; Pinneau, 1960). The finding of variability with age leads, of course, to the question of the predictive value of scores at earlier ages for later ages. Whereas infant IQs are not predictive of school age IQs in normal and superior children, they are highly predictive for neurologically impaired children (Pasamanick and Knobloch, 1960; Escalona and Moriarty, 1961). These earlier studies were generally concerned with overall scores. When patterns of scores were analyzed, it was largely for the theoretically motivated concern with the structure of intelligence itself as in the various factor analytic studies (Cohen, 1959; Meyers et al., 1962; Balinsky, 1941). Some work has also been done to analyze intellectual factors in subnormal samples (Baumeister, 1964; Baumeister and Bartlett, 1962a; Baumeister and Bartlett, 1962b) but not specifically with neurologically impaired children.

The work of Lesser et al. (1965) has brought renewed attention to the need to scrutinize patterns of abilities (as contrasted with the more general concern with simple IQ) in young children. Relying on a test battery which included measures of spatial, verbal, numerical and reasoning abilities, they were able to demonstrate meaningful differences in patterns of ability among various ethnic and socio-economic groups. The obvious educational significance of this work derives from the findings that different groups of children need more attention in some cognitive areas than in others, and that a knowledge of the child's reference group is predictive of the kind of educational intervention he is most likely to need. It is surprising that so little is now known regarding such patterns in neurologically impaired children.

The lack of information in this area seems to stem from some ambiguity in the reference to "unevenness" of intellectual function. What is meant by this term? There are a number of clinical reports which support earlier findings (Piotrowski, 1937) that verbal scores are superior to performance scores in neurologically impaired children. At least one study fails to confirm this frequent finding (Birch, Belmont, Belmont and Taft, 1967). The same clinical generalization with respect to verbal-performance disparity has long been made for schizophrenic patients although even here the evidence is not unequivocal (Hertzig and Birch, 1966). Since this same pattern is used to describe several pathological entities, the diagnostic and discriminative utility of this pattern is somewhat mitigated. What about the educational utility of a verbal vs. performance characterization? There seems to be limited practical value in this description for the teacher (Bortner, 1968). In order for an assessment of intellectual ability to gain maximum utility, at least three additional kinds of information appear to be necessary: 1. What aspects of verbal and performance ability are relatively intact, and what aspects are relatively defective? 2. Does the character of this profile change with age or is it constant? 3. Quite aside from the issue of whether the child at a given point in time is uneven, we need to know if he grows unevenly. This is an entirely separate matter from question number two above, and may be restated as follows: Does the individual's style of intellectual performance at a given time relate systematically to his style of performance in subsequent periods? Only a longitudinal analysis can answer this question.

The foregoing suggests that a lucid characterization of intellectual functioning in brain damaged children that goes beyond the time honored but educationally limited "verbal in relation to performance" can be achieved by an analysis of patterns of mental abilities. Moreover, such patterns are most likely to be of educational value when they are described in age related terms since the intellectual profile that characterizes the impaired six year old may reveal different strengths and weaknesses than those seen at age seven or eight and so on. Finally, in addition to knowing whether these children are uneven, we need to know if they grow unevenly. It must be remembered that neither identical nor dissimilar profiles at consecutive age levels determined cross-sectionally tell us anything about individual style of growth since such cross-sectionally defined age related patterns are based on mean values which totally obscure individual differences in rate of growth. Ausubel (1964) has pointed out the essential irrelevance of cross-sectional studies to this problem.

The present report will deal with these issues in Section III entitled "Patterns of Abilities."

Chapter 2. Subjects, Test Procedures and Methods

Subjects

The subjects of this study were 210 children who had been educationally designated as brain damaged and assigned to special school placement. At the time of examination the children were in a special elementary school and ranged in age from 6 through 12 years. There were three times as many boys as girls in the sample. This sex distribution is in line with that in other studies (Birch, 1964; Rutter, Graham, and Yule, 1970).

The special school for brain damaged children from which the children of this study were drawn serves an entire suburban county of 56 school districts and approximately 350,000 pupils. The social class and ethnic characteristics of children attending this special school have been described in detail in a previous report (Bortner and Birch, 1970). In summary, the pupils were predominantly white, from upper working-class and middle-class backgrounds, and with a scattered representation of other social and ethnic groups. There was a marked underrepresentation of children from significantly deprived social and economic backgrounds.

Placement in this special school for brain damaged children was based on the county's educational policy which called for the placement of children with learning disabilities and/or behavioral problems in this facility when a neurologist had attested to the presence of neurological impairment.

To be sure, such medical evidence was not uniform and relied variously on (1) history, (2) the clinical neurological examination and/or (3) electroencephalography. However, while data was not uniform in all three areas, there was positive evidence in the school records from at least one of these three sources. Hence, some children came with a history of seizures, others with pathological reflex status, others with positive EEG, and still others with some combination of these signs. All children presumably came with at least one of these signs plus a history of difficulty in school achievement.

The sample studied consisted of 30 children selected at random from the pool at each age level in the age range 6-12. This range was selected because this is a period of growth and change. Slightly less than the original 30 children were followed in the second, third and fourth years of the study because of moves, transfers and illnesses. Even so, there was remarkable stability and the second, third and fourth years had Ns, respectively, of 203, 193, and 177. The high quality of the school undoubtedly influenced parents to remain in the school district, and prevented greater out-migration.

Methods

Both a cross-sectional and longitudinal approach were utilized.

a. Cross-Sectional

1. All children at each age level from 6-12 years were given the various test measures during the first year. At the end of the first year it was possible to describe age-specific patterns of intellectual functioning and deal directly with the question of whether these children were uneven in intellectual patterning at different points in the developmental sequence from 6 through 12 years.

2. The first year of testing also permitted evaluation of the problem of whether such patterning took different forms at different age levels.

b. Longitudinal

1. The children were followed for a total of four years. The second, third and fourth years saw the development of overlapping cohorts and the repeated testing of all children previously tested in the first year. Hence, children aged 6 in the first year were 7 in the second year, 8 in the third year and 9 in the fourth year. This

resulted in the following scheme:

Table 2

Overlapping Cohorts

Age of Child in:			
1st Year	2nd Year	3rd Year	4th Year
6	7	8	9
7	8	9	10
8	9	10	11
9	10	11	12
10	11	12	13
11	12	13	14

/ = Cohort

As can be seen from this table, two virtues attached to this method. First, the size of the N at each age level was greatly increased in the second, third and fourth years. For example, children who became 8 in the second year and those who became 8 in the third year were added to those who were 8 in the first year. With these enlarged Ns the statistical comparisons of antecedent with subsequent test results were made with greater power. The only limiting factor to this procedure occurs when, e.g. children who are eight in the first year of testing are significantly different in their test results from children who are eight years old in the second or third years of testing.

The second merit of this procedure derived from the fact that in the relatively short space of four years, the age span studied was increased three years and included 13 and 14 year olds without adding new children. Thus comparisons of antecedent with subsequent test results covered a wider age span.

2. Utilization of this longitudinal method permitted the examination of the relationship between antecedent and subsequent patterns of intellectual function. This dealt directly with the question raised earlier of whether neurologically impaired children grow unevenly.

3. Utilization of the longitudinal method also permitted the examination of the relation of antecedent intellectual patterning with subsequent academic achievement. That is, the predictive value of age specific patterns of mental ability for later academic functioning was explored.

4. Finally, the longitudinal method permitted the

examination of the relationship between antecedent and subsequent academic status.

Tests and Measures

A. Tests of Intelligence and Mental Ability

1. Wechsler Intelligence Scale for Children (WISC)

2. SRA (Thurstone) Primary Mental Abilities Test (PMA)

B. Tests of Academic Achievement

1. Metropolitan Achievement Tests (MAT)
    a. Primary I Battery, Grade 1
    b. Primary II Battery, Grade 2
    c. Elementary Battery, Grades 3-4
    d. Intermediate Battery, Grades 5-6

C. Rating Scales of Behavior

1. The Children's Behavior Questionnaire (Rutter, 1967) is a checklist which provides a teacher-rated assessment of the child's classroom behavior. It yields scores in the following areas of problem behavior: neurotic, anti-social and total problem behavior. Good re-test and inter-rater reliability has been reported. It has served as a screening device for children with behavioral and emotional disorders and has been effective in differentiating neurotic and anti-social problems.

2. The Behavior Problem Checklist (Quay, Morse and Cutler, 1966) is a factor analytically derived teacher-rating scale. It assesses frequently occurring problem behaviors in the following areas: conduct disorder, personality disorder, inadequacy or immaturity and total behavior problems. The items are easily responded to, and ratings have been satisfactorily obtained from parents, teachers and various other professionals. It has shown good reliability, and has been used with public school children, and emotionally disturbed children.

The results based on the use of these two rating scales are reported in Chapters 12 and 14.

D. Clinical Neurological Examination

This is described in detail in a later section of this report which presents the neurological findings in relation to certain intellectual features of the children. It can be noted here that each child in the present study was individually examined, and that a standard and uniformly administered set of procedures was adhered to. The problem of inter-examiner differences was obviated by using only one neurologist to test all the children.

E. Perceptual Adequacy

All children were individually administered a series of perceptual tests developed by the principal investigator. These test results were reported for all four years of the study. These tasks measured different aspects of perception including discrimination, analysis, synthesis and perceptual-motor integration. The growth of perceptual adequacy is reported in Section II, Chapter 3, and this is followed by a description of its relation to intellectual functioning and the relationship of perception to academic achievement. Data concerning the nature and reliability of these tests may be obtained by writing to the principal investigator. They are conceptually based on a number of interrelated studies including Bortner and Birch (1960, 1962), Birch and Lefford (1963, 1967).

F. Height and Weight

Height and weight (in inches and pounds) were reported for the children in the second, third and fourth years of the study. These results are found in Section II, Tables 13 and 14, which show the progress the children made in the last three years of the study.

G. Basis for Choice of Tests

The WISC and the PMA were chosen because both permit an analysis of patterning of intellectual abilities in addition to supplying overall measures of intellectual competence. Both tests have high reliability. The PMA is based on factors which, while not having proved to be orthogonal, do nevertheless identify areas of ability that are relatively discrete from an educational point of view.

These abilities for grades K-4 are labeled as follows: verbal meaning, perceptual speed, number facility and spatial relations; for grades 4-9 the PMA measures one ability additional to the above labeled reasoning. Both the WISC and the PMA have been studied in depth utilizing normal children.

The Metropolitan Achievement Tests provide appropriate forms for all grade levels. A wide variety of content is covered in these tests. In general, different aspects of language, reading and arithmetic are covered. This test and the Stanford Achievement Tests are viewed in the Sixth Mental Measurements Yearbook (Buros, 1965) as the two best achievement batteries available. The Metropolitan has established high reliability, and provides measures of skills and mastery of grade related content. The measurement of these different aspects of achievement is especially important in this study. The predictive value of patterns of growth of mental abilities for a wide range of specific skills and school achievements is more likely to have implications for educational instruction than would be the case if more global achievement scores were used.

1. Analysis of IQ Scores and Intellectual Profiles of WISC

There were several aspects to this problem.

a. There is the question of the depiction of an intellectual profile for a given age group. The following is a variation of the method described by Belmont and Birch (1966). The method is graphic. A zero abscissa is established by using the mean of all the scaled scores of a given age group above and below which are plotted the mean of the scaled scores for individual subtests. Thus, if the mean scaled score for age 6 years is 8, this value becomes the zero abscissa. If the mean scaled score for Information is 6, this would be plotted as a 2 point negative deviation below the zero abscissa of 8. The plotting of such deviation values around the mean of all subtest scores for a given age group provides a visual depiction of the magnitude of individual subtest variations, or in effect, an intellectual profile.

b. There is the question of the stability of the total IQ score from age to age. This question needs to be answered with respect to the longitudinal data. This is readily determined by the correlation coefficient.

c. There is the question of the similarity or dissimilarity of intellectual profile from year to year. Correlation coefficients can be applied to the cross-sectional comparisons, and relative similarity or dissimilarity of subtest profiles can be determined from the graphic method described above.

2. Pattern Analysis of the PMA

The use of the PMA and its identification of essentially discrete intellectual abilities make it possible to test the hypothesis that different age groups are characterized by different patterns of ability.

3. Factor Analysis of Intelligence Data

Factor analyses of the WISC for brain damaged children have not yet been reported. Such analysis applied to the cross-sectional data would be helpful in defining the structure of intellect in developmental terms. The usually reported factors include a general factor, a verbal and a performance factor. It is anticipated that this population will not depart in any important way from this frequent finding. However, one may ask whether the structure of intellectual functioning in brain damaged children undergoes increasing differentiation with increasing age, or indeed, whether age exerts any influence on obtained factors.

4. Growth and Prediction

The predictive value of intelligence data for academic achievement is a much studied area and characteristically reveals high correlations. Much less is known about the relationships of aspects of intellectual ability to concurrent achievement. Intercorrelational matrices of WISC and PMA subtests with achievement subtests will provide indications of the predictive value of different aspects of mental ability for level of achievement. Less is known about the relation of current intellectual indices and later academic performance. Results relating to this issue are reported in Section IV.

Finally, and in summary, it can be noted that a continuing and unresolved educational problem is the description of an appropriate instructional strategy for young brain damaged children. One of the difficulties inherent in studies which attempt to demonstrate the value of one or another method of instruction is the lack of information on basic intellectual abilities that define these children at different age levels, on the growth of these abilities, and whether, indeed, these abilities are systematically related to status and progress in school subjects.

The present status of research on the administrative category of brain damage in children strongly suggests that this is a heterogeneous aggregation within which meaningful educational sub-categories are yet to be developed. Intellectual competence constitutes one set of abilities central to learning and therefore pertinent to educational classification. The present series of studies seeks to analyze this aspect of competence as a first step toward the eventual description of pertinent instructional strategies for children with brain damage.

Section II: Stability and Change

Chapter 3. Intelligence, Achievement and Other Variables: Summary for Four Years

The large amount of data collected in this study were not analyzed in accordance with the large number of questions that one could generate about them. While certain basic issues such as stability, pattern of scores, growth and prediction were dealt with and will be discussed below, an interesting array of potentially important questions remain unanswered but answerable from the present data. It therefore became a goal of the investigator to present all the data in the kind of summary form which would permit other interested investigators to re-examine or analyze any aspect of the data they wished. Tables 1 through 65 accomplish this goal. Significant issues, unanswered questions and unresolved problems are sometimes explicitly stated in appropriate places throughout the text; and it is hoped that they will stimulate other investigators to pursue questions left unresolved in the present report.

A. How to Read the Tables

Tables 1-18 may be read for four different kinds of information. In a given column, reading from top to bottom are the longitudinal data which tell us the progress of a given age group over the four year period. In a given row are discrete groups of children who were the same age, albeit, in different years of the study. In the last column these same-age cohorts are combined and provide increased Ns for any given age level over the extended age range 6-15 years and constitute semi-longitudinal data. Finally, by reading the first, second, third and fourth row of each column (excluding the last column) the reader obtains the cross-sectional data and can compare consecutive age-levels (e.g. 6, 7, 8 and 9 years).

B. Wechsler Intelligence Scale for Children

Tables 1-3 show the mean IQ scores for the WISC for all age groups in each of the four years of the study and for cohorts of combined same-ages. As can be seen in Table 1 the WISC Verbal quotient for the cohort of combined same ages varies from a low of 69.87 at age 6 to a high of 79.25 at age 14. Hence, the Verbal IQs are in the borderline range of intelligence for the group as a whole and for individual age levels. When one looks at the cohorts there is a steady rise in IQ as one proceeds from the younger to the older cohorts. However, it appears that there is a difference between those who were age 6 and 7 in the initial year of the study and the older children starting with those who were age 8 in the initial year. The children who were age 6 or 7 in the initial year started with Verbal IQs at 69 and 70 respectively and by the end of the fourth year did not increase beyond IQ scores of 71 or 72, whereas those children who were age 8 or above in the initial year started with Verbal IQs never lower than 74 and went as high as 80 in the fourth year. That is, whereas the younger children started low and made no progress, the older children started somewhat higher and ended still higher at the end of four years.

Table 2 shows the distribution of Performance quotients. These results are similar to those reported for the Verbal scores. As one proceeds from the younger cohorts to the older cohorts there is a steady rise in Performance IQ from a low of 69.33 at age 6 to a high of 81.91 at age 14. Hence, the Performance IQs are essentially in the borderline range of intelligence for the group as a whole and for individual age levels. However children age 6 and 7 in the initial year of the study attain Performance IQs of 69 and 71 respectively, whereas children 8 years and above (with the exception of the 10 year olds) start out with much higher scores and maintain their lead throughout the four years of the study. The 11 and 12 year olds, e.g., start out with Performance IQs of 78 and 75 respectively in the initial year and improve to 84 and 79 in the fourth year.

Table 3 shows the distribution of mean Full Scale IQs. The same steady rise in scores can be seen in the cohorts as one proceeds from younger to older children, and the same difference between the two younger groups (age 6 and 7) and the older groups can be observed, with the younger age groups doing more poorly.

C. Primary Mental Abilities Test

Tables 4-8 show the distribution of mean IQ scores for the PMA test for any given age group in each of the four years (longitudinal data) and for cohorts of combined same ages (semi-longitudinal data).

Table 4 shows the distribution of mean PMA Verbal Quotients. The cohorts of combined same ages (last column) show a steady rise in Verbal IQ from a low of 73.77 at age 6 to a high of 92.63 at age 14. Hence, the verbal intelligence of these children appears to vary with age level from borderline functioning at the youngest ages through dull-normal and normal at increasingly older ages. At ages 6 and 7 the children attain Verbal IQs in the 70s in the initial year of the study and never go beyond scores in the low 80s; whereas children age 8 and above in the initial year characteristically start out with Verbal IQs in the low 80s and end up with Verbal IQs in the range of 89-92.

Table 5 shows the distribution of mean PMA Perceptual Quotients. The cohorts show a steady rise in Perceptual IQ from a low of 76.75 at age 7 to a high of 92.65 at age 15. These scores represent, therefore, a range of functioning from borderline through normal with children in the age range of 6-8 functioning in the borderline range and children age 9 and above functioning in the dull-normal to normal range. However, it is the children who were 6 or 7 in the initial year of the study who start out with borderline functioning and improve to dull-normal functioning by the fourth year, whereas children age 8 and above show no such improvement and start out as dull-normal in the initial year and end up dull-normal in the fourth year. The exception to this can be seen in the scores of the 12 year olds who start out with Perceptual IQs in the dull-normal range (86-90) and attain a normal level of functioning by the fourth year.

Table 6 shows the distribution of mean PMA Number Quotients. It is immediately apparent that ability in this area of intellectual functioning is qualitatively inferior to that observed for verbal and perceptual areas. The cohorts show a steady rise with age from a low of 65.86 at age 7 to a high of 86.95 at age 15. Hence, the range of ability in this area of functioning is wide, with the younger children at retarded levels and the older children (starting at age 12) never exceeding dull-normal. However, there is an important difference between younger and older children; and children who were 6-10 years in the first year of the study started at moderately retarded levels but improved and finally attained borderline levels, whereas 11 and 12 year old children started at dull-normal levels and remained there.

Table 7 shows the distribution of mean PMA Spatial Quotients. The scores vary considerably in this area of functioning and the cohorts show a steady rise in ability level with age and range from a low of 68.30 at age 6 to a high of 94.13 at age 15. Hence, the range of ability is from moderately retarded at the youngest level through borderline functioning at ages 7-10, through dull-normal at ages 11-13, and normal at ages 14-15. However, the children age 6 and 7 in the initial year made little or no progress after 4 years, whereas children age 8 or above made progress over the 4 years which varied with age level. E.g., whereas the 10 year olds obtained initial and final scores of 82.93 and 84.70 respectively, the 12 year olds progressed from an initial score of 86.77 to a final score of 94.13. Moreover, the younger children (age 6 and 7 in the initial year) remain in the same category of functioning over the 4 years, whereas the older children (age 9, 11 and 12) moved from the dull-normal to the normal category of intellectual functioning in this area.

Table 8 shows the distribution of mean PMA Reasoning Quotients. The cohorts show essentially normal functioning at those ages where there are sufficient children to make an inference. Of course, the younger children do not have scores on this subtest since it was not given to the younger children. However, the cross-sectional data starting from age 10 upwards (in the initial year) reveal essentially consistent and low normal scores ranging from a low of 85.13 to a high of 95.63. The semi-longitudinal data (last column) are confirmed by the longitudinal data. A graphic presentation of the longitudinal data is shown in Figures 1-7, which show the progress for each of the PMA subtests over the four year period. Each graph depicts the progress of a given group of children for each subtest using their age in the initial year of the study as the point of departure; hence, one chart for each initial age group.

D. Metropolitan Achievement Test

Tables 9-12 show the distribution of mean scores on several subtests of the MAT for all age groups in each year of the study, and for cohorts of combined same ages. It is especially important to note the sample sizes in these tables. The usual N of 30 in the first year of the study did not obtain for the MAT since many of the children did not read sufficiently well to take even the Primary I level form; instead, they took the Readiness Level form which did not yield a reading grade equivalent.

The cohort data in Table 9 shows the MAT Reading Grade equivalent to increase with age from a low score in the middle of the first grade at age 6 to a high fourth grade level at age 15. Similarly, the longitudinal data reveal the same slow progress with 6 year olds (in the initial year) starting at grade level one and not going beyond the middle of the second grade three years later. When one recalls that these results reflect the functioning of only those children competent enough to take the Primary I level form, and that large numbers of the children, especially at the younger ages, had to take the Readiness Level, then it will be recognized that the functioning grade levels reported in this table (and in Tables 10-12) are an over-estimate for the age levels in general. In Year 1 of the study the 6 year olds attained a Reading Grade equivalent of 1.73; however, this was based on only 9 of the 30 children tested at this age--the other 21 children (not in this table) were "reading" at various stages of readiness. The 7 year olds also read at the first grade level in the initial year of the study and failed to get beyond the middle of the second grade three years later. The 8 and 9 year olds start out in the initial year of the study at near- and early-second grade reading but fail to get beyond middle 3rd grade reading three years later. The 10, 11 and 12 year olds read at middle second and early third grade level respectively in the initial year and for the most part do not exceed 4th grade level reading 3 years later. The one exception to this is the (initial year) 11 year old group who after starting at grade level 3 reach the 5th grade reading level by age 14.

The cohorts in Table 10 show a slow and steady increase with age in Arithmetic Computation skills as measured by the MAT, with the 9 year olds attaining scores in the middle of the third grade and the 15 year olds attaining scores near the top of the fifth grade. Of the 22 mean arithmetic scores reported for the various age groups, 16 are in the 4th and 5th grade. Only 7 of the reported Reading Grade equivalents were at this level, and it is thus clear that these children are somewhat better at arithmetic than in reading. Their superiority in arithmetic is of the order of one year.

Table 11 presents the scores for Arithmetic Problem Solving. Again, the cohorts show a slow and steady increase with age. The 8, 9 and 10 year olds functioned at the third grade level, the 11, 12 and 13 year olds at the fourth grade level and the 14 and 15 year olds at the fifth grade level. The mean scores for any given age group do not improve from the initial year to the fourth year by more than 1 year. Hence, while these children were superior in their Arithmetic Problem Solving ability to their Reading ability, they demonstrated rather limited growth over a three year period.

Table 12 shows the grade equivalents for the Arithmetic Total subtest of the MAT. The cohorts demonstrate a high second grade and early third grade attainment for all age groups without any clear pattern of improvement. The small Ns at individual age levels preclude more interpretation.

E. Height and Weight

Table 13 shows the mean height in inches for all age groups in each of the second, third and fourth year of the study, and for cohorts of combined same ages. The cohorts reveal a steady increase in height with age, with the average 7 year old at 48 inches and the average 15 year old at 66 inches, and an approximately 2 inches per year increase characterizing the age trend.

Table 14 shows the mean weight in pounds for all age groups in each of the second, third and fourth years of the study and for cohorts of combined same ages. The cohorts reveal the expected steady increase in weight with age and ranges from 56 pounds at age 7 to 136 pounds at age 15.

F. Perceptual Adequacy--Tests of Discrimination, Analysis, Synthesis and Integration

Tables 15-18 present the findings for the four subtests of the perceptual test which measures different aspects of visual perception. In Table 15 which presents data for the Discrimination subtest, the age cohorts reveal a steady rise in score from a low of 8 at age 6 to a high of 15 (out of a possible score of 17) at ages 14 and 15. Performance on this test is characterized by a relatively quick emergence of competence at early ages and a tendency to level off by age 10. Scores of 14 characterize the next few years with relatively little improvement thereafter.

Scores on the Analysis subtest (see Table 16) clearly reflect a later-emerging skill than that observed for Discrimination. The age cohorts do not achieve scores of above 1 (out of a possible 17) until age 9. They do not reach 4 until age 13 and never rise above a score of 6. It can be inferred that the task represented by the Analysis subtest is relatively difficult for these children. Moreover, since there is no leveling off in the curve of improvement in the age range studied, we may infer that growth in this skill continues beyond age 15.

Scores on the Synthesis subtest (see Table 17) are somewhat higher than those observed for Analysis. They range from a low of 1 at cohort age 6 to a high of 7 at ages 14 and 15. Since guessing is possible on this subtest (and there are 4 multiple-choices per item) it is important to note that scores above 4 (and hence roughly above-chance scores) do not occur until age 11. As was the case with Analysis, it is inferred that growth in Synthetic skills continues beyond age 15.

Scores on the Integration subtest (see Table 18) reflect a slowly emerging skill since a score of 1 (out of a possible 17) does not occur in the age cohorts until age 8. Moreover, even by age 15 scores do not rise above 6 with slow but steady improvement characterizing the 6-15 age range as a whole.

G. WISC: Correlation of Scores Across Years

The coefficient of correlation provides the most commonly used index to the stability of a test score. In the present study it is possible to assess the stability of WISC IQ scores obtained for a group of children over a period of four years by correlating their scores in Year 1 with their scores in Years 2, 3 and 4. It is also possible to compare 2nd year scores with those obtained in Years 3 and 4 of the study; and finally, we may compare scores obtained in Year 3 with those obtained in Year 4 of the study. Tables 19-21 summarize the across-year correlations (Pearson coefficients) for the WISC Verbal Scale, Performance Scale and Full Scale IQs over a four year time span. Correlations are presented on an age-specific basis for the age range 6-12 years. All possible comparisons are made for Years 1 through 4 of the study.

Table 19 shows the stability of the Verbal Scale IQ. At all age levels, all comparisons (e.g. Year 1 with Year 2, Year 1 with Year 3, and so on) are not only statistically significant but very high and range from a low (!) of .79 to a high of .95. It is easily inferred from the data that WISC Verbal Scale IQs for the groups studied are very stable from Year 1 to Years 2, 3 and 4; and that IQs obtained in any year of the study are remarkably consistent (for a given age group) with those obtained in any other year of the study.

Perusal of Tables 20 and 21 which present comparable information on Performance Scale and Full Scale IQs permit conclusions identical to those expressed for the Verbal Scale IQs.

H. PMA--Correlation of Scores Across Years

Tables 22-26 show the across-year correlations for the IQs based on each of the five PMA subtests. The correlations are presented on an age-specific basis. Hence, in Table 22 we may compare the PMA Verbal Quotients obtained in Year 1 of the study with those obtained in Years 2, 3, and 4 for the six year olds, seven year olds and so on. Moreover, the Verbal Quotients obtained in any given year of the study may be compared with those obtained in any other year for a particular age group.

In general, each of the PMA quotients shows high stability at all age levels from Year 1 through Year 4 of the study and in all other year to year comparisons (see Tables 22-26). In Table 22 it can be seen that this Verbal score stability is most pronounced for children aged 6 through 10 years where all but one of the 30 correlations are statistically significant. However, the 11 and 12 year olds do not demonstrate a similar stability of Verbal scores, and the magnitude of the correlation coefficients is drastically reduced. The meaning of this is difficult to assess, and it should be noted that nothing comparable occurred in any of the remaining subtests (see Tables 23-25) where great stability was noted for all age groups.

Table 26 presents the correlation coefficients for the PMA Reasoning Quotient. Only the 11 and 12 year olds took this subtest in sufficient numbers to permit the use of correlation procedures. In general, the magnitude of these coefficients suggests great stability of functioning from year to year. Although only 5 of the 12 coefficients were statistically significant, the magnitude of most of the non-significant coefficients was such as to suggest that there were meaningful correlations between sets of scores that fell short of statistical significance because of small Ns.

I. Comparison of WISC and PMA Stabilities

It is clear that while both the WISC IQs and the PMA Quotients demonstrate great stability from year to year, there is an important difference in the magnitude of stability evidenced by these two tests. While the WISC stability coefficients are consistently in the .90 range, those for the PMA are more frequently in the .50 to .70 range. What is the meaning of this difference in test score stability?

This question may be dealt with by postulating that "education" and the "school" are the intervening variables. If this is the case, then successful educational programs would tend to lower coefficients of stability, and unsuccessful programs would contribute to the long range maintenance of initially high stability (observed, say, between 1st and 2nd year scores). That is, if everybody improves (and individual differences are maintained) then correlations will remain high. However, if the "school" tends to "minimize" individual differences, then different people will improve at different rates and correlations would be lowered.

In this view of education, low correlations between successive scores in consecutive years would be considered indicators of success, and the PMA may therefore be a more sensitive indicator than the WISC of what has been happening to the present study sample in their school. The WISC correlations may be higher in the context of this view, because the WISC measures constellations of ability, i.e. more general ability, and is therefore less likely to be affected by school experience. The school would be expected to exert more influence on specific skills and therefore on the results of the PMA testing.

J. MAT--Correlation of Scores Across Years

It is commonly accepted that the best predictor of future performance is past performance. This is especially true of academic work. However, this generalization is based on empirical work with essentially normal children. It remained to be determined whether this conclusion could be applied to brain damaged children, especially since unevenness has been a frequently reported distinguishing characteristic of such children. Unevenness usually referred to unequal levels of cognitive performance on different tasks, but it also referred to unequal levels of performance on the same task through time (Bortner, 1968).

Since the fact of wide fluctuations in performance through time has been used not merely to describe but to actually define these children, one could expect such fluctuations to minimize the correlations of test with same test through time in a group of children so defined. The present data afford the opportunity to study this issue. Tables 27-29 present correlations (Pearson coefficients) for each of three subtests of the Metropolitan Achievement Tests--each test with itself--for any combination of years in the four years of the study. E.g. in Tables 27-29 we can find the correlation of Year 1 with Year 2 Reading Grade Equivalent scores for 6 year olds, 7 year olds and so on, or the correlation of Year 1 with Year 4 Reading Grade Equivalent scores for any of the initial-age groups from 6 through 12 years. Table 28 presents identical information on Arithmetic Computation, and Table 29 deals with Arithmetic Problem Solving. The latter two tables do not include children aged 6-8 since these younger children did not take these two subtests in sufficient numbers to warrant correlational procedures.

The evidence is overwhelming in these three tables that stability of relative position in academic functioning characterizes each of the age groups of brain damaged children. In Table 27, of 42 correlations only 4 do not attain statistical significance and even these are high order correlations that would easily be significant with slightly higher Ns. In Table 28, of 21 correlations calculated, only 3 failed to attain statistical significance, again because of insufficient N. In Table 29, of 21 correlations calculated only 1 failed to attain statistical significance.

One cannot fail to be impressed with the high order of these correlations--statistical significance not withstanding--which are in the 70's, 80's and 90's. One must infer from such high correlations that, as is the case for normal children, the best predictor of future academic performance is present academic performance. More directly, it is clear from these correlations that the relative class standing of particular children within any given age group (between 6 and 12 years) remains highly stable.

What does not emerge from these data is the fate of those children who do not remain stable in their academic performance. It would be valuable to identify children who show relative spurts in academic progress and who transcend in a given year their previous year's class standing. That is, if we can identify and separate out so-called high achievers from low achievers (in both cases, the children could be defined in accordance with their departure in a given year from their previous year's class standing) it would then be feasible to begin the search for the relevant correlates of success--an old story which has never been completed.

Readily available for interested investigators from Tables 27-29 are answers to questions dealing with the relative predictive value of scores obtained in Year 1, 2 or 3 for 4th Year performance, whether arithmetic fundamentals as contrasted with problem solving shows the same amount of stability, and whether performance in arithmetic as contrasted with reading is more or less stable in any given year of the study or over the four years.

K. Correlations of WISC and PMA--Within Same Year

WISC Verbal Quotient and PMA Subtests

It was not unexpected to find that the Verbal Scale of the WISC would be highly correlated with the PMA Verbal subtest. The obtained correlations are presented in Table 30 in the diagonal. At ages 6, 7, 8, 10 and 11 years all correlations (save one) are statistically significant. Within these age levels there is a clearly diminishing magnitude in the correlations as one proceeds from the younger age levels to the older age levels, with correlations at ages 6 and 7 in the 70's and 80's and falling to the 40's and 50's in the older children. At ages 9 and 12 only 1 of 8 correlations is significant, and the magnitude of the correlations drops sharply at age 12 where two of the four correlations are of a zero order.

In Table 31 are presented the correlations between the WISC Verbal Scale and the PMA Perceptual Speed Quotient. Again, as one proceeds from the younger age levels to the older age levels the correlations diminish in magnitude and, of course, in the number which are statistically significant. Moreover, the magnitude of those correlations that are statistically significant is consistently lower than those observed for the WISC Verbal Scale and PMA Verbal subtest. The age level in which the number of statistical significances sharply decrease begins at age 9 and continues through age 12. At ages 6 and 7, where the correlations are consistently significant, they are of the order of .5 and .6 as contrasted with the high correlations of .7 and .8 reported earlier for WISC Verbal Scale and PMA Verbal subtest.

Table 32 contains the correlations between the WISC Verbal Scale and the PMA Numerical Quotient. Every one of the 56 correlations are statistically significant. Again, there is the observed tendency, although less pronounced here than was reported for the PMA Verbal and Perceptual subtests, for the magnitude of the correlations to decrease with age. It is noted, with some surprise, that the magnitude of the correlations between WISC Verbal Scale and PMA Numerical Quotient is consistently greater than that observed between WISC Verbal Scale and PMA Verbal Quotient.

The correlations between WISC Verbal Scale and PMA Spatial Quotient are presented in Table 33. High order and statistically significant relationships characterize the correlation data for these two sets of scores. However, as was the case for the PMA Verbal and Perceptual

Speed Quotients, this relationship changes sharply at age 12 and this is reflected in zero order correlations.

The correlations between WISC Verbal Scale and PMA Reasoning Quotient are presented in Table 34. Only a small number of children took this subtest and the Ns are so small that the absence of statistical significances is not surprising. However, even within this context it appears that there is a tendency for the magnitude of the correlations to decrease with increasing age, and one observes two correlations above .6 at age 10, 1 at age 11 and none at age 12.

WISC Performance Quotient and PMA Subtests

The correlations between WISC Performance Quotient and PMA Verbal Quotient for a given year is seen in the diagonal in Table 35. In general, these correlations show a high order relationship between these two sets of scores. The correlations are higher at the younger ages where they hover in the .50's and .60's, drop off inexplicably at age 9, hover in the .30's and .40's at ages 10 and 11 and again diminish at age 12 by which time there are no statistically significant correlations.

Table 36 shows the correlations between the WISC Performance Quotient and the PMA Perceptual Speed Quotient. In general, these correlations demonstrate a high order relationship between these sets of scores. At ages 6, 7 and 8 years the correlations hover in the .60's and .70's. Again, there is the drop-off at age 9 with resumption of significant correlations occurring at ages 10 and 11, and finally a reduction in the magnitude and number of significant values at age 12.

Table 37 shows the correlations between the WISC Performance Quotients and the PMA Numerical Quotients for the same year in the diagonal. All correlations (save one at Year 12) are statistically significant. In general, the magnitude of these correlations appears to hold up at all ages until age 12 where a sharp reduction occurs.

Table 38 shows the correlation between the WISC Performance Quotients and the PMA Spatial Quotients. All correlations for all years are statistically significant. Again, it is not until age 12 that any correlations below .50 occur.

Table 39 shows the correlations between the WISC Performance Quotients and the PMA Reasoning Quotients. Only the 10, 11 and 12 year olds took this subtest in sufficient numbers to justify correlational procedures and even these Ns were small. At ages 11 and 12 the correlations suggest a high order relationship between these sets of scores.

WISC Full Scale Quotient and PMA Subtests

Tables 40-44 show the correlations within any given year between the WISC Full Scale Quotients and each of the PMA subtests in the diagonals. Since the WISC Full Scale Quotients do not represent new data and merely continue to reflect Verbal Scale and Performance Scale Quotients it is not surprising that the nature of the relationships thus summarized does not depart from what has already been described for each of the WISC Scales separately. In general, the relationships revealed are strong with a tendency to diminish with increasing age.

L. Correlations of WISC and PMA Across Years

WISC Verbal Quotient and PMA Subtests

The correlations between the WISC Verbal Scale and the PMA Verbal subtest are presented in Table 30 where it can be seen that they are highly and significantly correlated at the earlier ages of 6, 7 and 8 years; 34 of 36 correlations are significant and hover in the range of .5 to .7. At age 9 years there is a decline in the number of significant correlations (5 out of a possible 12). At ages 10 and 11 years, the correlations are again significant almost all the time (23 of 24) but they are of a somewhat lower order than that observed for the younger ages and hover in the range of .4 to .5. At age 12 years there is a precipitous drop in the magnitude of the correlations observed; they hover in the zero order range, and none are significant.

Table 31 shows the correlations of the WISC Verbal Scale and the PMA Perceptual Speed subtest scores for ages 6 through 12 years. It is clear that, in general, there is the same general tendency for the correlations to decrease in magnitude with age. At ages 6, 7 and 8 there are 27 significant values (out of a possible 36) with values ranging from .4 to .7. However, at ages 9 and above the correlations drop sharply to the order of .2 and .3 with only 12 of 48 correlations significant. By age 12 years, none of the reported correlations are significant.

Table 32 shows the correlations of the WISC Verbal Scale and the PMA Numerical subtest. These correlations are high and significant at all ages. In general, their magnitude hovers in the range of .6 to .8 at the younger age levels, and drops off to approximately .4 and .5 at age twelve years. In Table 33, the correlations of the WISC Verbal Scale and the PMA Spatial subtest are also seen to be significant and of a high order of magnitude with the magnitude apparently diminishing with age. By age twelve years all correlations fail to achieve significance.

In Table 34 the correlations of the WISC Verbal Scale and the PMA Reasoning subtests are frequently of a high order magnitude, especially at ages ten and eleven years but fail to achieve significance because of the low N. At age twelve years there is the usual drop in the magnitude of the correlations.

WISC Performance Quotient and PMA Subtests

Tables 35-37 show the correlations between the WISC Performance Scale and (respectively) the PMA Verbal, Perceptual, and Numerical subtests. In general, again, the correlations are of a high magnitude and are overwhelmingly significant with the tendency for their magnitude to diminish with age. For all three PMA subtests the correlations drop off in magnitude most decisively at age twelve years, and for the PMA Verbal and Perceptual subtests there is also a decisive drop at age nine years.

Table 38 shows the correlations between the WISC Performance Scale and the PMA Spatial subtest. These correlations are all high and significant even at the older age levels. Table 39 shows the correlations between the WISC Performance Scale and the PMA Reasoning subtest. The Ns are small thus making it less likely for statistical significance to occur, but even so 14 of 24 correlations are significant at ages eleven and twelve years. The magnitude of these correlations hover in the range of .5 to .6.

WISC Full Scale Quotient and PMA Subtests

Tables 40-44 show the correlations between each of the PMA subtests and the WISC Full Scale Quotient, and the same high order magnitudes and high frequency of statistical significances are seen here that were seen for the WISC Verbal and WISC Performance Quotients. Again, there is the tendency for the magnitude of these correlations to drop off at ages 9 and 12 for the PMA Verbal and Perceptual subtests.

M. Correlations of WISC and MAT--Within Same Year WISC Verbal Quotient and MAT Subtests

The correlations of the WISC Verbal Quotient and several subtests of the MAT within any given year of the study are shown in Tables 45-48. The correlations of WISC Verbal Quotients and MAT Reading (Table 45) in the first year of the study are almost all significant (4 of 5 correlations) at all age levels when the Ns $\geq$ 20. For the second, third and fourth year of the study all the correlations are significant with the magnitude hovering in the .60's.

For all four years, when the WISC Verbal Quotient is correlated with the Arithmetic Computation subtest of the MAT (Table 46), it is only at the older age levels (10-12 years) that comparably high magnitudes obtain and only at age 11 where with sufficient N the magnitudes are significant. At the younger age levels (6-9 years) the Ns are too small to permit evaluation of the correlations.

When the element of reading ability is part of the arithmetic task, as it is in Arithmetic Problem Solving, the magnitude of its correlations with the WISC Verbal Quotient rises (Table 47). For all four years of the study, the correlations between Problem Solving Ability and Verbal Quotient are high, and in the .50 to .70 range.

Table 48 shows the correlations between the WISC Verbal Quotient and MAT Arithmetic Total. The Ns are too small to permit significance values to be considered too seriously, but, in general, the correlations reflect the findings reported in Tables 46 and 47.

WISC Performance Quotient and MAT Subtests

Tables 49-52 show the correlations between the WISC Performance Quotient and several MAT subtests. The relationship between reading ability and performance ability (Table 49) is frequently significant (12 of 22 correlations where $N \geq 20$) and of the order of .50 in these cases. This is true for all four years of the study.

Table 50 shows the correlations between the WISC Performance Quotient and MAT Arithmetic Computation. Except for ages 11 and 12 years the Ns are inadequate for statistical interpretation. Similar difficulties obtain in Tables 51 and 52 in which additional arithmetic scores are correlated with WISC performance scores. However, it is especially noticeable with the Arithmetic Total Scores that despite these small Ns the correlations are often quite high, and 18 of 28 correlations are above .50 (see Table 52).

WISC Full Scale Quotient and MAT Subtests

Reading ability is highly correlated with WISC Full Scale intelligence. Of 28 correlations (see the diagonals in Table 53), 23 are statistically significant and are of the magnitude .59. Again, however, the Ns are inadequate and mitigate the strength of any conclusions.

Arithmetic ability is also related to WISC Full Scale intelligence. Aside from the inadequate Ns which preclude statistical interpretation it is suggested from the magnitudes of the correlations, which are often in the .50 to .70 range, that various aspects of arithmetic ability, i.e. computation and problem solving, are both strongly related to general intelligence (see the diagonals in Tables 54-56).

N. Correlation of Primary Mental Abilities Test and MAT Reading Subtest--Within Same Year

The five subtests of the PMA are correlated with the reading subtests of the MAT in Tables 57-61. Somewhat surprisingly, the Verbal Quotient of the PMA is not especially related to performance on the Reading subtest of the MAT. Only at age 6, where the Ns are all below 20, are the correlations significant (4 out of 4 correlations, read the diagonals in Table 57). At all later ages, 7-12 years, where the Ns are often of sufficient size to warrant statistical interpretation, the magnitude of the correlations are unimpressive and infrequently significant (2 of 22 correlations are significant and are based on N $\geq$ 20).

A similar pattern is observed for the relationship between the PMA Perceptual Quotient and the MAT Reading score. Very few correlations are significant where the Ns are $\geq$ 20, and the few that are significant are unimpressive in magnitude (read the diagonals in Table 58).

Of 20 correlations based on N $\geq$ 20, 12 are significant for the relation between the PMA Numerical Quotient and MAT Reading (read the diagonal in Table 59). Moreover, even at age levels 6 and 7 years where the Ns are small, the magnitudes of the correlations are frequently high and average .55. This compares with an average of .41 for the remaining ages 8-12 years; but, if one looks only at the significant relationships at ages 8-12 years the average correlation is .51. Of all the PMA subtest correlations with MAT reading ability, the Numerical Quotient appears to show the strongest relationship.

Tables 60 and 61 show the relationships between the MAT Reading and those PMA subtests yielding a Spatial Quotient and a Reasoning Quotient. The correlations are of a low order magnitude and suggest a weak relationship among these variables.

O. Perceptual Tests and MAT Reading Subtest--Within Same Year

Tables 62-65 show the relationship between the perceptual tests and the MAT Reading subtest. The correlations are of a low order magnitude and suggest a weak relationship between the perceptual tests and the MAT reading subtest.

P. Correlations of WISC and MAT--Across Years

WISC Verbal Quotient and MAT Subtests

The correlations between the WISC Verbal Scale and the MAT Reading grade equivalent scores are presented in Table 45. It can be seen that at ages 6 and 7 years roughly half of the correlations are significant, but the remaining non-significant correlations are based on small Ns. At ages 8 through 12 years the Ns increase to the mid 20's and almost all the correlations (56 of 60) are significant and of the general order of .5 to .7.

The correlations between the WISC Verbal Scale and the MAT Arithmetic Computation grade equivalent scores are shown in Table 46. For ages 6-9 years the Ns are small; however, as the Ns increase the magnitude of the correlations increase and 20 of 36 correlations are significant.

Tables 47 and 48 show the correlations between the WISC Verbal Scale and, respectively, MAT Arithmetic Problem Solving and MAT Arithmetic Total. For ages 6-8 years the Ns are small, but as the Ns increase with age the magnitude of the correlations increase with an attendant increase in frequency of statistical significance.

WISC Performance Quotient and MAT Subtests

Tables 49-52 show the correlations between the WISC Performance Scale and, respectively, the MAT Reading, Arithmetic Computation, Arithmetic Problem Solving, and Arithmetic Total grade equivalent scores. The Ns for the Reading subtest are quite small at ages 6 and 7 years but the magnitude of the correlations imply a strong relationship. With increased Ns, statistical significance is achieved at older age levels except at ages 10 and 12 years.

The arithmetic subtests contain smaller Ns and therefore a smaller number of significant correlation values. With an increase in N there appears to be an increase in the frequency of significant correlation values. However, at age 12 years there is a decrease in the magnitude of the correlations.

WISC Full Scale Quotient and MAT Subtests

Tables 53-56 show the correlations between the WISC Full Scale and, respectively, the MAT Reading

Arithmetic Computation, Arithmetic Problem Solving and Arithmetic Total grade equivalent scores. In general, these correlations reflect the same trends observed for the WISC Verbal and Performance Scales. It emerges somewhat more clearly that the younger age levels contain correlations of larger magnitudes (with a consequent greater frequency of significant values), and a decrease in magnitude of correlation at age 12 years for all of the MAT subtests considered here.

Q. Correlation of PMA and MAT Reading Subtests-Across Years

Tables 57-61 contain the correlations between each of the PMA subtests and the MAT Reading grade equivalent. It would be expected that the Verbal Scale of the WISC would be closely related to the tasks of the MAT Reading subtest (see Table 57), and indeed at the younger age levels (6-9 years) this was the case. At these younger levels, the Ns are often small thus almost precluding statistical significance, but the consistency with which relatively moderate magnitudes obtain implies a strong underlying relationship between these two measures. However, with increasing age (from 10-12 years) the magnitude of the correlations decreases even though the Ns increase.

The relationship of the PMA Perceptual Quotient and the MAT Reading grade equivalent (see Table 58) appears to be greater at the younger age levels (age 6 and 7 years) with magnitudes often in the .50 to .70 range, and smaller with increasing age (8-12 years). The relationship of the PMA Numerical Quotient and the MAT Reading grade equivalent (see Table 59) also appears to be stronger at younger age levels and to decrease at older age levels, until at age 12 years almost none of the correlations are significant.

Table 60 shows the relationship between the PMA Spatial Quotient and the MAT Reading grade equivalent to be of an essentially low order. Finally, the PMA Reasoning Quotient and the MAT Reading subtest do not show a large number of significant correlations, largely because the N for the PMA Reasoning subtest was frequently nonexistent or quite low.

R. Correlation of Perceptual Tests and MAT Reading Subtest--Across Years

Table 62 shows the correlations between the Discrimination subtest of the perceptual tests and the Reading test of the MAT. If one focuses on those correlations where the Ns are above 20, it can be seen that at age 6 none of the correlations are based on Ns so large. At age 7, of the five correlations with Ns of 20 or above, 4 are significant. In the remaining years almost none of the correlations are significant except for age 11 years where 8 of 12 correlations are moderately significant and of the order of .4.

Table 63 shows the correlations between the Analysis subtest of the perceptual tests and the Reading subtest of the MAT. At ages 6 and 12 years none of these correlations are significant. At age 7 years 3 of 5 or 60% of the correlations based on N $\geq$ 20 are significant. At age 8 years, 6 of 10 or 60% of the correlations based on N $\geq$ 20 are again significant. Between the ages of 9 and 11 years the magnitude of these correlations falls off and the number of significant values is reduced to between 25 and 34% of those reported values based on N $\geq$ 20.

Table 64 shows the correlations between the Synthesis subtest of the perceptual tests and the Reading subtest of the MAT. At ages 6, 10 and 12 none of the correlations are significant. At age 7 years 4 of 5 or 80% of the correlations based on N $\geq$ 20 are significant; at ages 8 and 9 years the percentage of significant correlations drops and at age 11 years increases again.

Table 65 shows the correlations between the Integration subtest of the perceptual tests and the Reading subtest of the MAT. At age 6, 11 and 12 years none of the reported correlations are significant. Between the ages of 7 and 10 years the percentage of significant correlations based on N $\geq$ 20 varies between 100% (at age 7 years) to less than 10% (at age 10 years).

In general, these correlations suggest that the perceptual tasks are more frequently related to reading between the ages of 7 and 11 years. There is a tendency for the Discrimination task to be more consistently related to reading at the earlier ages (6 and 7 years) and less consistently related at later ages (8-12). The tasks of Analysis, Synthesis and Integration are more frequently related to reading after age 7 years. This was expected since these latter perceptual tasks are later in their developmental emergence, and it is not till after age 7 that performance is clearly better than random.

Table 1

VARIABLE: WISC VERBAL QUOTIENT

	VI*			VII			VIII			IX			X			XI			XII			- TOTAL -		
AGE	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MW	SD	N	MN	SD
6 yrs	30	69.87	12.92																			30	69.87	12.92
7	28	71.93	13.44	30	70.40	13.53																58	71.05	13.52
8	27	72.48	13.14	28	71.11	12.43	30	75.37	14.23													85	72.87	13.47
9	25	72.44	14.48	27	69.22	12.72	30	75.87	13.43	30	74.70	10.86										112	73.29	13.21
10				26	71.15	15.44	26	79.27	12.19	28	77.07	12.13	30	75.43	11.97							110	75.74	13.34
11							22	78.64	11.95	27	76.44	12.89	29	76.79	12.91	30	82.80	15.59				108	78.75	13.84
12										25	76.36	9.79	28	76.79	11.17	30	83.27	13.60	30	79.03	9.19	113	79.01	11.50
13													27	75.96	11.92	29	81.66	13.74	30	79.13	9.65	86	78.98	12.15
14																29	80.76	14.33	29	77.76	9.74	58	79.25	12.44
15																			23	77.57	10.47	23	77.56	10.70

* AGE AT TIAL YEAR study

Table 2

VARIABLE: WISC PERFORMANCE QUOTIENT

	VI*			VII			VIII			IX			X			XI			XII			TOTAL		
AGE	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6yrs	30	69.33	11.88																			30	69.33	11.88
7	28	73.14	12.92	30	71.23	19.98																58	72.15	17.11
8	27	75.15	13.14	28	70.21	21.02	30	78.80	19.08													85	74.64	18.61
9	25	75.32	14.31	27	70.93	24.42	30	79.77	16.26	30	77.30	13.01										112	75.98	17.85
10				26	73.00	22.92	26	78.89	16.78	28	79.00	15.34	30	70.80	15.22							110	75.31	18.16
11							22	77.23	20.03	27	80.37	14.33	29	72.07	17.72	30	78.60	17.45				108	76.98	17.71
12										25	80.40	14.28	28	73.86	18.59	30	79.77	17.70	30	75.40	13.35	113	77.34	16.49
13													27	75.15	17.55	29	84.10	20.69	30	80.83	14.04	86	80.15	18.07
14																29	84.52	22.75	29	79.31	15.75	58	81.91	19.90
15																			23	79.91	16.82	23	79.91	17.20

* AGE AT INITIAL YEAR OF STUDY

Table 3

VARIABLE: WISC FULL SCALE QUOTIENT

AGE	VI*			VII			VIII			IX			X			XI			XII			TOTAL		
	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6 yrs	30	66.67	12.59																			30	66.67	12.59
7	28	70.00	13.01	30	67.90	17.39																58	68.86	15.53
8	27	71.26	13.31	28	67.89	17.[illegible]	30	74.80	16.86													85	71.21	16.33
9	25	71.32	14.60	27	67.15	18.77	30	75.70	14.61	30	73.63	11.69										112	72.16	15.46
10				26	69.12	19.59	26	77.12	13.95	28	75.86	13.58	30	76.70	13.28							110	73.15	15.65
11							22	75.77	15.78	27	76.30	13.71	29	72.04	14.91	30	78.90	16.61				108	75.75	15.57
12										25	76.32	12.15	28	72.96	14.46	30	79.93	15.87	30	75.07	10.38	113	76.15	13.72
13													27	73.37	14.58	29	81.17	17.52	30	78.07	11.24	86	77.63	15.06
14																29	80.97	18.70	29	76.45	11.89	58	78.70	15.97
15																			23	76.65	11.83	23	76.65	12.10

* AGE AT INITIAL YEAR STUDY

Table 4

VARIABLE: PMA VERBAL QUOTIENT

AGE	VI*			VII			VIII			IX			X			XI			XII			TOTAL		
	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6 Yrs	30	73.77	15.14																			30	73.77	15.14
7	28	73.86	18.78	30	78.70	20.21																58	76.36	19.85
8	27	81.85	17.12	27	78.52	22.63	30	81.40	19.89													84	80.66	20.18
9	25	80.08	13.89	27	83.00	19.05	28	91.14	18.88	30	84.40	13.80										110	84.79	17.15
10				25	82.00	17.27	24	91.50	15.75	26	88.39	15.58	30	82.40	16.65							105	85.86	16.90
11							21	89.19	12.52	25	90.60	16.14	29	87.79	17.44	30	92.10	12.94				105	89.97	15.17
12										24	91.79	13.55	27	89.56	15.07	30	97.43	13.65	30	86.47	10.34	111	91.33	13.90
13													27	89.15	17.04	28	93.75	17.36	30	88.43	10.42	85	90.41	15.43
14																29	92.31	15.73	28	92.96	10.09	57	92.63	13.38
15																			23	91.09	10.40	23	91.08	10.62

* AGE AT INITIAL YEAR OF STUDY

Table 5

VARIABLE: PMA PERCEPTUAL QUOTIENT

AGE	VI*			VII			VIII			IX			X			XI			XII			TOTAL		
	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6 yrs	30	77.73	18.16																			30	77.73	18.16
7	28	78.43	20.51	30	75.20	19.35																58	76.75	20.15
8	27	79.44	18.04	27	71.70	16.28	30	80.53	18.83													84	76.17	19.35
9	25	83.16	16.78	27	77.78	23.07	28	86.14	19.13	30	82.63	15.83										110	82.45	19.19
10				25	86.00	20.50	24	88.00	15.87	26	88.62	18.16	30	82.97	18.24							105	86.23	18.51
11							21	86.91	19.23	25	88.84	19.82	29	87.07	13.69	30	86.13	17.50				105	87.19	17.62
12										24	89.42	14.78	27	86.48	17.74	30	93.60	12.69	30	86.90	12.97	111	89.15	16.26
13													26	85.08	14.63	26	81.69	18.32	30	88.47	18.67	82	86.19	17.56
14																20	83.35	14.21	26	90.92	19.08	46	87.63	17.73
15																			20	92.65	14.76	20	92.65	15.14

* AGE AT INITIAL YEAR OF STUDY

Table 6

VARIABLE: PMA NUMBER QUOTIENT

AGE	VI*			VII			VIII			IX			X			XI			XII			TOTAL		
	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6 yrs	30	68.27	14.07																			30	68.27	14.07
7	28	65.96	11.30	30	65.77	16.01																58	65.86	14.05
8	27	64.52	11.65	27	64.78	15.18	30	71.13	14.29													84	67.02	14.22
9	25	67.12	12.83	27	64.19	15.46	28	76.57	18.80	30	72.57	13.07										110	70.29	16.05
10				25	67.32	17.09	24	77.50	18.64	26	78.31	17.57	30	72.40	12.76							105	73.81	17.12
11							21	75.95	16.60	25	82.80	20.62	29	73.72	13.33	30	80.57	16.80				105	78.28	17.38
12										24	82.04	17.91	27	75.26	17.39	30	84.07	19.20	30	84.33	13.10	111	81.55	17.46
13													27	74.78	12.92	28	80.11	15.61	30	85.80	15.62	85	80.42	15.57
14																29	82.66	17.33	28	85.68	14.69	57	84.14	16.30
15																			23	86.96	17.18	23	86.95	17.56

*AGE AT INITIAL YEAR OF STUDY

Table 7

VARIABLE: PMA SPATIAL QUOTIENT

	VI*			VII			VIII			IX			X			XI			XII			- TOTAL -		
AGE	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6 YRS	30	68.30	16.70																			30	68.30	16.70
7	28	70.43	17.86	30	71.07	21.96																58	70.75	20.26
8	27	67.59	17.74	27	70.19	22.07	30	78.00	20.99													84	72.17	21.00
9	25	69.68	16.48	27	70.85	22.05	28	81.21	19.46	30	86.43	15.64										110	77.47	19.94
10				25	66.40	21.17	24	83.63	21.79	26	83.85	15.84	30	82.93	19.74							105	79.38	21.11
11							21	84.05	23.26	25	87.44	20.24	29	82.90	17.31	30	84.40	19.75				105	84.61	20.14
12										24	91.46	15.84	27	82.07	18.22	30	89.83	21.81	30	86.77	18.20	111	87.30	19.20
13													27	84.70	20.15	28	87.93	21.71	30	91.03	18.37	85	88.00	20.36
14																29	91.86	20.61	28	93.39	16.02	57	92.61	18.67
15																			23	94.13	20.65	23	94.13	21.11

*AGE AT INITIAL YEAR OF STUDY

Table 8

VARIABLE: PMA REASONING QUOTIENT

	VI*			VII			VIII			IX			X			XI			XII			-TOTAL-		
AGE	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6YRS	0																					0		
7	0			0																		0		
8	0			0			0															0		
9	0			0			0			0												0		
10				0			3	84.67	16.66	0			0	0	0							3	73.50	6.50
11							1	141.00	—	1	100.00	—	6	88.33	11.77	6	95.00	10.54				14	95.78	17.31
12										4	78.75	14.65	5	92.40	14.38	12	94.42	11.54	9	87.67	13.20	30	89.96	[illegible]
13													8	85.13	7.42	16	92.35	15.07	18	88.06	15.48	42	89.45	14.67
14																15	89.87	19.82	15	92.27	8.84	30	91.06	15.65
15																			15	95.13	12.38	15	95.13	12.81

*AGE AT INITIAL YEAR OF STUDY

Table 9

VARIABLE: MAT READING: GRADE EQUIVALENT

	VI*			VII			VIII			IX			X			XI			XII			TOTAL		
AGE	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6yrs	9	1.73	0.54																			9	1.73	0.54
7	6	2.80	0.70	13	1.77	0.43																19	2.09	0.73
8	19	2.12	0.94	8	2.48	0.72	25	1.96	0.74													52	2.09	0.84
9	18	2.56	1.06	21	2.17	0.88	23	2.40	0.95	28	2.26	0.56										90	2.33	0.87
10				20	2.56	1.24	24	2.75	1.17	24	3.04	1.18	29	2.55	0.84							97	2.73	1.13
11							20	3.31	1.16	26	3.09	1.09	29	3.04	1.09	29	3.29	1.16				104	3.17	1.13
12										23	3.58	1.31	26	3.55	1.14	29	4.32	1.81	30	3.51	1.03	108	3.75	1.41
13													26	4.07	1.52	29	4.77	2.16	30	4.04	1.37	85	4.28	1.77
14																28	5.46	2.69	29	4.14	1.51	57	4.78	2.28
15																			23	4.84	1.57	23	4.83	1.60

* AGE AT INITIAL YEAR OF STUDY

Table 10

VARIABLE: MAT ARITH. COMPUTATION: GRADE EQUIVALENT

AGE	VI*			VII			VIII			IX			X			XI			XII			TOTAL		
	N	MN	SD	N	MN	SD	N	MN	SD	N	MW	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MW	SD
6 YRS	0																					0		
7	0			0																		0		
8	2	2.95	0.05	0			0															2	2.95	0.05
9	5	3.60	1.27	1	3.20	—	0			1	2.90	—										7	3.44	1.19
10				5	4.38	0.48	7	4.46	1.02	10	3.68	1.12	6	3.70	0.65							28	4.00	1.00
11							8	5.13	1.57	14	4.34	1.10	10	4.15	1.31	14	4.64	0.96				46	4.53	1.26
12										14	4.96	1.21	13	4.62	1.40	17	5.51	1.08	19	4.97	1.21	63	5.04	1.27
13													18	4.59	0.89	23	5.15	1.38	23	5.45	1.15	64	5.10	1.23
14																24	5.40	1.25	27	5.20	1.31	51	5.29	1.29
15																			21	5.80	1.77	21	5.80	1.77

*AGE AT INITIAL YEAR OF STUDY

Table 11

VARIABLE: MAT ARITH. PROBLEM SOLVING: GRADE EQUIVALENT

AGE	VI			VII			VIII			IX			X			XI			XII			—TOTAL—		
	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6yrs	0																					0	–	–
7	0			0																		0	–	–
8	1	3.40	---	0			0															1	3.40	0
9	5	3.04	0.34	1	3.80	—	0			1	3.00	0.										7	3.14	0.49
10				5	3.68	0.92	7	4.31	1.25	10	3.43	0.82	6	3.72	0.59							28	3.75	0.91
11							8	4.50	1.63	14	4.19	1.06	10	3.83	1.28	14	4.64	.94				46	4.30	1.18
12										14	4.61	1.29	13	4.40	1.39	17	5.48	1.32	19	4.87	1.41	63	4.88	1.35
13													18	4.19	1.08	23	5.24	1.60	23	5.17	1.60	64	4.92	1.47
14																24	5.40	1.56	26	5.21	1.83	50	5.30	1.70
15																			21	5.63	1.87	21	5.65	1.87

* AGE AT INITIAL YEAR OF STUDY

Table 12

VARIABLE: MAT ARITH. TOTAL: GRADE EQUIVALENT

AGE	VI*			VII			VIII			IX			X			XI			XII			- TOTAL -		
	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6YRS	0																					0		
7	2	2.55	0.05	1	2.40	-																3	2.50	0.10
8	5	2.54	0.72	2	4.20	0	4	3.13	0.59													11	3.07	0.93
9	6	2.17	0.45	8	2.80	0.85	7	3.43	1.04	16	2.74	0.71										37	2.79	0.87
10				4	2.83	0.40	5	2.08	0.42	6	3.40	0.85	8	2.86	.74							23	2.82	0.82
11							8	3.11	0.76	6	2.65	0.98	7	3.21	.73	9	3.40	1.07				30	3.13	0.95
12										8	2.98	1.03	9	3.16	.94	6	3.42	1.02	10	3.28	0.75	33	3.19	0.95
13													4	3.08	.46	3	2.77	1.31	6	3.07	0.94	13	3.00	0.97
14																3	3.10	0.65	0	0	0	3	3.10	0.79
15																			2	2.85	0.35	2	2.85	0.49

* AGE AT INITIAL YEAR F STUDY

Table 13

VARIABLE: HEIGHT (IN INCHES)

	VI			VII			VIII			IX			X			XI			XII			TOTAL		
AGE	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6 YRS	—																					—		
7	28	48.22	3.37	—																		28	48.22	3.37
8	27	50.15	3.63	27	49.95	3.52	—															54	50.05	3.60
9	26	52.47	4.11	27	51.84	3.81	28	53.31	3.72	—												81	52.54	3.94
10				26	54.41	3.77	26	55.29	3.82	26	56,51	2,85	—									78	55.40	3.63
11							22	57.65	4.36	26	58,55	2.80	29	56,74	2,82	—						77	57.60	3.43
12										25	61.32	3.05	28	59,01	2,92	29	59,13	3,80	—			82	59.75	3.47
13													27	62,21	3,09	29	60,93	4,08	30	61.82	3,70	86	61.64	3.71
14																29	64,21	4,02	29	63,81	3,50	58	64.00	3.83
15																			23	66,54	3,31	23	66.53	3.38

* AGE AT INITIAL YEAR OF STUDY

Table 14

VARIABLE: WEIGHT (IN POUNDS).

AGE	VI*			VII			VIII			IX			X			XI			XII			—TOTAL—		
	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6YRS	—	—	—																			—	—	—
7	28	56·37	16·62	—	—	—																28	56·37	16·62
8	27	62·06	19·33	27	60·60	14·62	—	—	—													54	61·33	17·31
9	26	69·87	23·19	27	66·55	17·97	28	67·39	13·47	—	—	—										81	67·90	18·68
10				26	75·55	21·64	26	74·56	14·43	26	82.42	14.63	—	—	—							78	77·51	17·69
11							22	85·40	20·49	26	93.56	18.03	29	88.74	26.41	—	—	—				77	89·41	22·57
12										25	109.49	23.52	28	102.25	30.53	29	95.86	26.70	—	—	—	82	102·19	27·91
13													27	115.74	32.26	29	111.02	31.84	30	108.37	24.78	86	111·57	30·03
14																29	126.73	35.52	24	123.41	27.49	58	125·07	32·08
15																			23	136.08	39.23	23	136·07	40·11

* AGE AT INITIAL YEAR OF STUDY

Table 15

VARIABLE: PERCEPTUAL DISCRIMINATION

	VI*			VII			VIII			IX			X			XI			XII			- TOTAL -		
AGE	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6 YRS	30	8.53	5.66																			30	8.53	5.66
7	28	11.29	4.33	30	9.83	4.34																58	10.53	4.43
8	27	12.41	3.64	27	11.00	4.24	30	12.53	3.51													84	12.00	3.88
9	24	14.08	1.79	27	12.67	3.32	28	13.68	2.56	30	13.73	2.61										110	13.40	2.98
10				24	13.00	3.10	26	14.58	1.71	26	14.81	1.36	30	13.87	2.17							106	14.07	2.27
11							21	15.14	1.49	26	14.12	2.90	29	14.48	1.69	30	13.97	2.92				106	14.37	2.43
12										23	15.26	1.15	28	14.57	2.01	30	14.77	2.09	30	14.80	2.10	111	14.82	1.93
13													27	14.96	1.32	29	14.97	1.94	30	14.43	2.91	86	14.77	2.20
14																29	15.45	1.69	29	15.35	1.15	58	15.39	1.46
15																			23	15.78	1.06	23	15.78	1.08

* AGE AT INITIAL YEAR OF STUDY

74

Table 16

VARIABLE: PERCEPTUAL ANALYSIS

	VI*			VII			VIII			IX			X			XI			XII			—TOTAL—		
AGE	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6 YRS	30	0.10	0.30																			30	0.10	0.30
7	28	0.07	0.26	30	0.40	0.80																58	0.24	0.62
8	27	0.37	1.09	27	0.33	1.36	30	1.50	2.51													84	0.76	1.89
9	24	2.25	3.36	27	1.11	2.20	28	1.43	2.63	30	1.77	2,11										110	1.60	2.60
10				24	1.67	3.24	26	2.58	3.43	26	2,00	2.51	30	1.5a	2.64							106	1.92	3.00
11							21	3.10	4.56	26	3.08	3.33	29	1.49	2.34	30	3.53	3.43				106	2.76	3.53
12										23	4.70	3.39	28	1.64	2.22	30	4.40	4.07	30	3.03	3.54	111	3.39	3.61
13													27	5.26	4.88	29	4.86	3.63	30	3.90	3.96	86	4.65	4.23
14																29	7.79	5.69	29	4.41	4.08	58	6.10	5.27
15																			23	6.48	4.88	23	6.47	4.98

* AGE AT INITIAL YEAR OF STUDY

Table 17

VARIABLE: PERCEPTUAL SYNTHESIS

AGE	VI*			VII			VIII			IX			X			XI			XII			TOTAL		
	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6 YRS	30	1.17	1.46																			30	1.17	1.46
7	28	2.36	2.41	30	1.70	2.65																58	2.01	2.57
8	27	2.48	2.74	27	2.26	2.80	30	2.73	2.92													84	2.50	2.84
9	24	3.25	2.69	27	2.44	2.49	28	3.61	2.94	30	2.53	2.41										110	2.91	2.68
10				24	3.63	3.41	26	3.96	3.55	26	4.35	3.09	30	3.17	3.07							106	3.75	3.32
11							21	5.33	4.06	26	5.04	3.38	29	4.59	3.54	30	5.67	3.99				106	5.15	3.78
12										23	6.00	3.04	28	5.50	3.82	30	6.73	4.23	30	5.77	3.66	111	6.00	3.79
13													27	6.74	3.97	29	6.69	4.12	30	6.23	3.84	86	6.54	4.00
14																29	7.72	4.72	29	6.83	3.76	58	7.27	4.32
15																			23	7.13	3.47	23	7.13	3.54

* AGE AT INITIAL YEAR F STUDY

Table 18

VARIABLE: PERCEPTUAL INTEGRATION

AGE	VI*			VII			VIII			IX			X			XI			XII			TOTAL		
	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD	N	MN	SD
6yrs	30	0.57	0.92																			30	0.57	0.92
7	28	0.93	1.13	30	0.67	1.49																58	0.79	1.34
8	27	1.30	1.54	27	1.07	2.16	30	1.37	2.79													84	1.25	2.25
9	24	1.91	1.83	27	2.07	2.54	28	2.25	3.14	30	2.37	1.74										110	2.14	2.39
10				24	2.33	2.90	26	2.89	3.20	26	2.85	2.14	30	2.20	2.41							106	2.55	2.71
11							21	3.76	4.20	26	3.46	2.27	29	3.38	3.07	30	4.07	3.57				106	3.66	3.33
12										23	4.35	2.71	28	3.39	2.76	30	5.07	3.86	30	4.17	3.38	111	4.25	3.31
13													27	5.04	4.17	29	5.21	3.79	30	5.30	3.75	86	5.18	3.92
14																29	6.97	4.77	29	5.17	4.22	58	6.06	4.62
15																			23	6.44	3.92	23	6.43	4.00

* AGE AT INITIAL YEAR OF STUDY

VARIABLE: WISC Verbal Quotient: Correlations

olds

	Yr 3	Yr 4
** 3	81** N=27	79** N=25
	88** N=27	87** N=25
		89** N=25

Seven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	89** N=28	92** N=27	91** N=26
Yr 2		92** N=27	91** N=26
Yr 3			92** N=26

Eight year olds

	Yr 2	Yr 3	Yr 4
Yr 1	91** N=30	87** N=26	86** N=22
Yr 2		93** N=26	87** N=22
Yr 3			91** N=22

ar olds

	Yr 3	Yr 4
** 3	83** N=27	72** N=25
	92** N=26	91** N=25
-		90** N=25

Ten year olds

	Yr 2	Yr 3	Yr 4
Yr 1	91** N=29	91** N=28	88** N=27
Yr 2		90** N=28	91** N=27
Yr 3			94** N=27

Eleven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	93** N=30	92** N=29	92** N=29
Yr 2		92** N=29	94** N=29
Yr 3			95** N=29

Twelve year olds

	Yr 2	Yr 3	Yr 4
Yr 1	87** N=30	86** N=29	80** N=23
Yr 2		92** N=29	79** N=23
Yr 3			81** N=23

#Note: For Tables 19 to 65,
* denotes $p < .05$ and
** denotes $p < .01$
Decimal points omitted.

Table 20 VARIABLE: WISC Performance Quotient: Correlations

Six year olds

	Yr 2	Yr 3	Yr 4
Yr 1	77** N=28	84** N=27	78** N=25
Yr 2		87** N=27	90** N=25
Yr 3			93** N=25

Seven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	92** N=28	88** N=27	88** N=26
Yr 2		97** N=27	94** N=26
Yr 3			96** N=26

Eight year olds

	Yr 2	Yr 3	Yr 4
Yr 1	93** N=30	89** N=26	94** N=22
Yr 2		94** N=26	91** N=22
Yr 3			91** N=22

Nine year olds

	Yr 2	Yr 3	Yr 4
Yr 1	91** N=28	84** N=27	67** N=25
Yr 2		92** N=26	83** N=25
Yr 3			86** N=25

Ten year olds

	Yr 2	Yr 3	Yr 4
Yr 1	92** N=29	90** N=28	93** N=27
Yr 2		93** N=28	94** N=27
Yr 3			94** N=27

Eleven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	93** N=30	96** N=29	96** N=29
Yr 2		93** N=29	94** N=29
Yr 3			96** N=29

Twelve year olds

	Yr 2	Yr 3	Yr 4
Yr 1	89** N=30	80** N=29	86** N=23
Yr 2		90** N=29	89** N=23
Yr 3			93** N=23

Table 21 VARIABLE: WISC Full Scale Quotient: Correlations

Six year olds

	Yr 2	Yr 3	Yr 4
Yr 1	87** N=28	87** N=27	84** N=25
Yr 2		90** N=27	91** N=25
Yr 3			94** N=25

Seven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	93** N=28	90** N=27	91** N=26
Yr 2		97** N=27	95** N=26
Yr 3			97** N=26

Eight year olds

	Yr 2	Yr 3	Yr 4
Yr 1	97** N=30	94** N=26	95** N=22
Yr 2		95** N=26	91** N=22
Yr 3			93** N=22

Nine year olds

	Yr 2	Yr 3	Yr 4
Yr 1	88** N=28	86** N=27	77** N=25
Yr 2		95** N=26	93** N=25
Yr 3			91** N=25

Ten year olds

	Yr 2	Yr 3	Yr 4
Yr 1	96** N=29	94** N=28	96** N=27
Yr 2		95** N=28	96** N=27
Yr 3			97** N=28

Eleven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	96** N=30	96** N=29	97** N=29
Yr 2		95** N=29	97** N=29
Yr 3			97** N=29

Twelve year olds

	Yr 2	Yr 3	Yr 4
Yr 1	89** N=30	85** N=29	82** N=23
Yr 2		93** N=29	85** N=23
Yr 3			90** N=23

Table 22 VARIABLE: PMA Verbal Quotient: Correlations

Six year olds

	Yr 2	Yr 3	Yr 4
Yr 1	71** N=28	71** N=27	46* N=25
Yr 2		76** N=27	63** N=25
Yr 3			80** N=25

Seven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	82** N=27	89** N=27	70** N=25
Yr 2		85** N=27	79** N=25
Yr 3			77** N=25

Eight year olds

	Yr 2	Yr 3	Yr 4
Yr 1	75** N=28	64** N=24	70** N=21
Yr 2		72** N=24	68** N=21
Yr 3			36 N=21

Nine year olds

	Yr 2	Yr 3	Yr 4
Yr 1	45* N=26	73** N=25	76** N=24
Yr 2		42* N=25	47* N=24
Yr 3			79** N=23

Ten year olds

	Yr 2	Yr 3	Yr 4
Yr 1	70** N=29	56** N=27	69** N=27
Yr 2		64** N=27	63** N=27
Yr 3			69** N=26

Eleven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	23 N=30	22 N=28	24 N=29
Yr 2		21 N=28	65** N=29
Yr 3			07 N=28

Twelve year olds

	Yr 2	Yr 3	Yr 4
Yr 1	25 N=30	31 N=28	01 N=23
Yr 2		47* N=28	51* N=23
Yr 3			39 N=22

Table 23 VARIABLE: PMA Perceptual Quotient: Correlations

Six year olds

	Yr 2	Yr 3	Yr 4
Yr 1	54** N=28	55** N=27	48* N=25
Yr 2		57* N=27	13 N=25
Yr 3			47* N=25

Seven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	65** N=27	79** N=27	67** N=25
Yr 2		72** N=27	68** N=25
Yr 3			87** N=25

Eight year olds

	Yr 2	Yr 3	Yr 4
Yr 1	73** N=28	54** N=24	64** N=21
Yr 2		52* N=24	69** N=21
Yr 3			80** N=21

Nine year olds

	Yr 2	Yr 3	Yr 4
Yr 1	58** N=26	59** N=25	54** N=24
Yr 2		24 N=25	39 N=24
Yr 3			39 N=23

Ten year olds

	Yr 2	Yr 3	Yr 4
Yr 1	56** N=29	69** N=27	59** N=26
Yr 2		72** N=27	47* N=26
Yr 3			55** N=25

Eleven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	55** N=30	58** N=26	56* N=20
Yr 2		62** N=26	36 N=20
Yr 3			46* N=19

Twelve year olds

	Yr 2	Yr 3	Yr 4
Yr 1	56** N=30	58** N=26	16 N=20
Yr 2		42* N=26	22 N=20
Yr 3			03 N=19

Table 24 VARIABLE: PMA Number Quotient: Correlations

Six year olds

	Yr 2	Yr 3	Yr 4
Yr 1	85** N=28	73** N=27	68** N=25
Yr 2		77** N=27	59** N=25
Yr 3			85** N=25

Seven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	94** N=27	86** N=27	89** N=25
Yr 2		80** N=27	82** N=25
Yr 3			92** N=25

Eight year olds

	Yr 2	Yr 3	Yr 4
Yr 1	83** N=28	83** N=24	78** N=21
Yr 2		87** N=24	83** N=21
Yr 3			80** N=21

Nine year olds

	Yr 2	Yr 3	Yr 4
Yr 1	64** N=26	53** N=25	72** N=24
Yr 2		69** N=25	76** N=24
Yr 3			58** N=23

Ten year olds

	Yr 2	Yr 3	Yr 4
Yr 1	78** N=29	75** N=27	67** N=27
Yr 2		90** N=27	72** N=27
Yr 3			63** N=26

Eleven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	81** N=30	74** N=28	56** N=29
Yr 2		59** N=28	59** N=29
Yr 3			41* N=28

Twelve year olds

	Yr 2	Yr 3	Yr 4
Yr 1	62** N=30	61** N=28	76** N=23
Yr 2		38* N=28	73** N=23
Yr 3			69** N=22

Table 25

VARIABLE: PMA Spatial Quotient: Correlations

Six year olds

	Yr 2	Yr 3	Yr 4
Yr 1	71** N=28	56** N=27	66** N=25
Yr 2		66** N=27	65** N=25
Yr 3			72** N=25

Seven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	89** N=27	90** N=27	84** N=25
Yr 2		90** N=27	93** N=25
Yr 3			91** N=25

Eight year olds

	Yr 2	Yr 3	Yr 4
Yr 1	77** N=28	79** N=24	82** N=21
Yr 2		84** N=24	68** N=21
Yr 3			78** N=21

Nine year olds

	Yr 2	Yr 3	Yr 4
Yr 1	72** N=26	63** N=25	71** N=24
Yr 2		61** N=25	60** N=24
Yr 3			70** N=23

Ten year olds

	Yr 2	Yr 3	Yr 4
Yr 1	69** N=29	74** N=27	76** N=27
Yr 2		80** N=27	80** N=27
Yr 3			83** N=26

Eleven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	84** N=30	80** N=28	85** N=29
Yr 2		80** N=28	78** N=29
Yr 3			76** N=28

Twelve year olds

	Yr 2	Yr 3	Yr 4
Yr 1	85** N=30	64** N=28	84** N=23
Yr 2		60** N=28	89** N=23
Yr 3			80** N=22

Table 26 VARIABLE: PMA Reasoning Quotient: Correlations

Six year olds

	Yr 2	Yr 3	Yr 4
Yr 1	0 N=0	0 N=0	0 N=0
Yr 2		0 N=0	0 N=0
Yr 3			0 N=0

Seven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	0 N=0	0 N=0	0 N=0
Yr 2		0 N=0	0 N=0
Yr 3			0 N=0

Eight year olds

	Yr 2	Yr 3	Yr 4
Yr 1	0 N=0	0 N=0	0 N=0
Yr 2		0 N=0	0 N=0
Yr 3			0 N=1

Nine year olds

	Yr 2	Yr 3	Yr 4
Yr 1	0 N=0	0 N=0	0 N=0
Yr 2		0 N=0	0 N=0
Yr 3			0 N=1

Ten year olds

	Yr 2	Yr 3	Yr 4
Yr 1	0 N=0	0 N=0	0 N=0
Yr 2		41 N=4	55 N=4
Yr 3			42 N=4

Eleven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	51 N=6	84* N=6	08 N=6
Yr 2		79** N=12	63* N=12
Yr 3			45 N=12

Twelve year olds

	Yr 2	Yr 3	Yr 4
Yr 1	63 N=8	42 N=8	90** N=7
Yr 2		25 N=13	65* N=13
Yr 3			38 N=13

Table 27 VARIABLE: MAT Reading Grade Equivalent: Correlations

Six year olds

	Yr 2	Yr 3	Yr 4
Yr 1	80 N=6	80* N=8	75 N=7
Yr 2		95** N=6	89* N=5
Yr 3			83** N=18

Seven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	70 N=7	72* N=11	63 N=10
Yr 2		79* N=8	80* N=8
Yr 3			96** N=19

Eight year olds

	Yr 2	Yr 3	Yr 4
Yr 1	86** N=23	71** N=21	82** N=18
Yr 2		86** N=20	81** N=18
Yr 3			71** N=20

Nine year olds

	Yr 2	Yr 3	Yr 4
Yr 1	81** N=24	70** N=24	66** N=22
Yr 2		85** N=24	63** N=22
Yr 3			72** N=23

Ten year olds

	Yr 2	Yr 3	Yr 4
Yr 1	86** N=28	71** N=25	55** N=26
Yr 2		87** N=26	74** N=26
Yr 3			83** N=24

Eleven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	87** N=29	79** N=28	90** N=28
Yr 2		89** N=28	91** N=28
Yr 3			86** N=28

Twelve year olds

	Yr 2	Yr 3	Yr 4
Yr 1	90** N=30	82** N=29	84** N=23
Yr 2		84** N=29	79** N=23
Yr 3			69** N=23

Table 28 VARIABLE: MAT Arith. Comp. Grade Equivalent: Correlations

Six year olds

	Yr 2	Yr 3	Yr 4
Yr 1	0 N=0	0 N=0	0 N=0
Yr 2		0 N=0	0 N=0
Yr 3			0 N=0

Seven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	0 N=0	0 N=0	0 N=0
Yr 2		0 N=0	0 N=0
Yr 3			0 N=1

Eight year olds

	Yr 2	Yr 3	Yr 4
Yr 1	0 N=0	0 N=0	0 N=0
Yr 2		0 N=0	0 N=0
Yr 3			86 N=5

Nine year olds

	Yr 2	Yr 3	Yr 4
Yr 1	0 N=1	0 N=1	0 N=1
Yr 2		90** N=10	72* N=10
Yr 3			88** N=13

Ten year olds

	Yr 2	Yr 3	Yr 4
Yr 1	78 N=6	54 N=6	33 N=6
Yr 2		86** N=8	76* N=9
Yr 3			77** N=13

Eleven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	67** N=14	76** N=14	86** N=14
Yr 2		78** N=17	84** N=17
Yr 3			85** N=23

Twelve year olds

	Yr 2	Yr 3	Yr 4
Yr 1	83** N=19	86** N=18	87** N=15
Yr 2		90** N=22	85** N=17
Yr 3			93** N=21

87

Table 29 VARIABLE: MAT Arith. Prob. Solv. Grade Equiv.: Correlations

Six year olds

	Yr 2	Yr 3	Yr 4
Yr 1	0 N=0	0 N=0	0 N=0
Yr 2		0 N=0	0 N=0
Yr 3			0 N=0

Seven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	0 N=0	0 N=0	0 N=0
Yr 2		0 N=0	0 N=0
Yr 3			0 N=1

Eight year olds

	Yr 2	Yr 3	Yr 4
Yr 1	0 N=0	0 N=0	0 N=0
Yr 2		0 N=0	0 N=0
Yr 3			99** N=5

Nine year olds

	Yr 2	Yr 3	Yr 4
Yr 1	0 N=1	0 N=1	0 N=1
Yr 2		87** N=10	73* N=10
Yr 3			86** N=13

Ten year olds

	Yr 2	Yr 3	Yr 4
Yr 1	85* N=6	83* N=6	77 N=6
Yr 2		90** N=8	82** N=9
Yr 3			94** N=13

Eleven year olds

	Yr 2	Yr 3	Yr 4
Yr 1	79** N=14	89** N=14	88** N=14
Yr 2		87** N=17	79** N=17
Yr 3			93** N=23

Twelve year olds

	Yr 2	Yr 3	Yr 4
Yr 1	82** N=19	87** N=17	89** N=15
Yr 2		94** N=21	92** N=17
Yr 3			95** N=20

Six year olds

WISC VQ

PMA VQ

Year	1	2	3	4
1	76** N=30	79** N=28	80** N=27	77** N=25
2	57** N=28	73** N=28	67** N=27	65** N=25
3	66** N=27	76** N=27	70** N=27	68** N=25
4	44* N=25	52** N=25	46* N=25	43* N=24

Seven year olds

	1	2	3	4
1	80** N=30	72** N=28	81** N=27	75** N=26
2	87** N=27	83** N=27	88** N=27	80** N=26
3	82** N=27	76** N=27	79** N=27	76** N=26
4	71** N=25	71** N=25	62** N=25	66** N=25

Eight year olds

	1	2	3	4
1	69** N=30	72** N=30	66** N=26	58** N=22
2	74** N=28	65** N=28	71** N=26	73** N=22
3	48* N=24	48* N=24	54** N=24	39 N=22
4	43 N=21	45* N=21	47* N=21	40 N=21

Nine year olds

1	69** N=30	51** N=28	52** N=27	42* N=25
2	19 N=26	15 N=26	08 N=26	-02 N=25
3	55** N=25	39 N=25	37 N=25	36 N=24
4	55** N=24	39 N=24	34 N=24	38 N=24

Ten year olds

39* N=30	49** N=29	57** N=28	53** N=27
47* N=29	44* N=29	53** N=28	46* N=27
60** N=27	55** N=27	53** N=27	56** N=26
54** N=27	55** N=27	57** N=27	45* N=27

Eleven year olds

54** N=30	53** N=30	57** N=29	59** N=29
48** N=30	47** N=30	41* N=29	30 N=29
50** N=28	43* N=28	41* N=28	44* N=28
43* N=29	49** N=29	43* N=29	39* N=29

Twelve year olds

1	32 N=30	19 N=30	02 N=29	19 N=23
2	10 N=30	07 N=30	01 N=29	26 N=23
3	01 N=28	05 N=28	-01 N=28	-07 N=22
4	32 N=23	17 N=23	28 N=23	32 N=23

Table 30

Variables: PMA VQ correlated with WISC VQ

Six year olds

WISC VQ

PMA PQ

Year	1	2	3	4
1	67** N=30	74** N=28	75** N=27	62** N=25
2	55** N=28	57** N=28	56** N=27	48* N=25
3	28 N=27	39* N=27	62** N=27	48* N=25
4	-10 N=25	09 N=25	36 N=25	25 N-24

Seven year olds

	1	2	3	4
1	63** N=30	65** N=28	65** N=27	64** N=26
2	53** N=27	55** N=27	63** N=27	52** N=26
3	66** N=27	67** N=27	65** N=27	58** N=26
4	55** N=25	54** N=25	53** N=25	52** N=25

Eight year olds

	1	2	3	4
1	48** N=30	41* N=30	27 N=26	64** N=22
2	47* N=28	39* N=28	41* N=26	64** N=22
3	40 N=24	32 N=24	24 N=24	34 N=22
4	49* N=21	44* N=21	37 N=21	36 N=21

Nine year olds

1	43* N=30	41* N=28	57** N=27	51** N=25
2	11 N=26	03 N=26	16 N=26	08 N=25
3	37 N=25	30 N=25	39 N=25	41* N=24
4	23 N=24	14 N=24	24 N=24	06 N=24

Ten year olds

35 N=30	29 N=29	30 N=28	31 N=27
46* N=29	45* N=29	39* N=28	39* N=27
36 N=27	37 N=27	36 N=27	42* N=26
25 N=26	22 N=26	20 N=26	09 N=26

Eleven year olds

56** N=30	59** N=30	55** N=29	55** N=29
36 N=30	43* N=30	34 N=29	40* N=29
30 N=26	28 N=26	30 N=26	31 N=26
20 N=20	26 N=20	28 N=20	20 N=20

Twelve year olds

1	01 N=30	06 N=30	10 N=29	-13 N=23
2	01 N=30	15 N=30	16 N=29	19 N=23
3	-21 N=26	-14 N=26	-08 N=26	-32 N=21
4	27 N-20	22 N=20	40 N=20	47* N=20

Table 31

Variables: PMA PQ correlated with

WISC VQ

Six year olds

WISC VQ

Year (PMA NQ)	1	2	3	4
1	79** N=30	76** N=28	77** N=27	78** N=25
2	70** N=28	77** N=28	76** N=27	77** N=25
3	57** N=27	67** N=27	70** N=27	74** N=25
4	29 N=25	52** N=25	54** N=25	71** N=24

Seven year olds

	1	2	3	4
1	76** N=30	76** N=28	86** N=27	79** N=26
2	82** N=27	82** N=27	88** N=27	80** N=26
3	68** N=27	77** N=27	86** N=27	77** N=26
4	79** N=25	81** N=25	88** N=25	88** N=25

Eight year olds

	1	2	3	4
1	75** N=30	84** N=30	80** N=26	77** N=22
2	76** N=28	77** N=28	78** N=26	81** N=22
3	63** N=24	71** N=24	76** N=24	68** N=22
4	58** N=21	67** N=21	68** N=21	71** N=21

Nine year olds

1	61** N=30	55** N=28	64** N=27	59** N=25
2	46* N=26	67** N=26	68** N=26	63** N=25
3	46* N=25	56** N=25	64** N=25	66** N=24
4	52** N=24	61** N=24	61** N=24	68** N=24

Ten year olds

72** N=30	67** N=29	76** N=28	76** N=27
74** N=29	71** N=29	72** N=28	72** N=27
75** N=27	72** N=27	69** N=27	75** N=26
56** N=27	62** N=27	63** N=27	56** N=27

Eleven year olds

73** N=30	74** N=30	73** N=29	77** N=29
63** N=30	72** N=30	67** N=29	68** N=29
60** N=28	55** N=28	54** N=28	58** N=28
46* N=29	56** N=29	46* N=29	60** N=29

Twelve year olds

1	52** N=30	40* N=30	52** N=29	26 N=23
2	42* N=30	40* N=30	50** N=29	61** N=23
3	34 N=28	39* N=28	44* N=28	17 N=22
4	57** N=23	56** N=23	68** N=23	56** N=23

Table 32

Variables: PMA NQ correlated

with WISC VQ

Six year olds

WISC VQ

PMA SQ

Year	1	2	3	4
1	53** N=30	57** N=28	56** N=27	65** N=25
2	24 N=28	42* N=28	40* N=27	59** N=25
3	47* N=27	51** N=27	59** N=27	59** N=25
4	18 N=25	38 N=25	46* N=25	57** N=24

Seven year olds

	1	2	3	4
1	70** N=30	70** N=28	74** N=27	70** N=26
2	79** N=27	78** N=27	86** N=27	76** N=26
3	75** N=27	66** N=27	81** N=27	74** N=26
4	76** N=25	72** N=25	81** N=25	75** N=25

Eight year olds

	1	2	3	4
1	59** N=30	53** N=30	45* N=26	73** N=22
2	45* N=28	46* N=28	43* N=26	60** N=22
3	68 ** N=24	63 ** N=24	54** N=24	64 ** N=22
4	74** N=21	61** N=21	59** N=21	62** N=21

Nine year olds

1	42* N=30	51** N=28	50** N=27	49* N=25
2	19 N=26	29 N=26	24 N=26	27 N=25
3	45* N=25	17 N=25	53** N=25	45* N=24
4	45* N=24	50* N=24	56** N=24	53** N=24

Ten year olds

30 N=30	29 N=29	35 N=28	39* N=27
46* N=29	43* N=29	45* N=28	53* N=27
37 N=27	47* N=27	40* N=27	45* N=26
37 N=27	33 N=27	31 N=27	34 N=27

Eleven year olds

39** N=30	40* N=30	39* N=29	35 N=29
44* N=30	46* N=30	46* N=29	42* N=29
55** N=28	62** N=28	59** N=28	54* N=28
42* N=29	45* N=29	49** N=29	46* N=29

Twelve year olds

1	15 N=30	16 N=30	11 N=29	11 N=23
2	14 N=30	18 N=30	17 N=29	16 N=23
3	-10 N=28	-10 N=28	-07 N=28	-21 N=22
4	15 N=23	17 N=23	24 N=23	18 N=23

Table 33

Variables: PMA SQ correlated

with WISC VQ

Six year olds

WISC VQ

Year	1	2	3	4
1	0 N=0	0 N=0	0 N=0	0 N=0
2	0 N=0	0 N=0	0 N=0	0 N=0
PMA RQ 3	0 N=0	0 N=0	0 N=0	0 N=0
4	0 N=0	0 N=0	0 N=0	0 N=0

Seven year olds

	1	2	3	4
	0 N=0	0 N=0	0 N=0	0 N=0
	0 N=0	0 N=0	0 N=0	0 N=0
	0 N=0	0 N=0	0 N=0	0 N=0
	0 N=0	0 N=0	0 N=0	0 N=0

Eight year olds.

	1	2	3	4
	0 N=0	0 N=0	0 N=0	0 N=0
	0 N=0	0 N=0	0 N=0	0 N=0
	100** N=3	100** N=3	99 N=3	100 N=2
	0 N=1	0 N=1	0 N=1	0 N=1

Nine year olds

1	0 N=0	0 N=0	0 N=0	0 N=0
2	0 N=0	0 N=0	0 N=0	0 N=0
3	0 N=1	0 N=1	0 N=1	0 N=1
4	37 N=4	22 N=4	46 N=4	05 N=4

Ten year olds

0 N=0	0 N=0	0 N=0	0 N=0
48 N=6	-05 N=6	51 N=6	63 N=6
63 N=5	28 N=5	75 N=5	64 N=5
38 N=8	59 N=8	73* N=8	69 N=8

Eleven year olds

67 N=6	75 N=6	54 N=6	68 N=6
-03 N=12	19 N=12	16 N=12	25 N=12
36 N=17	24 N=17	41 N=17	51* N=17
13 N=15	35 N=15	34 N=15	36 N=15

Twelve year olds

1	29 N=9	60 N=9	64 N=8	-62 N=7
2	-13 N=18	13 N=18	07 N=17	09 N=13
3	-16 N=15	10 N=15	11 N=15	-16 N=13
4	-14 N=15	-09 N=15	07 N=15	-15 N=15

Table 34

Variables: PMA RQ correlated

with WISC VQ

Six year olds

WISC PQ

Year	1	2	3	4
1	57** N=30	51** N=28	60** N=27	56** N=25
2	70** N=28	62** N=28	72** N=27	63** N=25
3	50** N=27	47* N=27	52** N=27	47* N=25
4	28 N=25	30 N=25	30 N=25	15 N=24

PMA VQ

Seven year olds

	1	2	3	4
1	66** N=30	64** N=28	56** N=27	59** N=26
2	80** N=27	76** N=27	64** N=27	65** N=26
3	74** N=27	67** N=27	60** N=27	60** N=26
4	54** N=25	47* N=25	35 N=25	39 N=25

Eight year olds.

	1	2	3	4
1	43* N=30	71** N=30	42* N=26	31 N=22
2	51** N=28	52** N=28	59** N=26	64** N=22
3	35 N=24	47* N=24	32 N=24	31 N=22
4	28 N=21	38 N=21	41 N=21	24 N=21

Nine year olds

1	24 N=30	27 N=28	30 N=27	38 N=25
2	22 N=26	34 N=26	23 N=26	24 N=25
3	28 N=25	33 N=25	32 N=25	44* N=23
4	27 N=24	37 N=24	40 N=24	51* N=24

Ten year olds

44* N=30	49** N=29	56** N=28	50** N=27
31 N=29	37* N=29	53** N=28	44* N=27
42* N=27	49** N=27	50** N=27	48* N=26
41* N=27	47* N=27	47* N=27	45* N=27

Eleven year olds

48** N=30	48** N=30	46* N=29	42* N=29
45* N=30	34 N=30	43* N=29	41* N=29
32 N=28	34 N=28	39* N=28	34 N=28
52** N=29	40* N=29	46* N=29	49** N=29

Twelve year olds

1	14 N=30	09 N=30	-03 N=29	01 N=23
2	-32 N=30	-22 N=30	-32 N=29	-38 N=23
3	15 N=28	18 N=28	09 N=28	05 N=22
4	15 N=23	25 N=23	20 N=23	20 N=23

Table 35

Variables: PMA VQ correlated

with WISC PQ

Six year olds

WISC PQ

PMA PQ Year	1	2	3	4
1	68** N=30	54** N=28	69** N=27	57** N=25
2	64** N=28	53** N=28	60** N=27	54** N=25
3	57** N=27	47* N=27	65** N=27	64** N=25
4	37 N=25	35 N=25	51** N=25	48* N=24

Seven year olds

1	2	3	4
85** N=30	79** N=28	79** N=27	81** N=26
66** N=27	77** N=27	76** N=27	74** N=26
80** N=27	75** N=27	73** N=27	75** N=26
69** N=25	68** N=25	67** N=25	72** N=25

Eight year olds

1	2	3	4
74** N=30	74** N=30	71** N=26	79** N=22
65** N=28	71** N=28	56** N=26	62** N=22
73** N=24	80** N=24	74** N=24	76** N=22
69** N=21	73** N=21	61** N=21	68** N=21

Nine year olds

1	52** N=30	56** N=28	67** N=27	57** N=25
2	23 N=26	32 N=26	28 N=26	26 N=25
3	39 N=25	36 N=25	32 N=25	33 N=24
4	54** N=24	41* N=24	50* N=24	34 N-24

Ten year olds

71** N=30	68** N=29	66** N=28	72** N=27
44* N=29	49** N=29	49** N=28	56** N=27
66** N=27	65** N=27	59** N=27	67** N=26
53** N=26	56** N=26	44* N=26	52** N=26

Eleven year olds

75** N=30	73** N=30	80** N=29	81** N=29
61** N=30	63** N=30	58** N=29	60** N=29
56** N=26	65** N=26	59** N=26	59** N=26
59** N=20	55* N=20	59** N=20	55* N=20

Twelve year olds

1	56** N=30	49** N=30	39* N=29	65** N=23
2	35 N=30	49** N=30	35 N=29	52* N=23
3	21 N=26	21 N=26	-04 N=26	11 N=21
4	19 N=20	24 N=20	18 N=20	25 N=20

Table 36
Variables: PMA PQ correlated
with WISC PQ

95

Table 37

Variables: PMA NQ correlated with WISC PQ

Six year olds

PMA NQ Year	WISC PQ 1	2	3	4
1	74** N=30	66** N=28	68** N=27	67** N=25
2	63** N=28	57** N=28	65** N=27	58** N=25
3	65** N=27	48* N=27	66** N=27	52** N=25
4	59** N=25	53** N=25	59** N=25	53** N=24

Seven year olds

	1	2	3	4
1	81** N=30	81** N=28	79** N=27	82** N=26
2	81** N=27	82** N=27	78** N=27	77** N=26
3	71** N=27	80** N=27	79** N=27	78** N=26
4	73** N=25	76** N=25	76** N=25	78** N=25

Eight year olds

	1	2	3	4
1	73** N=30	67** N=30	63** N=26	64** N=22
2	75** N=28	68** N=28	63** N=26	69** N=22
3	72** N=24	75** N=24	65** N=24	65** N=22
4	69** N=21	62** N=21	58** N=21	57** N=21

Nine year olds

1	65** N=30	68** N=28	69** N=27	48* N=25
2	73** N=26	75** N=26	77** N=26	69** N=25
3	74** N=25	70** N=25	65** N=25	49* N=24
4	64** N=24	74** N=24	76** N=24	74** N=24

Ten year olds

61** N=30	57** N=29	66** N=28	68** N=27
64** N=29	63** N=29	59** N=28	65** N=27
60** N=27	62** N=27	55** N=27	65** N=26
74** N=27	71** N=27	69** N=27	75** N=27

Eleven year olds

78** N=30	84** N=30	83** N=29	82** N=29
70** N=30	71** N=30	72** N=29	75** N=29
64** N=28	71** N=28	71** N=28	71** N=28
68** N=29	63** N=29	57** N=29	66** N=29

Twelve year olds

1	47** N=30	42* N=30	30 N=29	36 N=23
2	29 N=30	41* N=30	31 N=29	44* N=23
3	34 N=28	32 N=28	19 N=28	23 N=22
4	47* N=23	49* N=23	42* N=23	46* N=23

Six year olds

WISC PQ

Year	1	2	3	4
1	66** N=30	58** N=28	71** N=27	65** N=25
2	70** N=28	68** N=28	76** N=27	84** N=25
3	69** N=27	41* N=27	63** N=27	46* N=25
4	53** N=25	42* N=25	54** N=25	52** N=24

PMA SQ

Seven year olds

	1	2	3	4
1	89** N=30	87** N=28	84** N=27	91** N=26
2	85** N=27	85** N=27	80** N=27	85** N=26
3	81** N=27	82** N=27	79** N=27	85** N=26
4	82** N=25	80** N=25	75** N=25	82** N=25

Eight year olds

	1	2	3	4
1	84** N=30	82** N=30	84** N=26	86** N=22
2	80** N=28	79** N=28	76** N=26	81** N=22
3	87** N=24	84** N=24	79** N=24	85** N=22
4	83** N=21	83** N=21	84** N=21	84** N=21

Nine year olds

1	65** N=30	71** N=28	77** N=27	69** N=25
2	51** N=26	67** N=26	72** N=26	59** N=25
3	62** N=25	71** N=25	75** N=25	70** N=24
4	66** N=24	78** N=24	82** N=24	63** N=24

Ten year olds

75** N=30	74** N=29	71** N=28	73** N=27
73** N=29	70** N=29	66** N=28	78** N=27
80** N=27	74** N=27	64** N=27	76** N=26
78** N=27	73** N=27	66** N=27	82** N=27

Eleven year olds

77** N=30	81** N=30	79** N=29	81** N=29
77** N=30	77** N=30	79** N=29	78** N=29
76** N=28	79** N=28	84** N=28	85** N=28
81** N=29	76** N=29	81** N=29	81** N=29

Twelve year olds

1	47** N=30	55** N=30	60** N=29	74** N=23
2	64** N=30	62** N=30	67** N=29	87** N=23
3	44* N=28	46* N=28	49** N=28	57** N=22
4	69** N=23	67** N=23	68** N=23	78** N=23

Table 38
Variables: PMA SQ correlated

with WISC PQ

Six year olds

WISC PQ

Year	1	2	3	4
1	0 N=0	0 N=0	0 N=0	0 N=0
2	0 N=0	0 N=0	0 N=0	0 N=0
PMA RQ 3	0 N=0	0 N=0	0 N=0	0 N=0
4	0 N=0	0 N=0	0 N=0	0 N=0

Seven year olds

	1	2	3	4
	0 N=0	0 N=0	0 N=0	0 N=0
	0 N=0	0 N=0	0 N=0	0 N=0
	0 N=0	0 N=0	0 N=0	0 N=0
	0 N=0	0 N=0	0 N=0	0 N=0

Eight year olds

	1	2	3	4
	0 N=0	0 N=0	0 N=0	0 N=0
	0 N=0	0 N=0	0 N=0	0 N=0
	99 N=3	98 N=3	97 N=3	100 N=2
	0 N=1	0 N=1	0 N=1	0 N=1

Nine year olds

1	0 N=0	0 N=0	0 N=0	0 N=0
2	0 N=0	0 N=0	0 N=0	0 N=0
3	0 N=1	0 N=1	0 N=0	0 N=1
4	63 N=4	51 N=4	73 N=4	78 N=4

Ten year olds

0 N=0	0 N=0	0 N=0	0 N=0
48 N=6	27 N=6	49 N=6	23 N=6
24 N=5	36 N=5	08 N=5	-08 N=5
63 N=8	45 N=8	33 N=8	43 N=8

Eleven year olds

56 N=6	61 N=6	73 N=6	26 N=6
79** N=12	81** N=12	80** N=12	79** N=12
57* N=17	57* N=17	60* N=17	53* N=17
42 N=15	25 N=15	29 N=15	36 N=15

Twelve year olds

1	81** N=9	75* N=9	65 N=8	40 N=7
2	53* N=18	68** N=18	57* N=17	60* N=13
3	62* N=15	55* N=15	46 N=15	51 N=13
4	48 N=15	62* N=15	54* N=15	46 N=15

Table 39

Variables: PMA RQ correlated with WISC PQ

Six year olds

WISC FSQ

PMA VQ Year	1	2	3	4
1	73** N=30	73** N=28	76** N=27	73** N=25
2	72** N=28	75** N=28	75** N=27	70** N=25
3	67** N=27	71** N=27	67** N=27	64** N=25
4	43* N=25	49* N=25	42* N=25	34 N=24

Seven year olds

	1	2	3	4
1	77** N=30	70** N=28	70** N=27	71** N=26
2	88** N=27	82** N=27	78** N=27	77** N=26
3	81** N=27	74** N=27	71** N=27	72** N=26
4	65** N=25	60** N=25	49* N=25	55** N=25

Eight year olds

	1	2	3	4
1	59** N=30	64** N=30	60** N=26	47* N=22
2	66** N=28	66** N=28	73** N=26	75** N=22
3	44* N=24	52** N=24	47** N=24	38 N=22
4	36 N=21	43 N=21	48* N=21	33 N=21

Nine year olds

1	50** N=30	42* N=28	45* N=27	43* N=25
2	22 N=26	27 N=26	16 N=26	14 N=25
3	44* N=25	39 N=25	37 N=25	44* N=24
4	45* N=24	42* N=24	40 N=24	49* N=24

Ten year olds

47** N=30	55** N=29	63** N=28	57** N=27
44* N=29	45* N=29	59** N=28	50** N=27
58** N=27	58** N=27	57** N=27	57** N=26
53** N=27	57** N=27	57** N=27	50** N=27

Eleven year olds

55** N=30	55** N=30	53** N=29	53** N=29
52** N=30	43* N=30	45* N=29	40* N=29
44* N=28	41* N=28	42* N=28	41* N=28
52** N=29	47* N=29	48** N=29	49** N=29

Twelve year olds

1	26 N=30	15 N=30	-02 N=29	10 N=23
2	-18 N=30	-11 N=30	-23 N=29	-15 N=23
3	11 N=28	13 N=28	05 N=28	-01 N=22
4	26 N=23	25 N=23	28 N=23	31 N=23

Table 40

Variables: PMA VQ correlated with WISC FSQ

Six year olds

Year (PMA PQ)	WISC FSQ 1	2	3	4
1	73** N=30	71** N=28	78** N=27	73** N=25
2	67** N=28	61** N=28	62** N=27	55** N=25
3	49** N=27	49** N=27	68** N=27	60** N=25
4	15 N=25	23 N=25	48* N=25	39 N=24

Seven year olds

	1	2	3	4
1	79** N=30	77** N=28	79** N=27	79** N=26
2	64** N=27	72** N=27	76** N=27	70** N=26
3	78** N=27	75** N=27	75** N=27	73** N=26
4	68** N=25	67** N=25	68** N=25	69** N=25

Eight year olds

	1	2	3	4
1	67** N=30	63** N=30	59** N=26	80** N=22
2	62** N=28	61** N=28	55** N=26	68** N=22
3	63** N=24	63** N=24	59** N=24	65** N=22
4	64** N=21	63** N=21	56** N=21	61** N=21

Nine year olds

1	52** N=30	54** N=28	66** N=27	59** N=25
2	19 N=26	19 N=26	23 N=26	20 N=25
3	41* N=25	36 N=25	38 N=25	39 N=24
4	44* N=24	29 N=24	39 N=24	24 N=24

Ten year olds

61** N=30	56** N=29	57** N=28	60** N=27
51** N=29	52** N=29	50** N=28	54** N=27
59** N=27	58** N=27	55** N=27	62** N=26
44* N=26	45* N=26	38 N=26	37 N=26

Eleven year olds

71** N=30	71** N=30	74** N=29	75** N=29
53** N=30	57** N=30	51** N=29	55** N=29
47* N=26	52** N=26	51** N=26	51** N=26
43 N=20	44 N=20	50* N=20	44 N=20

Twelve year olds

1	39* N=30	34 N=30	32 N=29	41 N=23
2	24 N=30	39* N=30	32 N=29	48* N=23
3	04 N=26	05 N=26	-07 N=26	-10 N=21
4	24 N=20	25 N=20	29 N=20	38 N=20

Table 41
Variables: PMA PQ correlated with WISC FSQ

Six year olds

WISC FSQ

Year PMA NQ	1	2	3	4
1	84** N=30	79** N=28	79** N=27	78** N=25
2	75** N=28	74** N=28	76** N=27	74** N=25
3	69** N=27	65** N=27	74** N=27	69** N=25
4	50* N=25	60** N=25	62** N=25	69** N=24

Seven year olds

	1	2	3	4
1	83** N=30	83** N=28	87** N=27	87** N=26
2	86** N=27	86** N=27	87** N=27	84** N=26
3	74** N=27	83** N=27	87** N=27	84** N=26
4	80** N=25	83** N=25	88** N=25	89** N=25

Eight year olds

	1	2	3	4
1	80** N=30	83** N=30	80** N=26	76** N=22
2	82** N=28	81** N=28	78** N=26	81** N=22
3	73** N=24	79** N=24	78** N=24	73** N=22
4	67** N=21	68** N=21	68** N=21	69** N=21

Nine year olds

1	69** N=30	68** N=28	72** N=27	57** N=25
2	65** N=26	77** N=26	78** N=26	71** N=25
3	65** N=25	68** N=25	70** N=25	61** N=24
4	64** N=24	74** N=24	75** N=24	77** N=24

Ten year olds

74** N=30	69** N=29	79** N=28	78** N=27
76** N=29	75** N=29	72** N=28	74** N=27
76** N=27	75** N=27	68** N=27	75** N=26
74** N=27	75** N=27	74** N=27	73** N=27

Eleven year olds

82** N=30	86** N=30	84** N=29	86** N=29
72** N=30	77** N=30	75** N=29	76** N=29
67** N=28	68** N=28	68** N=28	71** N=28
62* N=29	64** N=29	56** N=29	68** N=29

Twelve year olds

1	59** N=30	48** N=30	46* N=29	40 N=23
2	42* N=30	47** N=30	45* N=29	64** N=23
3	41* N=28	32 N=28	34 N=28	26 N=22
4	61** N=23	60** N=23	61** N=23	62** N=23

Table 42
Variables: PMA NQ correlated with WISC FSQ

Six year olds

Year (PMA SQ)	WISC FSQ 1	2	3	4
1	64** N=30	63** N=28	67** N=27	71** N=25
2	52** N=28	60** N=28	61** N=27	76** N=25
3	65** N=27	52** N=27	66** N=27	57** N=25
4	40* N=25	45* N=25	56** N=25	59** N=24

Seven year olds

	1	2	3	4
1	86** N=30	85** N=28	86** N=27	88** N=26
2	87** N=27	87** N=27	88** N=27	88** N=26
3	84** N=27	80** N=27	85** N=27	86** N=26
4	85** N=25	82** N=25	84** N=25	85** N=25

Eight year olds

	1	2	3	4
1	78** N=30	74** N=30	76** N=26	89** N=22
2	70** N=28	69** N=28	69** N=26	80** N=22
3	84** N=24	79** N=24	76** N=24	84** N=22
4	82** N=21	77** N=21	80** N=21	83** N=21

Nine year olds

1	59** N=30	67** N=28	69** N=27	65** N=25
2	39* N=26	53** N=26	51** N=26	49* N=25
3	59** N=25	65** N=25	69** N=25	[illegible]4** N=24
4	62** N=24	71** N=24	75** N=24	63** N=24

Ten year olds

61** N=30	61** N=29	63** N=28	64** N=27
67** N=29	65** N=29	64** N=28	73** N=27
67** N=27	70** N=27	60** N=27	68** N=27
66** N=27	61** N=27	58** N=27	67** N=27

Eleven year olds

63** N=30	67** N=30	66** N=29	66** N=29
66** N=30	68** N=30	69** N=29	68** N=29
72** N=28	77** N=29	79** N=28	77** N=28
68** N=29	67** N=29	72** N=29	71** N=29

Twelve year olds

1	49** N=30	44* N=30	47* N=29	60** N=23
2	51** N=30	50** N=30	55** N=29	72** N=23
3	25 N=28	22 N=28	30 N=28	31 N=22
4	55** N=23	53* N=23	62** N=23	67** N=23

Table 43

Variables: PMA SQ correlated

with WISC FSQ

Six year olds

WISC FSQ

PMA RQ Year	1	2	3	4
1	0 N=0	0 N=0	0 N=0	0 N=0
2	0 N=0	0 N=0	0 N=0	0 N=0
3	0 N=0	0 N=0	0 N=0	0 N=0
4	0 N=0	0 N=0	0 N=0	0 N=0

Seven year olds

1	2	3	4
0 N=0	0 N=0	0 N=0	0 N=0
0 N=0	0 N=0	0 N=0	0 N=0
0 N=0	0 N=0	0 N=0	0 N=0
0 N=0	0 N=0	0 N=0	0 N=0

Eight year olds

1	2	3	4
0 N=0	0 N=0	0 N=0	0 N=0
0 N=0	0 N=0	0 N=0	0 N=0
100* N=3	99 N=3	98 N=3	100 N=2
0 N=1	0 N=1	0 N=1	0 N=1

Nine year olds

1	0 N=0	0 N=0	0 N=0	0 N=0
2	0 N=0	0 N=0	0 N=0	0 N=0
3	0 N=1	0 N=1	0 N=1	0 N=1
4	57 N=4	42 N=4	66 N=4	66 N=4

Ten year olds

0 N=0	0 N=0	0 N=0	0 N=0
20 N=6	17 N=6	52 N=6	38 N=6
59 N=5	39 N=5	33 N=5	24 N=5
63 N=8	61 N=8	55 N=8	59 N=8

Eleven year olds

92** N=6	78 N=6	83* N=6	62 N=6
46 N=12	64* N=12	66* N=12	68* N=12
60* N=17	52* N=17	63** N=17	67** N=17
35 N=15	36 N=15	38 N=15	45 N=15

Twelve year olds

1	86** N=9	80* N=9	67 N=8	17 N=7
2	39 N=18	59** N=18	48 N=17	63* N=13
3	35 N=15	41 N=15	38 N=15	43 N=13
4	38 N=15	53* N=15	53* N=15	36 N=15

Table 44

Variables: PMA RQ correlated

with WISC FSQ

Six year olds

MAT Reading

Year	1	2	3	4
1	62 N=9	51 N=6	27 N=19	26 N=18
2	16 N=8	72 N=6	54* N=19	49* N=18
3	44 N=8	55 N=6	65** N=19	57* N=18
4	58 N=6	94* N=5	58* N=17	56* N=17

WISC VQ

Seven year olds

	1	2	3	4
1	19 N=13	49 N=8	67** N=21	61** N=20
2	04 N=12	40 N=8	61** N=21	54* N=20
3	19 N=11	23 N=8	61** N=21	54* N=20
4	18 N=11	49 N=8	70** N=21	66** N=20

Eight year olds

	1	2	3	4
1	55** N=25	58** N=23	57** N=24	87** N=20
2	61** N=25	61** N=23	54** N=24	86** N=20
3	64** N=22	73** N=21	62** N=24	91** N=20
4	58 * N=18	61** N=18	59** N=21	85** N=20

Nine year olds

1	18 N=28	44* N=24	61** N=26	44* N=23
2	37 N=26	62** N=24	64** N=26	61** N=23
3	38 N=25	59** N=24	67** N=26	63** N=23
4	48* N=23	56** N=23	68** N=25	67** N=23

Ten year olds

39* N=29	67** N=29	70** N=26	76** N=26
37 N=28	69** N=29	75** N=26	77** N=26
39* N=27	67** N=28	72** N=26	71** N=26
36 N=26	67** N=27	72** N=25	76** N=26

Eleven year olds

65** N=29	55** N=29	56** N=29	56** N=28
72** N=29	60** N=29	59** N=29	64** N=28
72** N=28	59** N=28	64** N=29	65** N=28
74** N=28	61** N=28	67** N=29	68** N=28

Twelve year olds

1	57** N=30	53** N=30	53** N=29	60** N=23
2	54** N=30	57** N=30	62** N=29	50* N=23
3	57** N=29	61** N=29	64** N=29	57** N=23
4	67** N=23	63** N=23	68** N=23	70** N=23

Table 45

Variables: WISC VQ correlated

with MAT Reading

Six year olds

MAT Arith. Computation

Year WISC VQ	1	2	3	4
1	0 N=0	0 N=0	-100 N=2	-28 N=5
2	0 N=0	0 N=0	-100 N=2	17 N=5
3	0 N=0	0 N=0	-100 N=2	-15 N=5
4	0 N=0	0 N=0	0 N=1	39 N=5

Seven year olds

	1	2	3	4
1	0 N=0	0 N=0	0 N=1	25 N=5
2	0 N=0	0 N=0	0 N=1	71 N=5
3	0 N=0	0 N=0	0 N=1	96** N=5
4	0 N=0	0 N=0	0 N=1	47 N=5

Eight year olds.

	1	2	3	4
1	0 N=0	0 N=0	78* N=7	64 N=8
2	0 N=0	0 N=0	65 N=7	69 N=8
3	0 N=0	0 N=0	46 N=7	57 N=8
4	0 N=0	0 N=0	47 N=5	62 N=8

Nine year olds

1	0 N=1	06 N=10	-02 N=14	-14 N=14
2	0 N=1	34 N=10	38 N=14	38 N=14
3	0 N=1	48 N=10	45 N=14	42 N=14
4	0 N=1	44 N=10	32 N=13	31 N=14

Ten year olds

64 N=6	89** N=10	71** N=13	45 N=18
31 N=6	81* N=10	78** N=13	35 N=18
76 N=6	92** N=10	67* N=13	38 N=18
82 N=6	95** N=10	69** N=13	56* N=18

Eleven year olds

53 N=14	45 N=17	65** N=23	56** N=24
50 N=14	59* N=17	66** N=23	53** N=24
54* N=14	61** N=17	69** N=23	56** N=24
48 N=14	54* N=17	75** N=23	62** N=24

Twelve year olds

1	40 N=19	35 N=23	44* N=27	41 N=21
2	29 N=19	32 N=23	48* N=27	44* N=21
3	38 N=18	44* N=22	57** N=27	49* N=21
4	14 N=15	29 N=17	37 N=21	29 N=21

Table 46
Variables: WISC VQ correlated with MAT Arith. Computation

Six year olds

MAT Arith. Problem Solving

Year	1	2	3	4
1	0 N=0	0 N=0	0 N=1	-18 N=5
2	0 N=0	0 N=0	0 N=1	-07 N=5
3	0 N=0	0 N=0	0 N=1	17 N=5
4	0 N=0	0 N=0	0 N=0	41 N=5

WISC VQ

Seven year olds

	1	2	3	4
1	0 N=0	0 N=0	0 N=1	81 N=5
2	0 N=0	0 N=0	0 N=1	91* N=5
3	0 N=0	0 N=0	0 N=1	72 N=5
4	0 N=0	0 N=0	0 N=1	88* N=5

Eight year olds.

	1	2	3	4
1	0 N=0	0 N=0	76* N=7	66 N=8
2	0 N=0	0 N=0	65 N=7	71* N=8
3	0 N=0	0 N=0	52 N=7	76* N=8
4	0 N=0	0 N=0	34 N=5	69 N=8

Nine year olds

1	0 N=1	21 N=10	19 N=14	-13 N=14
2	0 N=1	43 N=10	46* N=14	21 N=14
3	0 N=1	50 N=10	45 N=14	38 N=14
4	0 N=1	53 N=10	35 N=13	23 N=14

Ten year olds

63 N=6	82** N=10	77** N=13	59** N=18
56 N=6	67* N=10	76** N=13	54* N=18
75 N=6	73* N=10	70** N=13	55* N=18
81 N=6	84** N=10	78** N=13	73** N=18

Eleven year olds

47 N=14	60* N=17	52* N=23	57** N=24
60* N=14	79** N=17	60** N=23	63** N=24
66* N=14	70** N=17	66** N=23	65** N=24
60* N=14	67** N=17	69** N=23	71** N=24

Twelve year olds

1	50* N=19	51* N=23	57** N=26	59** N=21
2	49* N=19	59** N=23	60** N=26	55** N=21
3	49* N=18	62** N=22	60** N=26	64** N=21
4	20 N=15	25 N=17	43 N=20	43 N=21

Table 47

Variables: WISC VQ correlated

with MAT Arith. Problem Solving

Six year olds

MAT Arith. Total

Year	1	2	3	4
1	0 N=0	100 N=2	-21 N=5	-46 N=6
2	0 N=0	100 N=2	31 N=5	-35 N=6
3	0 N=0	100 N=2	04 N=5	14 N=6
4	0 N=0	100 N=2	53 N=5	70 N=5

WISC VQ

Seven year olds

	1	2'	3	4
1	0 N=1	0 N=2	17 N=8	83 N=4
2	0 N=0	0 N=2	46 N=8	77 N=4
3	0 N=0	0 N=2	55 N=8	79 N=4
4	0 N=0	0 N=2	39 N=8	71 N=4

Eight year olds

	1	2	3	4
1	65 N=4	66 N=7	-79 N=5	50 N=8
2	69 N=4	75 N=7	33 N=5	75* N=8
3	39 N=4	61 N=7	31 N=5	57 N=8
4	50 N=4	81 N=6	-14 N=5	72* N=8

Nine year olds

1	43 N=16	52 N=6	94** N=6	65 N=8
2	63* N=14	58 N=6	76 N=6	78* N=8
3	81** N=14	81 N=6	92** N=6	82** N=8
4	72** N=12	63 N=5	80 N=6	87** N=8

Ten year olds

81* N=8	63 N=7	77* N=9	92 N=4
67 N=7	88** N=7	81** N=9	93 N=4
81* N=7	63 N=6	68* N=9	81 N=4
85* N=7	52 N=5	84** N=8	94 N=4

Eleven year olds

87** N=9	91* N=6	88 N=3	50 N=3
74* N=9	74 N=6	99 N=3	87 N=3
81* N=8	78 N=5	95 N=3	94 N=3
65 N=8	75 N=5	97 N=3	99 N=3

Twelve year olds

1	91** N=10	96** N=6	0 N=0	100 N=2
2	76* N=10	85* N=6	0 N=0	100 N=2
3	81** N=10	93** N=6	0 N=0	0 N=2
4	80* N=7	96* N=5	0 N=0	100 N=2

Table 48

Variables: WISC VQ correlated

with MAT Arith. Total

Six year olds

WISC PQ Year	MAT Reading 1	2	3	4
1	70* N=9	38 N=6	50* N=19	26 N=18
2	75* N=8	60 N=6	15 N=19	31 N=18
3	72* N=8	73 N=6	37 N=19	35 N=18
4	77 N=6	75 N=5	26 N=17	35 N=17

Seven year olds

1	2	3	4
26 N=13	48 N=8	71** N=21	68** N=20
11 N=12	48 N=8	62** N=21	66** N=20
12 N=11	48 N=8	60** N=21	69** N=20
13 N=11	44 N=8	62** N=21	66** N=20

Eight year olds

1	2	3	4
54** N=25	55** N=23	53** N=24	69** N=20
53** N=25	50* N=23	40 N=24	65** N=20
47* N=22	47* N=21	40 N=24	62** N=20
38 N=18	44 N=18	47* N=21	55* N=20

Nine year olds

1	33 N=28	48* N=24	50** N=26	22 N=23
2	41* N=26	51* N=24	57** N=26	35 N=23
3	32 N=25	42* N=24	40* N=26	23 N=23
4	30 N=23	34 N=23	40* N=25	38 N=23

Ten year olds

15 N=29	39* N=29	32 N=26	39* N=26
13 N=28	38* N=29	25 N=26	31 N=26
-01 N=27	29 N=28	24 N=26	31 N=26
15 N=26	38 N=27	29 N=25	33 N=26

Eleven year olds

57** N=29	55** N=29	60** N=29	54** N=28
49** N=29	46* N=29	49** N=29	42* N=29
50** N=28	50** N=28	54** N=29	50* N=23
47* N=28	47* N=28	52** N=29	48** N=28

Twelve year olds

1	15 N=30	11 N=30	17 N=29	09 N=23
2	16 N=30	19 N=30	22 N=29	10 N=23
3	14 N=29	19 N=29	26 N=29	-01 N=23
4	05 N=23	04 N=23	15 N=23	-02 N=23

Table 49

Variables: WISC PQ correlated with MAT Reading year olds

MAT Arith. Computation

2	3	4
0 N=0	-100 N=2	83 N=5
0 N=0	100 N=2	46 N=5
0 N=0	-100 N=2	80 N=5
0 N=0	0 N=1	73 N=5

year olds

57 N=10	66* N=14	46 N=14
59 N=10	70** N=14	65* N=14
75* N=10	75** N=14	62* N=14
51 N=10	35 N=13	50 N=14

WISC PQ correlated

Arith. Computation

Seven year olds

1	2	3	4
0 N=0	0 N=0	0 N=1	59 N=5
0 N=0	0 N=0	0 N=1	87 N=5
0 N=0	0 N=0	0 N=1	88* N=5
0 N=0	0 N=0	0 N=1	82 N=5

Ten year olds

37 N=6	62 N=10	11 N=13	14 N=18
58 N=6	60 N=10	-01 N=13	23 N=18
76 N=6	72* N=10	03 N=13	13 N=18
55 N=6	65 N=10	13 N=13	14 N=18

Twelve year olds

1	02 N=19	09 N=23	22 N=27	33 N=21
2	-05 N=19	07 N=23	21 N=27	30 N=21
3	-07 N=18	03 N=22	14 N=27	25 N=21
4	-10 N=15	12 N=17	10 N=21	22 N=22

Eight year olds

1	2	3	4
0 N=0	0 N=0	77* N=7	76* N=8
0 N=0	0 N=0	84* N=7	71* N=8
0 N=0	0 N=0	67 N=7	60 N=8
0 N=0	0 N=0	46 N=5	65 N=8

Eleven year olds

-03 N=14	51* N=17	58** N=23	41* N=24
18 N=14	47 N=17	66** N=23	47* N=24
27 N=14	61** N=17	64** N=23	49* N=24
24 N=14	60* N=17	66** N=23	44* N=24

Six year olds

MAT Arith. Problem Solving

WISC PQ

Year	1	2	3	4
1	0 N=0	0 N=0	0 N=1	99** N=5
2	0 N=0	0 N=0	0 N=1	75 N=5
3	0 N=0	0 N=0	0 N=1	87 N=5
4	0 N=0	0 N=0	0 N=0	60 N=5

Seven year olds

	1	2	3	4
1	0 N=0	0 N=0	0 N=1	95* N=5
2	0 N=0	0 N=0	0 N=1	95* N=5
3	0 N=0	0 N=0	0 N=1	92* N=5
4	0 N=0	0 N=0	0 N=1	93* N=5

Eight year olds

	1	2	3	4
1	0 N=0	0 N=0	88** N=7	78* N=8
2	0 N=0	0 N=0	87* N=7	76* N=8
3	0 N=0	0 N=0	73 N=7	68 N=8
4	0 N=0	0 N=0	64 N=5	69 N=8

Nine year olds

1	0 N=1	53 N=10	69** N=14	58* N=14
2	0 N=1	56 N=10	79** N=14	79** N=14
3	0 N=1	74* N=10	76** N=14	87** N=14
4	0 N=1	58 N=10	38 N=13	47 N=14

Ten year olds

48 N=6	50 N=10	14 N=13	43 N=18
64 N=6	50 N=10	06 N=13	49* N=18
83* N=6	72* N=10	11 N=13	45 N=18
73 N=6	64* N=10	15 N=13	46 N=18

Eleven year olds

18 N=14	47 N=17	54** N=23	55** N=24
23 N=14	43 N=17	54** N=23	51* N=24
40 N=14	57* N=17	58** N=23	54** N=24
30 N=14	46 N=17	59** N=23	56** N=24

Twelve year olds

1	20 N=19	23 N=23	25 N=26	31 N=21
2	14 N=19	23 N=23	27 N=26	26 N=21
3	07 N=18	23 N=22	22 N=26	15 N=21
4	-03 N=15	21 N=17	16 N=20	15 N=21

Table 51
Variables: WISC PQ correlated

with MAT Arith. Problem Solving

Six year olds

MAT Arith. Total

Year	1	2	3	4
1	0 N=0	100 N=2	82 N=5	-61 N=6
2	0 N=0	100 N=2	59 N=5	64 N=6
3	0 N=0	100 N=2	89* N=5	40 N=6
4	0 N=0	-100 N=2	86 N=5	48 N=5

WISC PQ

Seven year olds

	1	2	3	4
1	0 N=1	0 N=2	26 N=8	69 N=4
2	0 N=0	0 N=2	61 N=8	68 N=4
3	0 N=0	0 N=2	67 N=8	29 N=4
4	0 N=0	0 N=2	70 N=8	45 N=4

Eight year olds

	1	2	3	4
1	19 N=4	42 [illegible]	10 N=5	54 N=8
2	46 N=4	50 [illegible]	-10 N=5	38 N=8
3	44 N=4	[illegible] N=7	-50 N=5	45 N=8
4	-08 N=4	01 N=6	-47 N=5	48 N=8

Nine year olds

1	68** N=16	80 N=6	90* N=6	64 N=8
2	71** N=14	94** N=6	99** N=6	91** N=8
3	83** N=14	90* N=6	99** N=6	88** N=8
4	72** N=12	84 N=5	90* N=6	95** N=8

Ten year olds

66 N=8	-07 N=7	93 N=9	84 N=4
75 N=7	20 N=7	90** N=9	91 N=4
68 N=7	10 N=6	85** N=9	93 N=4
71 N=7	-41 N=5	92** N=8	97** N=4

Eleven year olds

83** N=9	86* N=6	08 N=3	57 N=3
80** N=9	79 N=6	-46 N=3	50 N=3
74* N=8	70 N=5	03 N=3	83 N=3
85** N=8	75 N=5	32 N=3	64 N=3

Twelve year olds

1	80** N=10	67 N=6	0 N=0	-100 N=2
2	82** N=10	90* N=6	0 N=0	-100 N=2
3	68* N=10	59 N=6	0 N=0	-100 N=2
4	76* N=7	59 N=5	0 N=0	-100 N=2

Table 52

Variables: WISC PQ correlated

with MAT Arith. Total

Six year olds

		MAT Reading			
	Year	1	2	3	4
WISC FSQ	1	73* N=9	62 N=6	44 N=19	32 N=18
	2	61 N=8	84* N=6	43 N=19	48 N=18
	3	65 N=8	71 N=6	57* N=19	52* N=18
	4	81 N=6	95* N=5	49* N=17	52* N=17

Seven year olds

1	2	3	4
25 N=13	50 N=8	73** N=21	70** N=20
08 N=12	46 N=8	65** N=21	66** N=20
16 N=11	43 N=8	65** N=21	70** N=20
18 N=11	47 N=8	71** N=21	73** N=20

Eight year olds

1	2	3	4
60** N=25	60** N=23	59** N=24	80** N=20
64** N=25	61** N=23	52** N=24	78** N=20
63** N=22	65** N=23	57** N=24	81** N=20
51* N=18	57** N=21	57** N=21	74** N=20

Nine year olds

1	29 N=28	50* N=24	61** N=26	36 N=23
2	44* N=26	62** N=24	65** N=26	54** N=23
3	38 N=25	55** N=24	58** N=26	47* N=23
4	40 N=23	46* N=23	56** N=25	55** N=23

Ten year olds

29 N=29	60** N=29	59** N=26	64** N=26
26 N=28	57** N=29	54** N=26	57** N=26
19 N=27	49* N=28	49* N=26	53** N=26
26 N=26	56** N=27	53** N=25	57** N=26

Eleven year olds

67** N=29	61** N=29	63** N=29	61** N=28
65** N=29	57** N=29	58** N=29	56** N=28
64** N=28	58** N=28	62** N=29	60** N=28
63** N=28	58** N=28	62** N=29	61** N=28

Twelve year olds

1	39* N=30	35 N=30	39* N=29	37 N=23
2	38* N=30	42* N=30	46* N=29	30 N=23
3	36 N=29	42* N=29	48** N=29	25 N=23
4	38 N=23	35 N=23	46* N=23	34 N=23

Table 53

Variables: WISC FSQ correlated

with MAT Reading

Six year olds

MAT Arith. Computation

Year (WISC FSQ)	1	2	3	4
1	0 N=0	0 N=0	-100 N=2	53 N=5
2	0 N=0	0 N=0	-100 N=2	47 N=5
3	0 N=0	0 N=0	-100 N=2	49 N=5
4	0 N=0	0 N=0	0 N=1	61 N=5

Seven year olds

	1	2	3	4
1	0 N=0	0 N=0	0 N=1	53 N=5
2	0 N=0	0 N=0	0 N=1	82 N=5
3	0 N=0	0 N=0	0 N=1	91* N=5
4	0 N=0	0 N=0	0 N=1	74 N=5

Eight year olds

	1	2	3	4
1	0 N=0	0 N=0	83* N=7	76* N=8
2	0 N=0	0 N=0	83* N=7	75* N=8
3	0 N=0	0 N=0	65 N=7	70 N=8
4	0 N=0	0 N=0	56 N=5	75* N=8

Nine year olds

1	0 N=1	35 N=10	32 N=14	17 N=14
2	0 N=1	56 N=10	63* N=14	63* N=14
3	0 N=1	70* N=10	67** N=14	62* N=14
4	0 N=1	58 N=10	38 N=13	50 N=14

Ten year olds

48 N=6	83** N=10	45 N=13	35 N=18
50 N=6	78** N=10	35 N=13	35 N=18
79 N=6	84** N=10	37 N=13	29 N=18
69 N=6	82** N=10	41 N=13	37 N=18

Eleven year olds

34 N=14	62** N=17	68** N=23	54** N=24
42 N=14	67** N=17	73** N=23	57** N=24
47 N=14	73** N=17	73** N=23	58** N=24
45 N=14	74** N=17	78** N=23	59** N=24

Twelve year olds

1	24 N=19	28 N=23	39* N=27	48* N=21
2	12 N=19	24 N=23	41* N=27	45* N=21
3	11 N=18	22 N=22	38 N=27	42 N=21
4	-02 N=15	25 N=17	28 N=21	33 N=21

Table 54

Variables: WISC FSQ correlated

with MAT Arith. Computation

Six year olds

MAT Arith. Prob. Solving

WISC FSQ

Year	1	2	3	4
1	0 N=0	0 N=0	0 N=1	74 N=5
2	0 N=0	0 N=0	0 N=1	58 N=5
3	0 N=0	0 N=0	0 N=1	71 N=5
4	0 N=0	0 N=0	0 N=0	57 N=5

Seven year olds

1	2	3	4
0 N=0	0 N=0	0 N=1	95* N=5
0 N=0	0 N=0	0 N=1	95* N=5
0 N=0	0 N=0	0 N=1	89* N=5
0 N=0	0 N=0	0 N=1	94* N=5

Eight year olds

1	2	3	4
0 N=0	0 N=0	88** N=7	78* N=8
0 N=0	0 N=0	85* N=7	78* N=8
0 N=0	0 N=0	71 N=7	77* N=8
0 N=0	0 N=0	67 N=5	81* N=8

Nine year olds

1	0 N=1	43 N=10	46 N=14	23 N=14
2	0 N=1	60 N=10	73** N=14	59* N=14
3	0 N=1	71* N=10	68** N=14	73** N=14
4	0 N=1	69* N=10	43 N=13	45 N=14

Ten year olds

55 N=6	71* N=10	50 N=13	63** N=18
63 N=6	64* N=10	39 N=13	63** N=18
84* N=6	78** N=10	44 N=13	62** N=18
80 N=6	76* N=10	47 N=13	67** N=18

Eleven year olds

45 N=14	70** N=17	63** N=23	63** N=24
52 N=14	74** N=17	63** N=23	63** N=24
64* N=14	74** N=17	68** N=23	66** N=24
54* N=14	70** N=17	71** N=23	71** N=24

Twelve year olds

1	45 N=19	49* N=23	49* N=26	56** N=21
2	35 N=19	49* N=23	52** N=26	47* N=21
3	25 N=18	45* N=22	45* N=26	41 N=21
4	06 N=15	31 N=17	36 N=20	36 N=21

Table 55

Variables: WISC FSQ correlated

with MAT Arith, Prob, Solving

Six year olds

MAT Arith. Total

1	2	3	4
0 N=0	100 N=2	59 N=5	-53 N=6
0 N=0	100 N=2	65 N=5	-15 N=6
0 N=0	100 N=2	61 N=5	43 N=6
0 N=0	100 N=2	77 N=5	94* N=5

Seven year olds

1	2	3	4
0 N=1	0 N=2	25 N=8	85 N=4
0 N=0	0 N=2	57 N=8	90 N=4
0 N=0	0 N=2	67 N=8	87 N=4
0 N=0	0 N=2	66 N=8	98* N=4

Eight year olds

1	2	3	4
46 N=4	62 N=7	-26 N=5	53 N=8
62 N=4	69 N=7	19 N=5	55 N=8
48 N=4	45 N=7	-57 N=5	55 N=8
11 N=4	43 N=6	-74 N=5	62 N=8

ne year olds

63** N=16	71 N=6	95** N=6	70 N=8
75 N=14	88** N=6	96** N=6	88** N=8
89** N=14	91* N=6	97** N=6	86** N=8
82** N=12	82 N=5	88* N=6	95** N=8

Ten year olds

76* N=8	31 N=7	90** N=9	99** N=4
79* N=7	53 N=7	91** N=9	96* N=4
79** N=7	29 N=6	83** N=9	96* N=4
80* N=7	-13 N=5	91** N=8	99** N=4

Eleven year olds

88** N=9	91* N=6	78 N=3	76 N=3
80** N=9	77 N=6	19 N=3	96 N=3
82* N=8	77 N=5	62 N=3	91 N=3
88* N=8	82 N=5	69 N=3	88 N=3

Twelve year olds

1	90** N=10	83 N=6	0 N=0	0 N=2
2	84** N=10	90* N=6	0 N=0	-100 N=2
3	81** N=10	80 N=6	0 N=0	-100 N=2
4	83* N=7	81 N=5	0 N=0	-100 N=2

6

es: WISC FSQ correlated

T Arith. Total

Six year olds

PMA VQ Year	MAT Reading 1	2	3	4
1	80** N=9	62 N=6	40 N=19	32 N=18
2	72* N=8	88* N=6	54* N=19	61** N=18
3	35 N=8	84* N=6	50* N=19	60** N=18
4	30 N=7	73 N=5	26 N=18	48* N=18

Seven year olds

	1	2	3	4
1	24 N=13	31 N=8	63** N=21	52* N=20
2	33 N=11	31 N=8	66** N=21	54* N=20
3	57 N=11	70 N=8	68** N=21	58** N=20
4	13 N=10	69 N=8	44 N=20	28 N=20

Eight year olds

	1	2	3	4
1	28 N=25	19 N=23	21 N=24	74** N=20
2	18 N=24	18 N=23	39 N=24	67** N=20
3	16 N=20	04 N=19	11 N=23	38 N=20
4	50* N=18	60** N=18	38 N=20	56* N=20

Nine year olds

1	22 N=28	46* N=24	61** N=26	50* N=23
2	-04 N=24	09 N=24	16 N=26	-02 N=23
3	12 N=23	16 N=23	31 N=25	43* N=22
4	13 N=22	19 N=22	22 N=24	37 N=23

Ten year olds

21 N=29	29 N=29	26 N=26	21 N=26
05 N=28	25 N=29	32 N=26	26 N=26
24 N=27	39 N=27	35 N=25	41* N=26
28 N=26	33 N=27	38 N=25	16 N=26

Eleven year olds

36 N=29	31 N=29	40* N=29	23 N=28
35 N=29	31 N=29	20 N=29	27 N=28
34 N=27	38 N=27	32 N=28	50** N=27
25 N=28	22 N=28	15 N=29	27 N=28

Twelve year olds

1	21 N=30	17 N=30	08 N=29	23 N=23
2	-14 N=30	-13 N=30	05 N=29	-13 N=23
3	-18 N=28	-06 N=28	03 N=28	-22 N=22
4	-02 N=23	-02 N=23	03 N=23	02 N=23

Table 57

Variables: PMA VQ correlated

with MAT Reading

Six year olds

MAT Reading

Year	1	2	3	4
PMA PQ 1	49 N=9	25 N=6	57* N=19	29 N=18
2	39 N=8	37 N=6	28 N=19	11 N=18
3	73* N=8	75 N=6	60** N=19	38 N=18
4	33 N=7	-44 N=5	42 N=18	18 N=18

Seven year olds

	1	2	3	4
	56* N=13	71* N=8	60** N=21	59** N=20
	21 N=11	-09 N=8	44* N=21	46* N=20
	33 N=11	51 N=8	64** N=21	63** N=20
	12 N=10	33 N=8	49* N=20	48* N=20

Eight year olds

	1	2	3	4
	34 N=25	38 N=23	21 N=24	63** N=20
	33 N=24	31 N=23	21 N=24	61** N=20
	10 N=20	-01 N=19	16 N=23	21 N=20
	27 N=18	15 N=18	27 N=20	29 N=20

Nine year olds

1	18 N=28	17 N=24	28 N=26	29 N=23
2	-03 N=24	-09 N=24	16 N=26	16 N=23
3	13 N=23	13 N=23	27 N=25	32 N=22
4	-12 N=22	-03 N=22	-26 N=24	02 N=23

Ten year olds

22 N=29	32 N=29	13 N=26	20 N=26
24 N=28	37 N=29	31 N=26	27 N=26
13 N=27	27 N=27	07 N=25	34 N=26
15 N=25	09 N=26	-14 N=24	-04 N=26

Eleven year olds

32 N=29	39* N=29	38* N=29	35 N=28
48** N=29	46* N=29	31 N=29	41* N=28
35 N=25	43* N=25	39* N=26	40* N=25
14 N=19	27 N=19	21 N=20	17 N=19

Twelve year olds

1	-29 N=30	-22 N=30	-17 N=29	-23 N=23
2	-11 N=30	02 N=30	04 N=29	11 N=23
3	-12 N=26	-14 N=26	-14 N=26	-11 N=21
4	12 N=20	02 N=20	12 N=20	33 N=20

Table 58

Variables: PMA PQ correlated

with MAT Reading

Six year olds

MAT Reading

1	2	3	4
88** N=9	70 N=6	50* N=19	42 N=18
69 N=8	80 N=6	49* N=19	32 N=18
48 N=8	23 N=6	63** N=19	24 N=18
52 N=7	39 N=5	50* N=18	29 N=18

ne year olds

31 N=28	54** N=24	59** N=26	33 N=23
40 N=24	65** N=24	53** N=26	39 N=23
36 N=23	41 N=23	48* N=25	26 N=22
31 N=22	44* N=22	40 N=24	46* N=23

59

es: PMA NQ correlated

T Reading

Seven year olds

1	2	3	4
33 N=13	12 N=8	63** N=21	60** N=20
35 N=11	32 N=8	62** N=21	58** N=20
25 N=11	32 N=8	54* N=21	50* N=20
32 N=10	37 N=8	68** N=20	62** N=20

Ten year olds

17 N=29	47* N=29	51** N=26	60** N=26
17 N=28	44* N=29	38 N=26	64** N=26
28 N=27	59** N=27	45* N=25	60** N=26
25 N=26	39* N=27	25 N=25	26 N=26

Twelve year olds

1	20 N=30	12 N=30	18 N=29	28 N=23
2	24 N=30	26 N=30	31 N=29	47* N=23
3	15 N=28	08 N=28	25 N=28	03 N=22
4	26 N=23	12 N=23	28 N=23	28 N=23

Eight year olds

1	2	3	4
57** N=25	66** N=23	57** N=24	69** N=20
48* N=24	50* N=23	45* N=24	69** N=20
61** N=20	63** N=19	42* N=23	59** N=20
68** N=18	70** N=18	63** N=20	67** N=20

Eleven year olds

61** N=29	58** N=29	51** N=29	54** N=28
60** N=29	48** N=29	32 N=29	44* N=28
27 N=27	25 N=27	35 N=28	33 N=27
37 N=28	37 N=28	38* N=29	40* N=28

year olds

MAT Reading

	2	3	4
*)	52 N=6	25 N=19	10 N=18
+ 3	46 N=6	44 N=19	35 N=18
3	48 N=6	62** N=19	27 N=18
)	34 N=5	66** N=18	41 N=18

Seven year olds

1	2	3	4
17 N=13	29 N=8	56** N=21	55* N=20
29 N=11	21 N=8	60** N=21	55* N=20
25 N=11	13 N=8	59** N=21	58** N=20
13 N=10	02 N=8	60** N=20	57** N=20

Eight year olds

1	2	3	4
38 N=25	40 N=23	37 N=24	67** N=20
40 N=24	41 N=23	16 N=24	63** N=20
52* N=20	50* N=19	42* N=23	64** N=20
38 N=18	26 N=18	37 N=20	57** N=20

year olds

8	32 N=24	25 N=26	19 N=23
4	14 N=24	08 N=26	-11 N=23
* 3	46* N=23	59** N=25	40 N=22
2	24 N=22	32 N=24	17 N=23

Ten year olds

-04 N=29	14 N=28	03 N=26	03 N=26
16 N=28	35 N=29	20 N=26	21 N=26
21 N=27	35 N=27	24 N=25	21 N=26
18 N=26	27 N=27	09 N=25	11 N=26

Eleven year olds

21 N=29	28 N=29	29 N=29	23 N=28
28 N=29	22 N=29	17 N=29	16 N=28
31 N=27	30 N=27	28 N=28	29 N=27
24 N=28	29 N=28	36 N=29	30 N=28

Twelve year olds

1	-19 N=30	-17 N=30	-02 N=29	-13 N=23
2	-06 N=30	-02 N=30	14 N=29	-09 N=23
3	-37 N=28	-35 N=28	-21 N=28	-44* N=22
4	-10 N=23	-09 N=23	03 N=23	-04 N=23

PMA SQ correlated

Reading

Six year olds

MAT Reading

PMA RQ

Year	1	2	3	4
1	0 N=0	0 N=0	0 N=0	0 N=0
2	0 N=0	0 N=0	0 N=0	0 N=0
3	0 N=0	0 N=0	0 N=0	0 N=0
4	0 N=0	0 N=0	0 N=0	0 N=0

Seven year olds

	1	2	3	4
1	0 N=0	0 N=0	0 N=0	0 N=0
2	0 N=0	0 N=0	0 N=0	0 N=0
3	0 N=0	0 N=0	0 N=0	0 N=0
4	0 N=0	0 N=0	0 N=0	0 N=0

Eight year olds

	1	2	3	4
1	0 N=0	0 N=0	0 N=0	0 N=0
2	0 N=0	0 N=0	0 N=0	0 N=0
3	100* N=3	99 N=3	98 N=3	100 N=2
4	0 N=1	0 N=1	0 N=1	0 N=1

Nine year olds

	1	2	3	4
1	0 N=0	0 N=0	0 N=0	0 N=0
2	0 N=0	0 N=0	0 N=0	0 N=0
3	0 N=1	0 N=1	0 N=1	0 N=1
4	-08 N=4	81 N=4	39 N=4	69 N=4

Ten year olds

	1	2	3	4
1	0 N=0	0 N=0	0 N=0	0 N=0
2	-06 N=6	02 N=6	-01 N=6	79 N=6
3	41 N=5	72 N=5	62 N=5	76 N=5
4	61 N=8	50 N=8	87** N=8	20 N=8

Eleven year olds

	1	2	3	4
1	75 N=6	39 N=6	39 N=6	55 N=6
2	61* N=12	59* N=12	38 N=12	72** N=12
3	51* N=17	58** N=17	64** N=17	68** N=17
4	53* N=15	30 N=15	24 N=15	67** N=15

Twelve year olds

	1	2	3	4
1	-62 N=9	-50 N=9	-08 N=8	-25 N=7
2	-18 N=18	-16 N=18	13 N=17	-17 N=13
3	-06 N=15	-26 N=15	09 N=15	-47 N=13
4	-42 N=15	-36 N=15	-24 N=15	04 N=15

Table 61

Variables: PMA RQ correlated

with MAT Reading

Six year olds

MAT Reading

Perceptual Discrimination

Year	1	2	3	4
1	54 N=9	84* N=6	56* N=19	42 N=18
2	-20 N=8	-39 N=6	08 N=19	-08 N=18
3	80* N=8	88* N=6	57* N=19	46 N=18
4	19 N=7	66 N=5	02 N=17	16 N=18

Seven year olds

1	2	3	4
31 N=13	46 N=8	64** N=21	62** N=20
23 N=11	42 N=8	55** N=21	53* N=20
19 N=11	-10 N=8	21 N=21	05 N=20
21 N=9	06 N=7	52* N=19	39 N=19

Eight year olds

1	2	3	4
-07 N=25	06 N=24	03 N=24	17 N=20
01 N=24	04 N=23	-11 N=24	38 N=20
17 N=22	12 N=21	-06 N=24	31 N=20
21 N=18	22 N=18	27 N=20	52* N=20

Nine year olds

1	25 N=28	12 N=24	11 N=26	31 N=23
2	32 N=24	28 N=24	16 N=26	39 N=23
3	23 N=24	23 N=24	09 N=26	27 N=23
4	04 N=21	07 N=21	22 N=23	17 N=22

Ten year olds

21 N=29	37 N=29	26 N=26	32 N=26
27 N=28	42* N=29	35 N=26	56** N=26
-15 N=27	09 N=28	-10 N=26	25 N=26
02 N=26	19 N=27	25 N=25	27 N=26

Eleven year olds

47* N=29	43* N=29	44* N=29	46* N=28
42* N=29	43* N=29	47* N=29	33 N=2
44* N=28	45* N=28	56** N=29	47* N=28
26 N=28	27 N=28	37 N=29	29 N=2

Twelve year olds

1	-20 N=30	-15 N=30	-15 N=29	-30 N=23
2	-17 N=30	-03 N=30	13 N=29	-32 N=23
3	-27 N=29	-30 N=29	-25 N=29	-42* N=23
4	16 N=23	21 N=23	44* N=23	14 N=23

Table 62

Variables: Perceptual Discrimination correlated with MAT Reading

Six year olds

MAT Reading

Perceptual Analysis

Year	1	2	3	4
1	-38 N=9	-38 N=6	-04 N=19	-08 N=18
2	0 N=8	0 N=6	-08 N=19	-13 N=18
3	-50 N=8	-32 N=6	-06 N=19	-12 N=18
4	16 N=7	26 N=5	-34 N=17	-26 N=17

Seven year olds

	1	2	3	4
1	-24 N=13	73 N=8	22 N=21	31 N=20
2	26 N=11	81* N=8	57** N=21	65** N=20
3	-04 N=11	34 N=8	51* N=21	55* N=20
4	-09 N=9	29 N=7	30 N=19	39 N=19

Eight year olds

	1	2	3	4
1	34 N=25	37 N=23	24 N=24	53* N=20
2	61** N=24	58** N=23	27 N=24	79** N=20
3	46* N=22	44* N=21	28 N=24	67** N=20
4	59** N=18	49* N=18	42 N=20	72** N=20

Nine year olds

1	26 N=28	39 N=24	41* N=26	07 N=23
2	34 N=24	43* N=24	28 N=26	24 N=23
3	45* N=24	42* N=24	38 N=26	40 N=23
4	32 N=21	35 N=21	30 N=23	32 N=22

Ten year olds

37* N=29	46* N=29	28 N=26	22 N=26
36 N=28	26 N=29	16 N=26	19 N=26
35 N=27	35 N=28	31 N=26	41* N=26
25 N=26	31 N=27	27 N=25	36 N=26

Eleven year olds

34 N=29	38* N=29	31 N=29	31 N=28
27 N=29	37* N=29	31 N=29	36 N=28
32 N=28	39* N=28	26 N=29	41* N=28
36 N=28	37 N=28	29 N=29	34 N=28

Twelve year olds

1	11 N=30	13 N=30	20 N=29	-07 N=23
2	-09 N=30	-09 N=30	03 N=29	-32 N=23
3	08 N=29	06 N=29	17 N=29	-04 N=23
4	06 N=23	-02 N=23	11 N=23	-04 N=23

Table 63

Variables: Perceptual Analysis

correlated with MAT Reading

Six year olds

MAT Reading

Perceptual Synthesis

Year	1	2	3	4
1	-02 N=9	-22 N=6	-01 N=19	01 N=18
2	-14 N=8	48 N=6	-06 N=19	-06 N=18
3	-02 N=8	-02 N=6	51* N=19	22 N=18
4	01 N=7	26 N=5	-07 N=17	-01 N=17

Seven year olds

	1	2	3	4
1	36 N=13	73* N=8	64** N=21	70** N=20
2	-10 N=11	28 N=8	37 N=21	55* N=20
3	-02 N=11	24 N=8	44* N=21	48 N=20
4	-04 N=9	-04 N=7	51* N=19	52* N=19

Eight year olds

	1	2	3	4
1	17 N=25	05 N=23	-06 N=24	50* N=20
2	20 N=24	12 N=23	10 N=24	24 N=20
3	52* N=22	50* N=21	33 N=24	59** N=20
4	37 N=18	44 N=18	40 N=20	52* N=20

Nine year olds

1	47* N=28	44* N=24	21 N=26	27 N=23
2	07 N=24	22 N=24	35 N=26	10 N=23
3	24 N=24	30 N=24	33 N=26	30 N=23
4	20 N=21	24 N=21	22 N=23	38 N=22

Ten year olds

-04 N=29	22 N=29	12 N=26	16 N=26
-16 N=28	01 N=29	-18 N=26	-03 N=26
06 N=27	25 N=28	05 N=26	14 N=26
15 N=26	30 N=27	14 N=25	22 N=26

Eleven year olds

42* N=29	52** N=29	50** N=29	43* N=28
36 N=29	40* N=29	46* N=29	36 N=28
43* N=28	39* N=28	41* N=29	48** N=28
38* N=28	44* N=28	51** N=29	45* N=28

Twelve year olds

1	-01 N=30	-09 N=30	09 N=29	-18 N=23
2	-09 N=30	-07 N=30	14 N=29	-14 N=23
3	-13 N=29	-07 N=29	-02 N=29	02 N=23
4	-02 N=23	-05 N=23	09 N=23	-14 N=23

Table 64

Variables: Perceptual Synthesis

correlated with MAT Reading

Six year olds

MAT Reading

Perceptual Integration Year	1	2	3	4
1	38 N=9	38 N=6	20 N=19	09 N=18
2	62 N=8	14 N=6	-11 N=19	-19 N=18
3	43 N=8	08 N=6	01 N=19	05 N=18
4	11 N=7	-24 N=5	-09 N=17	-09 N=17

Seven year olds

	1	2	3	4
1	32 N=13	78* N=8	56** N=21	65** N=20
2	14 N=11	60 N=8	58** N=21	70** N=20
3	01 N=11	48 N=8	56** N=21	72** N=20
4	-15 N=9	21 N=7	42 N=19	46* N=19

Eight year olds

	1	2	3	4
1	68** N=25	56** N=23	43* N=24	81** N=20
2	55** N=24	38 N=23	26 N=24	72** N=20
3	64** N=22	64** N=21	57** N=24	82** N=20
4	64** N=18	68** N=18	62** N=20	81** N=20

Nine year olds

1	31 N=28	41* N=24	39* N=26	05 N=23
2	37 N=24	29 N=24	36 N=26	11 N=23
3	19 N=24	18 N=24	29 N=26	09 N=23
4	31 N=21	17 N=21	21 N=23	28 N=22

Ten year olds

03 N=29	28 N=29	14 N=26	07 N=26
25 N=28	35 N=29	28 N=26	27 N=26
30 N=27	37 N=28	32 N=26	35 N=26
31 N=26	45* N=27	38 N=25	31 N=26

Eleven year olds

27 N=29	31 N=29	30 N=29	33 N=28
24 N=29	22 N=29	22 N=29	24 N=28
14 N=28	13 N=28	17 N=29	19 N=28
31 N=28	31 N=28	33 N=29	39* N=28

Twelve year olds

1	-12 N=30	-10 N=30	06 N=29	-14 N=23
2	-15 N=30	-16 N=30	01 N=29	-14 N=23
3	-05 N=29	-02 N=29	11 N=29	-08 N=23
4	11 N=23	02 N=23	12 N=23	05 N=23

Table 65

Variables: Perceptual Integration

correlated with MAT Reading

Children who were aged 6 in first year of study:
Longitudinal data for four year period

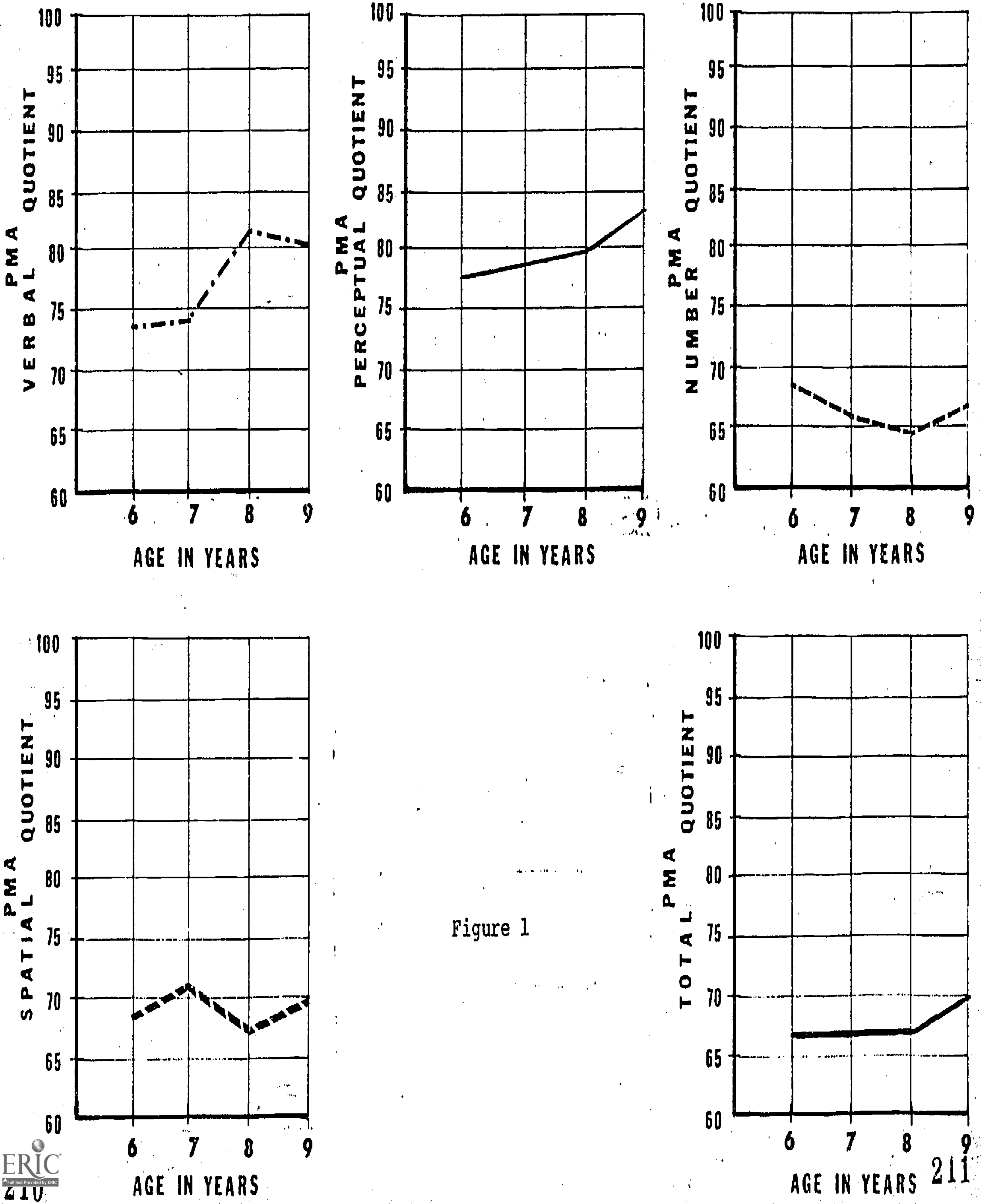


Figure 1

Children who were aged 7 in first year of study:
Longitudinal data for four year period

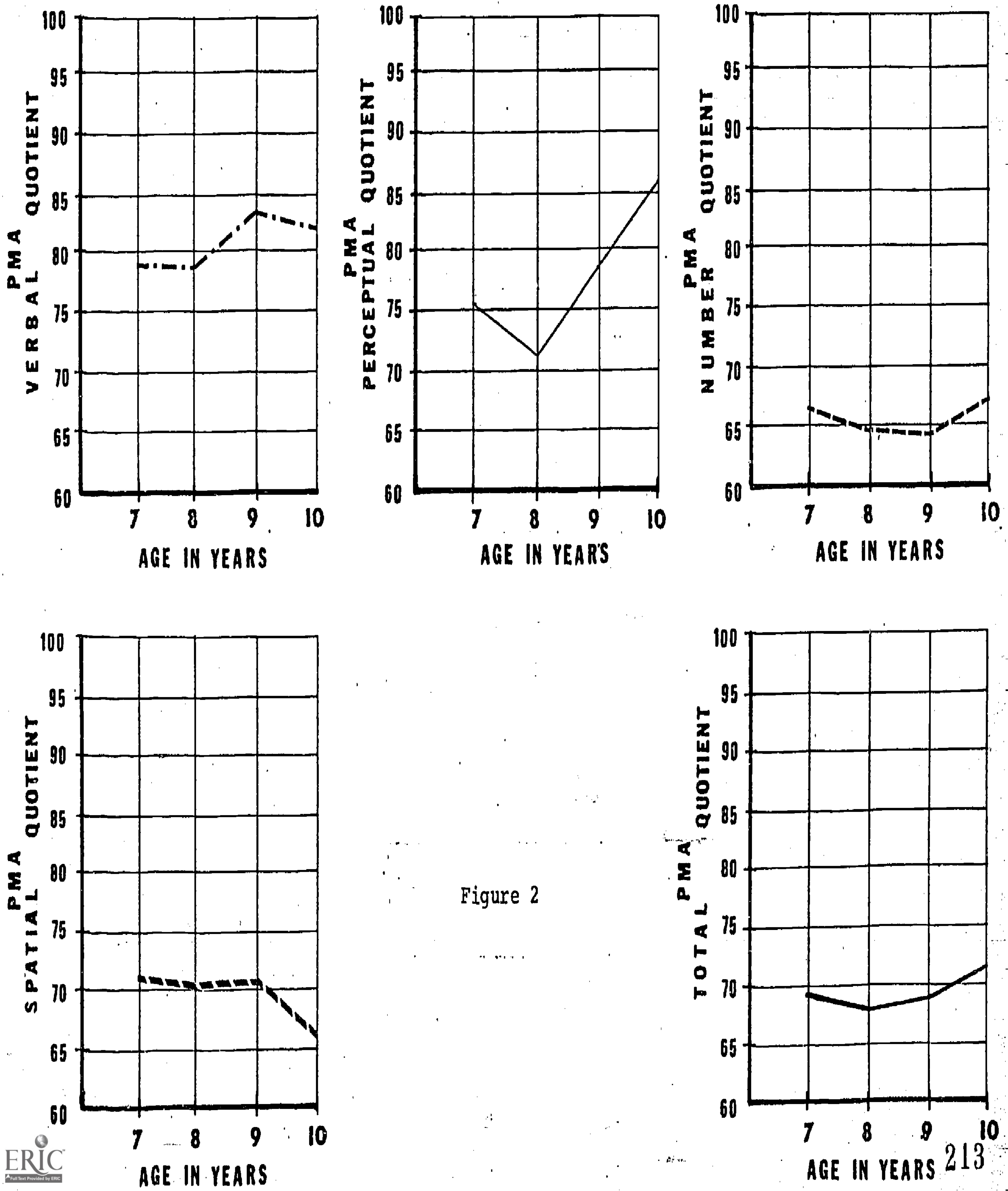


Figure 2

Children who were aged 8 in first year of study:
Longitudinal data for four year period

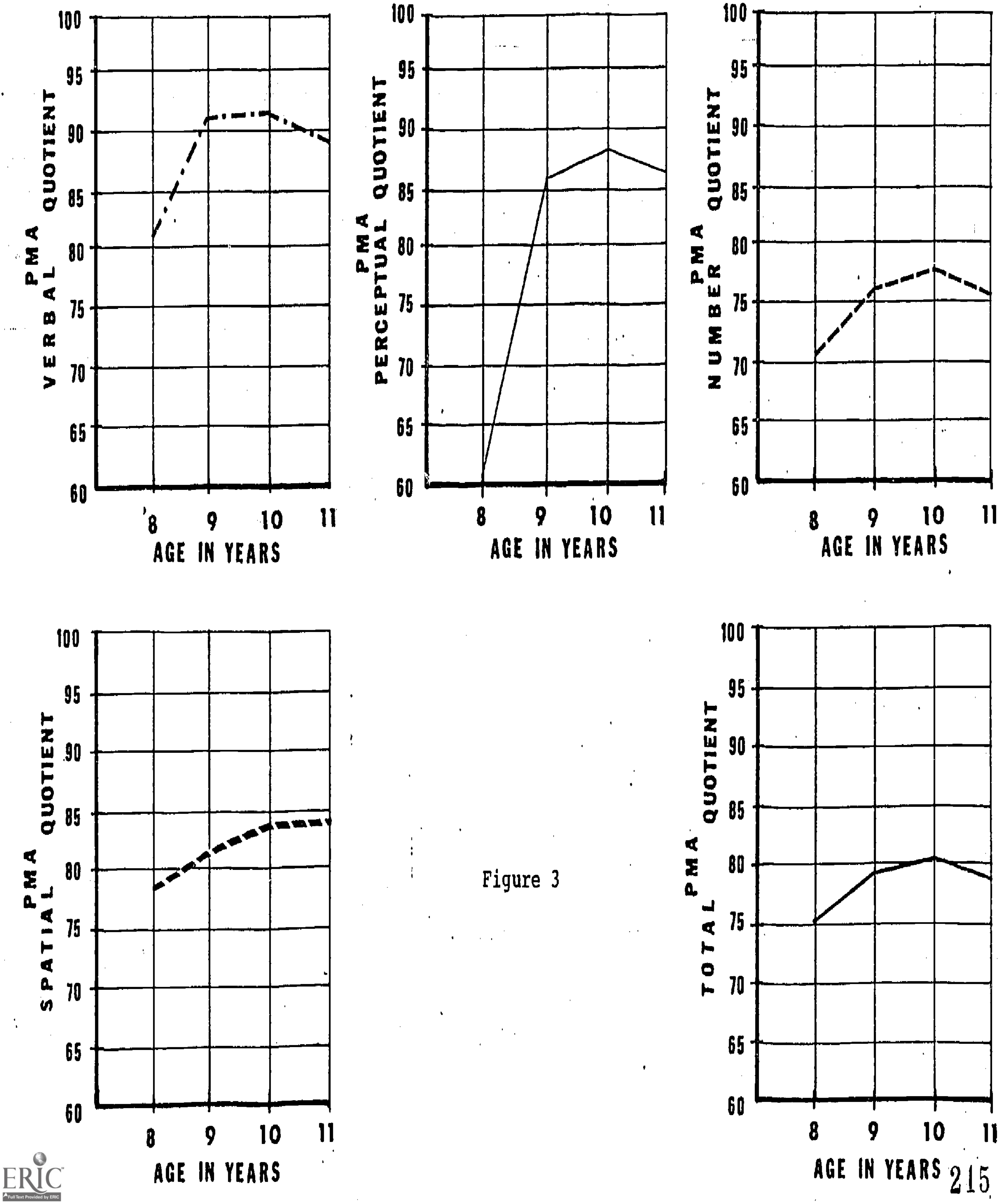
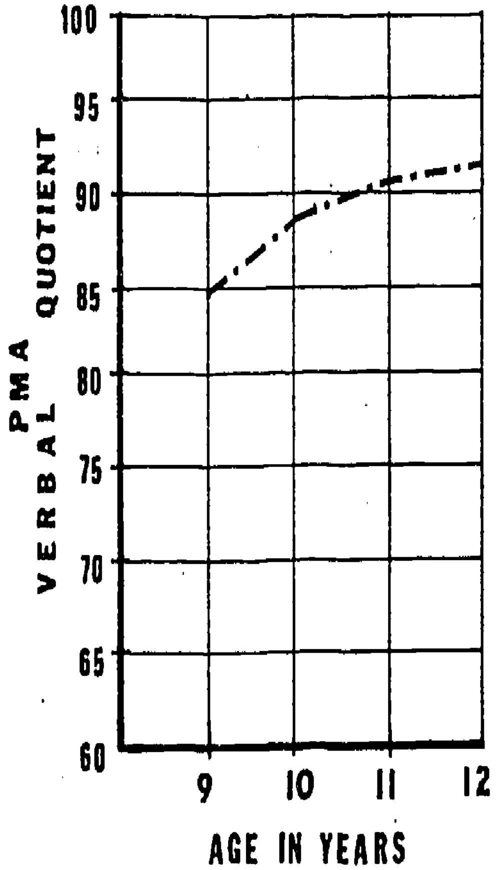
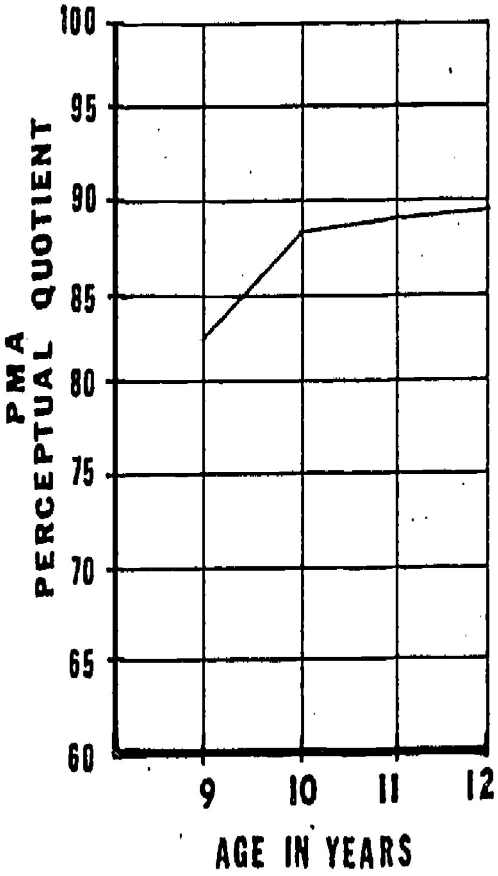
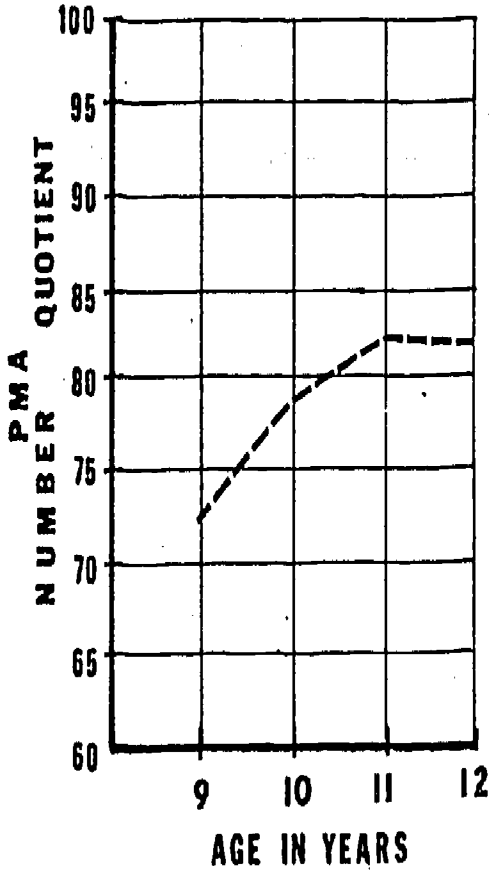


Figure 3

Children who were aged 9 in first year of study:
Longitudinal data for four year period







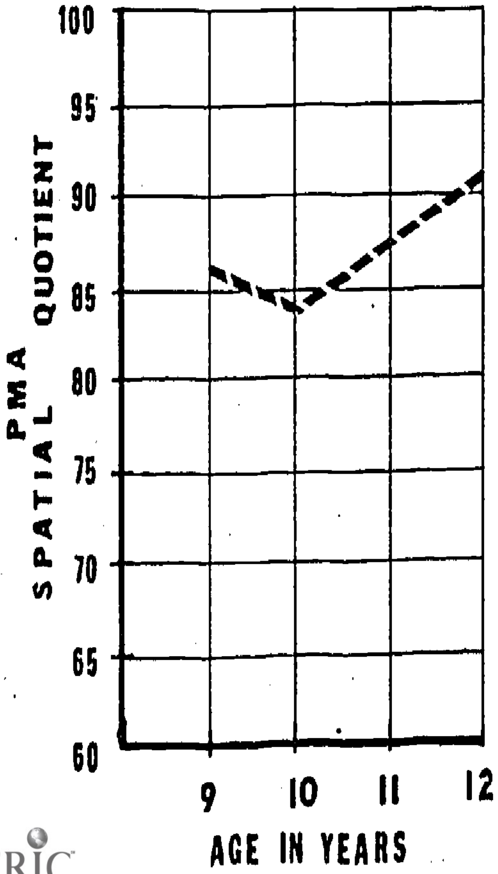
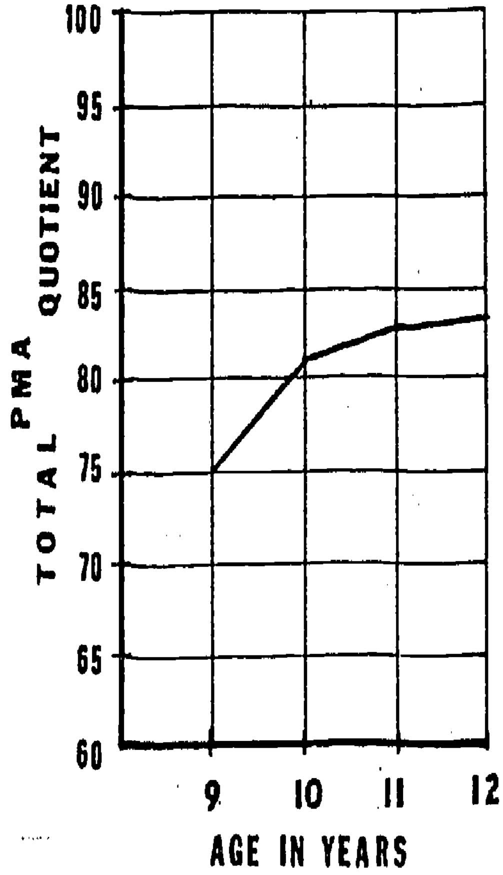


Figure 4



Children who were aged 10 in first year of study:
Longitudinal data for four year period

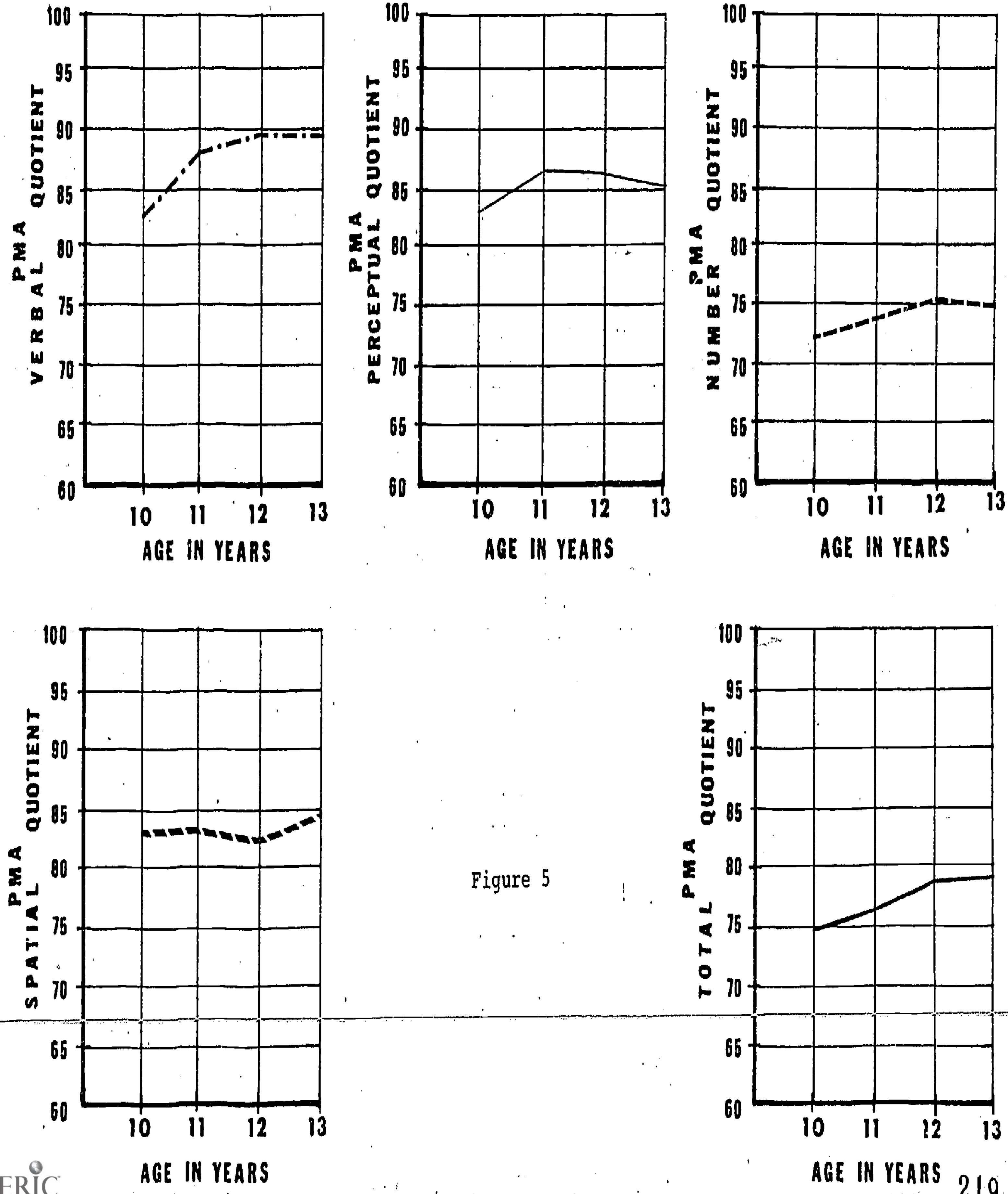


Figure 5

Children who were aged 11 in first year of study:

Longitudinal data for four year period

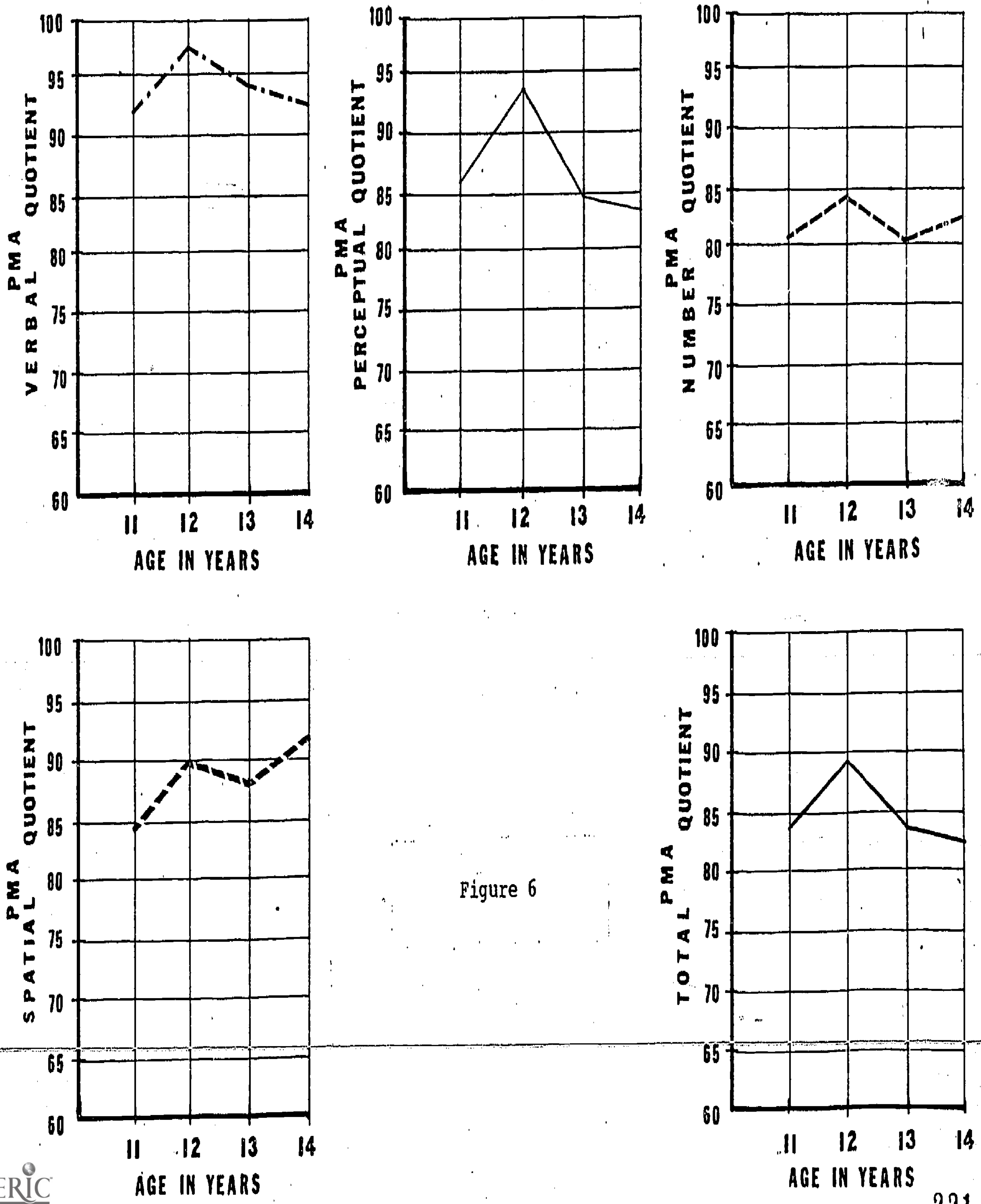


Figure 6

Children who were aged 12 in first year of study:
Longitudinal data for four year period

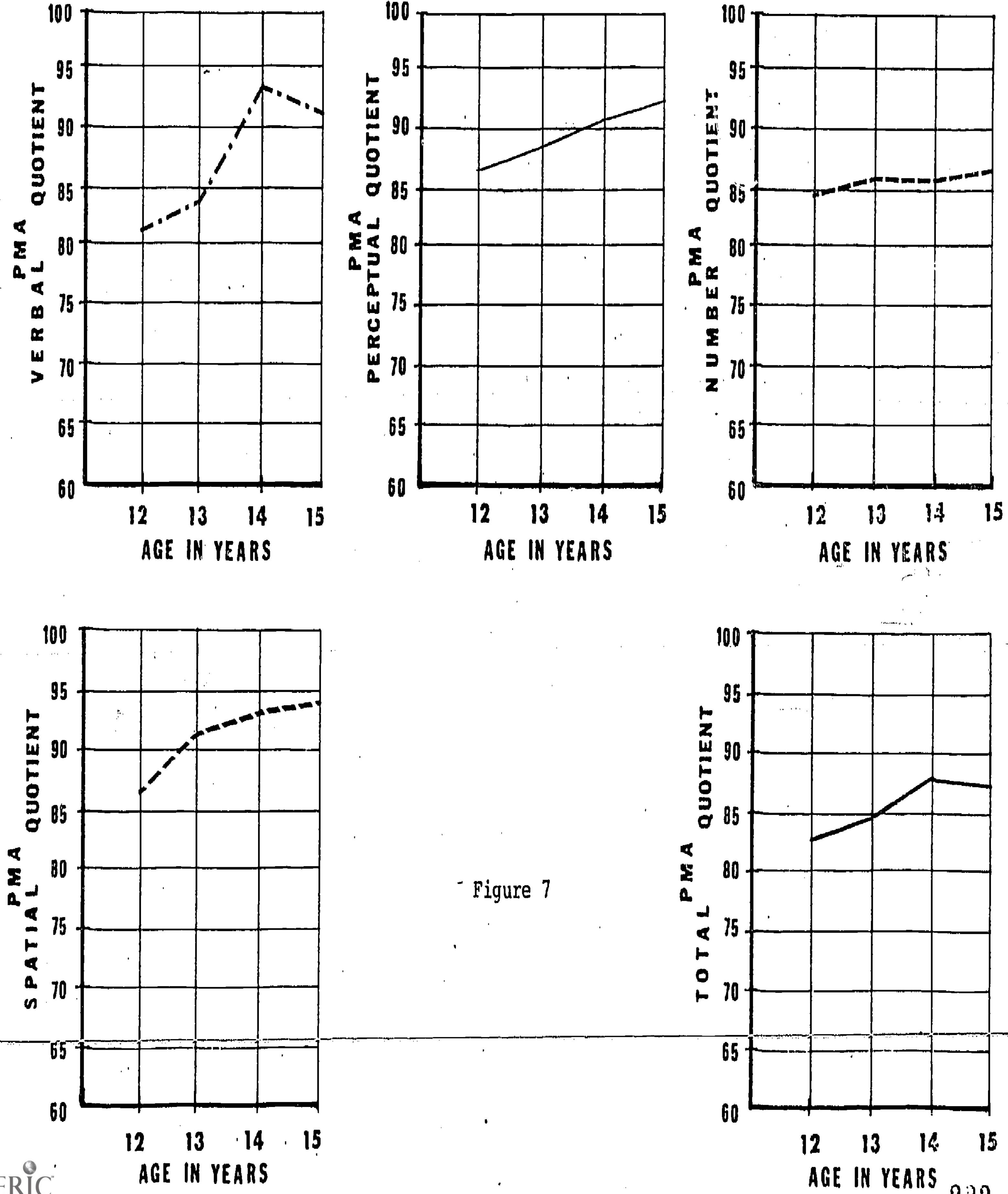


Figure 7

Chapter 4. Longitudinal Study of the WISC

Research has been reported on the neurological and cognitive heterogeneity of children educationally designated as brain damaged (Birch, 1964; Birch, Belmont, Belmont, and Taft, 1967; Birch and Bortner, 1968; Bortner and Birch, 1970; Bortner, Hertzig, and Birch, 1972). These studies show a concern with the problem of cognitive ability characteristics for brain damaged children, but longitudinal comparisons have not yet been investigated.

The present study concerns the longitudinal course of development of cognitive functioning in brain damaged children of school age. The issues of specific interest are the stability and variability of intellectual functioning and its patterns. This problem may be formulated as a question: What happens to the relative position of a child within her/his peer group both in terms of general intelligence test scores and in terms of specific aspects of intellectual functioning? The proposed study was designed to provide such information by tracing the developmental course of both the IQ and of patterns of intellectual abilities in children with neurological impairment.

It is important to ascertain whether this pattern of intellectual functioning changes with age or remains constant. Although cross-sectional analysis of intellectual patterns or profiles might provide this information about status at a given point in time, only longitudinal analysis is pertinent to the discovery of individual stability of growth patterns. That is, does a child's pattern of intellectual functioning at a given time relate systematically to his pattern of functioning in subsequent periods?

The primary objective of the present investigation was to provide information characterizing the stability and/or variability of intellectual functioning of neurologically impaired school age children studied longitudinally over a period of four years. A coordinate objective was to ascertain the presence and possible changes over time in patterns of intellectual functioning, and to discover whether or not these patterns, if present, were age-specific.

Method

Subjects

The subjects in the study were those 177 children, studied over the 4-year period, who were still present in the fourth year, thus providing a set of four WISCs for each child.

The children of the study sample initially consisted of 30 children, randomly selected, within each of 7 consecutive age groups, 6, 7, 8, 9, 10, 11, and 12 years old at the start of the investigation. This range was selected for study because of its potentiality for growth and change. As the starting-age groups grew older from one year to the next over the 4 years, they encompassed respective age ranges of 6-9, 7-10, 8-11, 9-12, 10-13, 11-14, and 12-15 years. The original total sample sustained out-migration loss over the 4-year period, dropping from 210 to 177 children. Analysis was accordingly limited to those children present for the entire 4-year span. Table 66 shows the resulting age and sex characteristics of the children studied, arranged by starting-age group. As observed in the table, boys outnumbered girls in the sample by approximately 3:1, representative of the special school population and also comparable with data reported in other studies of neurologically impaired children (Birch, 1964; Rutter, Graham and Yule, 1970).

These brain injured children were characterized by generally subaverage intellectual functioning. In terms of the Wechsler Intelligence Scale for Children (WISC) IQs obtained during the first year of the longitudinal study, 60% of the children had Full Scale IQs below 75, and 12% had IQs in the range from 75 through 80.

Table 66

Age and Sex Characteristics of the Longitudinal Starting-Age Groups of Children

Starting-Age Group	Longitudinal Range	Boys	Girls	Total
6	6-9	16	9	25
7	7-10	22	4	26
8	8-11	17	5	22
9	9-12	19	6	25
10	10-13	21	6	27
11	11-14	25	4	29
12	12-15	14	9	23
Total		134	43	177

On both the Verbal and Performance Scales, approximately half the children had IQs below 75, and nearly 20% had IQs from 75 through 80. Their mean intellectual status on each of the three scales is shown in Table 67, arranged by starting-age group during the first year of the study.

The table of means bears out the previous observations of overall borderline level of the scores. The mean score levels for Full Scale IQ ranged from 65 in the 6-year starting-age group to 79 in the 11-year starting-age group. Verbal Scale IQ ranged from 68 to 83, and Performance Scale IQ ranged from 68 to 78, with the same starting-age groups representing the extremes of the range.

Procedure

Over the 4-year duration of the longitudinal study, each child was tested at yearly intervals by the same psychologist. Each child was retested in the following year within a few weeks of the anniversary of the previous examination. This schedule enabled the observation and comparison of 4 repeated measures for each child, and provided for the longitudinal following of the children in the 7 starting-age groups. The WISC was selected in order to permit an analysis of patterning of the cognitive abilities of the children as well as to supply overall measures of intellectual functioning. Because the test has been studied in depth in both normal and pathological

Table 67

WISC IQ Characteristics of the Longitudinal Starting-Age Groups of Brain Damaged Children

Starting-Age Group		Verbal IQ		Performance IQ		Full Scale IQ	
	N	M	SD	M	SD	M	SD
6	25	68.48	10.20	68.76	9.93	65.56	9.52
7	26	71.38	13.05	71.54	18.96	68.62	16.59
8	22	77.27	13.42	79.36	20.97	76.18	17.86
9	25	73.60	10.76	76.96	12.64	72.80	11.40
10	27	75.07	12.48	70.04	15.60	70.11	13.69
11	29	83.52	15.37	78.97	17.64	79.48	16.59
12	23	78.13	9.43	73.26	13.82	73.43	10.62

Note. The means and standard deviations for the WISC IQ scales represent the scores obtained during the first year of the longitudinal study.

populations, a context of literature and empirical findings was available with which the results of the study could be evaluated and compared.

Design

Scaled scores of all the 12 subtests of the WISC as well as the 3 resulting Verbal Scale, Performance Scale, and Full Scale IQs were obtained for each of the 177 children, and were analyzed within each of the 7 starting-age groups. Thus, 15 one-way analyses of variance, repeated measures design, were performed in each of the 7 starting-age groups for a total of 105 comparisons to provide evidence of stability or change for each of the 15 measures over the 4 years. Wherever significant F values, $p < .05$, were found in the analyses of variance comparisons, orthogonal polynomial coefficients were used to determine the shapes of the trends for each set of 4 subtest means. F tests for the trend components provided information concerning the significance of linear, cubic, and/or quadratic characteristics.

In addition, Pearson correlation coefficients were obtained for the subtest scores, generating a correlation matrix describing the relationships of each year with the others on the 4-year comparisons for each starting-age group.

Finally, the 12 WISC subtest means were ranked within each of the 4 years for each of the 7 starting-age groups to provide ordinal evidence of cognitive patterning characteristics.

Results

Stability and Change in Cognitive Development

Examination of the test scores showed that of the 105 longitudinal comparisons available from the data, and tested by the analyses of variance, 70 comparisons emerged which remained stable over the four years. That is, *F* tests yielded no significant differences at the .05 level. In these 70 comparisons, the children maintained a rate of growth commensurate with the levels established at initial assessment during the first year of the study, i.e., scaled scores remained consistent over the four years. Further, the 70 comparisons which remained stable significantly outnumbered the 35 which showed change: $\chi^2(1) = 11.7$, $p < .001$.

However, although the 35 comparisons which showed change over the four years were significantly outnumbered by those which remained stable, the very incidence of these 35 significant differences out of 105 comparisons exceeded chance expectations. That is, since the significance level of the analyses of variance which tested the 105 comparisons was set at $p < .05$, the same criterion was applied to the

TABLE 68

Starting-Age 6: WISC Scaled Score Means and F Values for Analysis of Variance and Trend Analysis for Four Consecutive Years, N=25

Subtest		Age				ANOVA	Trend Analysis Components		
							Linear	Quadr.	Cubic
		6	7	8	9	F 3,72 df	F 1,72	F 1,72	F 1,72
1 Inform.	M	5.16	5.52	5.16	5.36	0.41			
	SD	2.22	2.35	2.38	2.54				
2 Compr.	M	4.88	5.84	5.28	4.84	2.74*	0.00	0.01	0.00
	SD	1.73	2.36	2.24	3.13				
3 Arith.	M	4.84	4.60	4.64	4.88	0.26			
	SD	1.78	2.64	2.35	2.27				
4 Simil.	M	5.64	6.04	6.76	7.24	2.79*	8.27**	0.01	0.09
	SD	2.57	2.52	3.15	3.25				
5 Vocab.	M	4.16	4.72	5.00	4.76	1.72			
	SD	2.03	1.87	1.96	2.75				
6 D.Span.	M	5.12	5.96	5.52	6.48	3.04*	5.90*	0.03	3.20
	SD	2.21	3.13	2.62	3.25				
7 P.Compl.	M	6.08	6.72	6.40	6.88	0.94			
	SD	2.46	2.07	1.88	2.37				
8 P.Arr.	M	5.92	5.12	6.12	5.92	1.54			
	SD	2.00	2.30	2.08	2.28				
9 Bl.Des.	M	5.64	7.40	7.04	7.04	4.30**	5.22*	5.49*	2.18
	SD	2.62	2.86	2.75	2.95				
10 Obj.A.	M	4.56	5.88	5.88	5.36	2.77*	2.05	6.03*	0.23
	SD	1.98	2.47	3.43	2.92				
11 Coding	M	4.76	6.16	6.36	7.04	7.64***	20.67***	1.08	1.18
	SD	3.01	3.35	3.22	3.73				
12 Mazes	M	6.04	6.32	6.20	6.40	0.29			
	SD	1.59	1.83	2.17	3.24				
13 V IQ	M	68.48	71.40	71.08	72.44	2.57			
	SD	10.20	11.96	12.02	14.48				
14 P IQ	M	68.76	74.00	74.52	75.32	8.38***	19.29***	4.66*	1.18
	SD	9.93	11.88	12.87	14.31				
15 F IQ	M	65.56	70.08	70.12	71.32	7.56***	17.59***	3.23	1.87
	SD	9.52	11.65	12.44	14.60				

*p < .05 **p < .01 ***p < .001

TABLE 69

Starting-Age 7: WISC Scaled Score Means and F Values for Analysis of Variance and Trend Analysis for Four Consecutive Years, N=26

Subtest		Age 7	8	9	10	ANOVA F 3,75 df	Trend Analysis Components Linear F 1,75	Quadr. F 1,75	Cubic F 1,75
1 Inform.	M	4.92	5.38	5.77	5.50	1.88			
	SD	2.35	2.20	2.45	2.75				
2 Compr.	M	6.08	5.65	4.62	5.27	3.87*	6.02*	2.91	2.68
	SD	2.37	2.51	1.96	3.29				
3 Arith.	M	5.12	4.31	4.04	4.42	3.25*	4.25*	5.49*	0.01
	SD	2.83	2.85	2.41	2.80				
4 Simil.	M	5.77	6.81	6.15	7.23	2.63			
	SD	2.41	2.59	3.36	3.63				
5 Vocab.	M	5.15	5.31	5.50	4.85	0.89			
	SD	3.13	2.16	2.27	2.66				
6 D.Span.	M	5.50	5.31	5.23	5.23	0.23			
	SD	2.34	2.85	2.59	2.44				
7 P.Compl.	M	6.35	6.12	5.23	5.62	2.02			
	SD	3.63	2.90	2.71	2.73				
8 P.Arr.	M	6.19	5.96	5.85	6.23	0.38			
	SD	3.34	3.49	4.55	3.66				
9 Bl.Des.	M	5.73	5.81	6.58	6.69	1.95			
	SD	2.81	3.06	3.97	4.23				
10 Obj.A.	M	5.85	5.96	6.38	6.15	0.52			
	SD	3.50	4.10	4.73	4.65				
11 Coding	M	5.08	5.58	5.96	5.73	1.12			
	SD	3.37	3.73	4.20	3.72				
12 Mazes	M	6.31	5.81	6.04	6.00	0.69			
	SD	2.49	2.70	3.01	3.31				
13 V IQ	M	71.38	71.50	69.96	71.15	0.67			
	SD	13.05	12.30	12.38	15.44				
14 P IQ	M	71.54	71.31	72.31	73.00	0.39			
	SD	18.96	20.96	23.82	22.92				
15 F IQ	M	68.62	68.69	68.31	69.12	0.13			
	SD	16.59	17.15	18.16	19.59				

*$p < .05$ **$p < .01$ ***$p < .001$

TABLE. 70

Starting-Age 8: WISC Scaled Score Means and F Values for Analysis of Variance and Trend Analysis for Four Consecutive Years, N=22

Subtest		Age				ANOVA	Trend Analysis Components		
		8	9	10	11	F 3,63 df	Linear F 1,63	Quadr. F 1,63	Cubic F 1,63
1 Inform.	M	6.27	6.64	6.68	6.18	0.78			
	SD	2.36	2.60	2.14	2.29				
2 Compr.	M	6.23	6.14	6.59	5.82	0.93			
	SD	2.35	2.45	1.87	2.12				
3 Arith.	M	6.32	5.41	6.05	5.59	2.77*	0.95	0.41	2.76
	SD	2.75	1.90	2.74	2.66				
4 Simil.	M	6.73	6.59	8.14	8.73	7.41***	19.03***	0.88	2.32
	SD	3.03	2.82	2.38	2.38				
5 Vocab.	M	6.05	6.45	6.23	5.64	1.54			
	SD	2.88	2.41	2.04	2.10				
6 D.Span.	M	6.64	6.55	7.00	7.59	2.12			
	SD	2.98	3.26	2.98	3.39				
7 P.Compl.	M	7.09	7.50	7.14	6.68	0.95			
	SD	2.91	2.54	2.96	2.93				
8 P.Arr.	M	7.14	6.68	6.59	6.95	0.50			
	SD	3.33	3.53	3.21	3.75				
9 Bl.Des.	M	7.73	7.91	6.95	6.27	6.02**	15.04***	1.98	1.06
	SD	3.74	3.55	3.31	3.91				
10 Obj.A.	M	6.82	7.05	7.68	6.82	1.14			
	SD	4.26	3.64	4.19	4.01				
11 Coding	M	7.27	7.91	7.14	7.05	1.83			
	SD	3.76	3.23	3.35	3.83				
12 Mazes	M	6.18	6.36	6.27	6.55	0.36			
	SD	2.52	2.03	2.65	3.14				
13 V IQ	M	77.27	76.91	79.64	78.64	1.92			
	SD	13.42	12.76	11.32	11.95				
14 P IQ	M	79.36	80.59	78.86	77.23	1.34			
	SD	20.97	17.26	18.14	20.03				
15 F IQ	M	76.18	76.73	77.32	75.77	0.59			
	SD	17.86	15.33	14.70	15.78				

*$p < .05$ **$p < .01$ ***$p < .001$

TABLE 71

Starting-Age 9: WISC Scaled Score Means and F Values for Analysis of Variance and Trend Analysis for Four Consecutive Years, N=25

Subtest		Age				ANOVA	Trend Analysis Components		
		9	10	11	12	F 3,72 df	Linear F 1,72	Quadr. F 1,72	Cubic F 1,72
1 Inform.	M	6.12	6.28	6.20	6.12	0.12			
	SD	2.12	2.20	2.48	2.05				
2 Compr.	M	5.56	5.84	5.56	4.88	2.00			
	SD	2.67	2.72	2.55	2.07				
3 Arith.	M	5.36	5.28	5.68	6.04	1.33			
	SD	2.36	2.55	2.49	2.09				
4 Simil.	M	5.96	7.44	7.92	8.24	5.38**	14.16***	1.78	0.19
	SD	2.62	2.86	3.36	2.08				
5 Vocab.	M	5.36	5.44	5.00	4.84	1.53			
	SD	2.54	2.47	2.50	2.05				
6 D.Span.	M	6.36	6.96	6.48	7.32	2.12			
	SD	2.48	2.27	2.76	2.60				
7 P.Compl.	M	6.68	7.04	6.96	6.88	0.20			
	SD	2.46	2.46	2.55	2.10				
8 P.Arr.	M	6.68	6.68	6.60	6.80	0.06			
	SD	3.53	3.72	3.71	3.27				
9 Bl.Des.	M	7.24	7.08	7.24	7.20	0.07			
	SD	2.29	2.62	2.82	2.64				
10 Obj.A.	M	6.72	6.96	6.72	6.88	0.09			
	SD	2.29	3.04	2.99	3.63				
11 Coding	M	6.96	7.88	8.44	8.72	3.35*	9.48**	0.57	0.00
	SD	3.05	2.98	3.07	3.07				
12 Mazes	M	5.88	5.68	6.56	6.44	2.20			
	SD	2.01	2.24	2.83	2.64				
13 V IQ	M	73.60	76.28	75.72	76.36	1.83			
	SD	10.76	12.27	12.78	9.79				
14 P IQ	M	76.96	78.32	79.80	80.40	1.79			
	SD	12.64	14.23	14.50	14.28				
15 F IQ	M	72.80	75.04	75.60	76.32	2.81*	7.52**	0.70	0.21
	SD	11.40	13.14	13.67	12.15				

*$p < .05$ **$p < .01$ ***$p < .001$

TABLE 72

Starting-Age 10: WISC Scaled Score Means and F Values for Analysis of Variance and Trend Analysis for Four Consecutive Years, N=27

Subtest			Age				ANOVA	Trend Analysis Components		
			10	11	12	13	F 3,78 df	Linear F 1,78	Quadr. F 1,78	Cubic F 1,78
1	Inform.	M	6.63	7.04	6.52	6.19	2.43			
		SD	2.28	2.53	2.17	2.39				
2	Compr.	M	5.67	5.22	5.11	4.41	3.47*	9.64**	0.21	0.55
		SD	2.55	2.86	2.31	2.45				
3	Arith.	M	5.00	5.26	5.74	5.67	2.48			
		SD	2.94	2.46	2.14	2.02				
4	Simil.	M	6.63	7.85	7.93	8.37	4.72**	11.90**	1.28	0.98
		SD	2.97	2.58	2.43	2.83				
5	Vocab.	M	5.59	5.93	5.33	4.81	4.19**	8.16**	3.46	0.95
		SD	2.83	2.79	2.33	2.78				
6	D.Span.	M	6.63	6.67	7.22	7.59	1.88			
		SD	2.54	3.24	2.66	2.47				
7	P.Compl.	M	6.22	6.22	6.52	6.26	0.18			
		SD	3.12	2.95	3.01	2.30				
8	P.Arr.	M	5.81	6.52	6.96	6.70	1.96			
		SD	2.47	3.63	3.70	3.12				
9	Bl.Des.	M	5.93	5.96	6.15	6.04	0.14			
		SD	3.47	2.96	2.55	3.06				
10	Obj.A.	M	5.33	5.44	5.26	5.52	0.13			
		SD	2.82	3.42	3.99	3.91				
11	Coding	M	5.78	5.93	6.63	7.33	7.87***	22.20***	1.19	0.24
		SD	2.77	2.48	2.92	3.31				
12	Mazes	M	4.93	5.70	6.04	6.78	11.31***	33.21***	0.01	0.69
		SD	2.51	3.33	3.55	3.34				
13	V IQ	M	75.07	77.04	77.00	76.00	1.59			
		SD	12.48	13.23	11.33	11.92				
14	P IQ	M	70.04	71.96	73.93	75.15	5.62**	16.68***	0.14	0.34
		SD	15.60	18.04	18.93	17.55				
15	F IQ	M	70.11	72.11	73.07	73.37	6.01**	16.00***	2.01	0.02
		SD	13.69	15.20	14.71	14.58				

*p < .05 **p < .01 ***p < .001

TABLE 73

Starting-Age 11: WISC Scaled Score Means and F Values for Analysis of Variance and Trend Analysis for Four Consecutive Years, N=29

	Subtest		Age 11	12	13	14	ANOVA F 3,84df	Trend Analysis Components: Linear F 1,84	Quadr. F 1,84	Cubic F 1,84
1	Inform.	M	7.21	7.31	6.76	7.00	1.27			
		SD	2.55	2.44	2.62	2.77				
2	Compr.	M	6.69	6.28	5.90	5.76	1.82			
		SD	2.87	3.06	2.96	3.54				
3	Arith.	M	6.59	6.83	6.31	5.79	4.01*	8.53**	2.92	0.58
		SD	2.79	2.46	2.32	2.68				
4	Simil.	M	9.00	9.31	8.62	8.83	0.91			
		SD	3.25	2.15	2.81	1.82				
5	Vocab.	M	7.41	6.76	6.69	6.17	3.96*	10.99**	0.07	0.82
		SD	3.97	3.02	2.81	2.77				
6	D.Span.	M	7.24	7.93	8.00	8.07	1.86			
		SD	2.91	2.99	3.36	3.28				
7	P.Compl.	M	7.38	7.66	7.14	8.03	2.52			
		SD	3.20	3.00	3.12	3.41				
8	P.Arr.	M	7.14	7.59	8.69	8.07	3.17*	5.44*	2.05	2.03
		SD	3.26	3.12	3.85	3.92				
9	Bl.Des.	M	7.52	7.07	7.90	7.52	1.27			
		SD	2.75	2.89	3.23	3.76				
10	Obj.A.	M	7.21	6.83	8.17	8.41	4.89**	10.45**	0.82	3.39
		SD	3.74	3.48	4.68	4.76				
11	Coding	M	6.97	7.17	7.52	7.62	1.38			
		SD	3.56	3.68	3.69	4.16				
12	Mazes	M	5.59	6.97	6.83	6.97	6.14**	10.95**	5.27*	2.20
		SD	2.40	2.95	2.91	3.16				
13	V IQ	M	83.52	83.66	81.66	80.76	3.75*	9.78**	0.50	0.97
		SD	15.37	13.67	13.73	14.33				
14	P IQ	M	78.97	80.55	84.10	84.52	7.76***	21.55***	0.36	1.37
		SD	17.64	17.48	20.69	22.75				
15	F IQ	M	79.48	80.55	81.17	80.97	1.28			
		SD	16.59	15.78	17.52	18.70				

*$p < .05$ **$p < .01$ ***$p < .001$

TABLE 74

Starting-Age 12: WISC Scaled Score Means and F Values for Analysis of Variance and Trend Analysis for Four Consecutive Years, N=23

Subtest			Age				ANOVA	Trend Analysis Components		
								Linear	Quadr.	Cubic
			12	13	14	15	F 3,66df	F 1,66	F 1,66	F 1,66
1	Inform.	M	6.00	5.87	5.87	5.70	0.41			
		SD	1.82	1.96	1.70	1.73				
2	Compr.	M	4.87	5.09	4.04	4.87	2.30			
		SD	1.39	2.19	2.24	2.51				
3	Arith.	M	6.57	6.65	6.04	7.35	3.69*	1.94	4.76*	4.37*
		SD	2.60	2.71	2.88	3.24				
4	Simil.	M	8.70	8.22	8.30	8.09	0.89			
		SD	2.01	1.38	1.12	1.44				
5	Vocab.	M	5.57	5.26	5.17	4.83	1.49			
		SD	1.47	1.98	1.99	2.46				
6	D.Span.	M	7.48	7.91	7.65	8.09	0.57			
		SD	2.68	3.39	2.99	3.93				
7	P.Compl.	M	6.00	6.87	7.13	7.04	2.67			
		SD	2.41	2.45	2.33	2.63				
8	P.Arr.	M	6.39	7.13	6.78	6.78	0.59			
		SD	3.19	2.31	2.59	2.69				
9	Bl.Des.	M	6.52	7.17	6.57	6.65	0.82			
		SD	2.26	3.06	3.47	3.62				
10	Obj.A.	M	6.17	6.83	6.48	7.00	1.10			
		SD	3.36	3.53	3.63	3.98				
11	Coding	M	6.30	7.13	6.87	8.00	5.74**	13.41***	0.27	3.53
		SD	1.73	2.63	2.51	2.73				
12	Mazes	M	5.61	6.70	6.43	7.26	4.76**	11.12**	0.17	2.99
		SD	2.48	2.76	3.63	3.30				
13	V IQ	M	78.13	78.13	76.26	77.57	1.14			
		SD	9.43	8.97	8.56	10.47				
14	P IQ	M	73.26	78.96	77.17	79.91	6.21***	11.87**	1.57	5.18*
		SD	13.82	14.75	15.53	16.82				
15	F IQ	M	73.43	76.57	74.43	76.65	3.32*	3.68	0.27	6.00*
		SD	10.62	11.27	11.03	11.83				

*p < .05 **p < .01 ***p < .001

number of significant comparisons which might be expected by chance out of 105. The resultant chi-square value (177.5) of the deviation from this chance expectation of difference was significant beyond the .001 level. Tables 68-74 present means and standard deviations for the 12 WISC subtests, and the Verbal, Performance, and Full Scale IQs obtained annually over the 4-year period, for each of the 7 starting-age groups. The associated _F_ values are shown for the 105 analyses of variance, as well as the _F_ values for the trend components, linear, cubic, and/or quadratic, for the 35 significant differences obtained in longitudinal score comparisons on the repeated WISC measures.

Significant deviations. These 35 deviations from the more numerous stable comparisons consisted of 30 instances of significant linear upward or downward trends (22 upward, mixed with 3 quadratic and 1 cubic trend; and 8 downward, mixed with 1 quadratic trend) in the measures repeated over the four years. There were also 3 scattered instances, 1 each, of exclusively quadratic, cubic, and mixed quadratic and cubic trends. Finally, there were 2 significant comparisons which failed to show any significant trend components. Table 75 presents a summary of these trends.

Table 75

Summary of Significant Trends in Cognitive Development over Four Years on the WISC

	Starting-Age Groups						
Test	6-9	7-10	8-11	9-12	10-13	11-14	12-15
Inf.							
Compr.		L*-			L**-		
Arith.		L*- Q*				L**-	Q* C*
Simil.	L**+		L***+	L***+	L**+		
Vocab.					L**-	L**-	
D.Span	L*+						
V IQ						L**-	
P.Compl.							
P.Arr.						L*+	
Bl.Des.	L*+ Q*		L***-				
Obj.A.	Q*					L**+	
Coding	L***+			L**+	L***+		L***+
Mazes					L***+	L**+ Q*	L**+
P IQ	L***+ Q*				L***+	L***+	L**+ C*
F IQ	L***+			L**+	L***+		C*

Note. Trends are abbreviated as follows: L = Linear, Q = Quadratic, C = Cubic. Positive (+) and Negative (-) indicate linear direction.

*$p < .05$. **$p < .01$. ***$p < .001$.

Examination of the 30 linear trend deviations from the overall stable score levels reveals that the 22 upward trends significantly outnumbered the 8 downward trends, $\chi^2(1) = 6.53$, $p < .01$. Upward trends were mainly confined to the Performance Scale scores, and downward trends were nearly always limited to Verbal Scale scores.

Specifically, upward trends were shown on Picture Arrangement in the 11-year starting-age group; on Block Design in the 6-year starting-age group; on Object Assembly in the 11-year starting-age group; on Coding in the 6-year, 9-year, 10-year, and 12-year starting-age groups; on Mazes in the 10-year, 11-year, and 12-year starting-age groups. As expected, the upward trends on Performance Scale subtests were also reflected in upward trends for Performance Scale IQ in the 6-year, 10-year, 11-year, and 12-year starting-age groups; and for Full Scale IQ in the 6-year, 9-year, and 10-year starting-age groups. A few linear upward trends were also found on Verbal Scale subtests: Similarities showed an upward trend in the 6-year, 8-year, 9-year, and 10-year starting-age groups; and Digit Span showed an upward trend in the 6-year starting-age group.

Conversely, downward linear trends were shown in the Verbal Scale subtest scores of Comprehension in the 7-year and 10-year starting-age groups; on Arithmetic in the 7-year and 11-year starting-age groups; on Vocabulary in the 10-year and 11-year starting-age groups; on Verbal Scale IQ in the 11-year starting age group. One of the Performance Scale subtests, Block Design, showed a downward linear trend in the 8-year starting-age group. It should be noted that the observation of a downward trend in no way represents a loss in raw score values, but rather reflects that raw scores did not gain sufficiently to maintain the previous scaled score levels. Thus, from one year to the next, children could remain at the same absolute (raw score) level or even increase slightly, but scaled scores would show a loss because they are normed for age group.

Exceptions from the linear trends were observed in 4 isolated instances: Object Assembly showed a quadratic trend in the 6-year starting age group. Arithmetic showed a combination of quadratic and cubic trends in the 12-year starting-age group. Full Scale IQ showed a cubic trend in the 12-year starting-age group.

Consistency

Overall patterning of subtest scores was relatively consistent. Table 76 presents the correlation matrices for each of the groups in comparisons of subtest functioning. In all but three instances, there was a significant positive, although sometimes low correlation from year to

Table 76

Pearson Correlation Matrices for Subtest Comparisons for Each Starting-Age Group

Age 6 N = 25

6	7	8	9
6	.52**	.63**	.62**
7		.81**	.75**
8			.81**

Age 7 N = 26

7	8	9	10
7	.59**	.16	.43*
8		.66**	.87**
9			.81**

Age 8 N = 22

8	9	10	11
8	.82**	.46*	.34
9		.48*	.26
10			.81**

Age 9 N = 25

9	10	11	12
9	.81**	.71**	.67**
10		.90**	.88**
11			.95**

Age 10 N = 27

10	11	12	13
10	.83**	.70**	.49**
11		.87**	.73**
12			.93**

Age 11 N = 29

11	12	13	14
11	.72**	.57**	.56**
12		.67**	.74**
13			.91**

Age 12 N = 23

12	13	14	15
12	.86**	.85**	.72**
13		.95**	.92**
14			.88**

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*p < .05 **p < .01

year on longitudinal comparisons. The exceptions were in the 7-year starting-age group, with year-7 showing a low correlation with year-9; and in the 8-year starting-age group, with year-11 showing low correlations with years 8 and 9.

Individual strengths and weaknesses. Notwithstanding that differences among the 12 subtest scaled score means in any given year were actually small (Tables 68-74), it was of interest to ascertain whether areas of relative strength and weakness might be present. Applying a criterion of ordinal position to the mean scaled scores of the 12 WISC subtests, and classifying as a relative strength those subtests within an ordinal range of 1 through 5, and as a relative weakness those subtests within an ordinal range of 8 through 12, cognitive patterns were identified. Table 77 presents the ordinal positions for each of the subtest scaled score means for each year of the longitudinal study within each of the 7 starting-age groups. It was observed that relatively consistent patterns of weakness and strength emerged in each of the starting-age groups. These patterns were rarely age-specific, but instead were usually maintained, with occasional spottiness, from one year to the next over the four years within each longitudinal starting-age group:

Table 77

Ordinal Positions of Ranked Subtest Scaled Score Means Within Each Starting-Age Group Over the 4-Year Longitudinal Span

Age	Group	WISC Subtests											
		I	C	A	S	V	D	PC	PA	BD	OA	Cd	M
6	6	6	8	9	4	12	7	1	3	5	11	10	2
	7	9	8	12	5	11	6	2	10	1	7	4	3
	8	10	9	12	2	11	8	3	6	1	7	4	5
	9	8	11	10	1	12	5	4	8	2	9	3	6
7	7	12	4	10	6	9	8	1	3	7	5	11	2
	8	9	7	12	1	10	11	2	3	5	4	8	6
	9	7	11	12	3	8	9	10	6	1	2	5	4
	10	8	9	12	1	11	10	7	3	2	4	6	5
8	8	9	10	8	6	12	7	4	3	1	5	2	11
	9	6	11	12	7	9	8	3	5	1	4	2	10
	10	7	8	12	1	11	5	3	9	6	2	4	10
	11	9	10	12	1	11	2	6	4	8	5	3	7
9	9	7	10	11	8	12	6	4	5	1	3	2	9
	10	8	9	12	2	11	5	4	7	3	6	1	10
	11	9	11	10	2	12	8	4	6	3	5	1	7
	12	9	11	10	2	12	3	5	7	4	6	1	8
10	10	1	8	11	2	9	3	4	6	5	10	7	12
	11	2	12	11	1	7	3	5	4	6	10	8	9
	12	5	12	9	1	10	2	6	3	7	11	4	8
	13	7	12	9	1	11	2	6	5	8	10	3	4
11	11	6	10	11	1	3	5	4	8	2	7	9	12
	12	5	12	9	1	11	2	3	4	7	10	6	8
	13	9	12	11	2	10	4	7	1	5	3	6	8
	14	8	12	11	1	10	3	5	4	7	2	6	9
12	12	8	12	3	1	11	2	9	5	4	7	6	10
	13	10	12	9	1	11	2	6	4	3	7	5	8
	14	10	12	9	1	11	2	3	5	6	7	4	8
	15	10	11	4	1	12	2	6	8	9	7	3	5

Starting-age 6. Relative strength was shown by Similarities, Picture Completion, Block Design, Mazes, and also Coding after an initial weak start. Relative weakness was shown by Information (after a middling start), Comprehension, Arithmetic, Vocabulary, and Object Assembly.

Starting-age 7. Relative strength was shown by Similarities, Picture Arrangement, Block Design (after a middling start), Object Assembly, Mazes (middling). Picture Completion shifted from a position of relative strength to one of relative weakness in the last two years of the four. Weaker abilities were shown by Information, Comprehension (after a middling start), Arithmetic, Vocabulary, and Digit Span.

Starting-age 8. Relatively stronger abilities were shown by Similarities (after a middling start), Picture Completion, Picture Arrangement (which dropped in the third year and regained in the fourth), Object Assembly, and Coding. Block Design started out very strong in the first two years, but shifted to a middling-weak position for the last two years. Relatively weaker abilities emerged on Comprehension, Arithmetic, Vocabulary, and Mazes.

Starting-age 9. Relatively stronger abilities were shown by Similarities (after a weak start), Picture

Completion, Block Design, and Coding. Weaker abilities were shown by Information, Comprehension, Arithmetic, Vocabulary, and Mazes.

Starting-age 10. Relative strength was apparent on Similarities and Digit Span throughout the 4-year span of this starting-age group. Information was relatively strong for the first two years, and dropped to a middling position for the last two years. Relative weakness was shown by Comprehension, Arithmetic, Vocabulary, Object Assembly, and Mazes, with the latter showing some gain in relative position in the fourth year of the study.

Starting-age 11. Relatively consistent strength was shown by Similarities and Digit Span, as well as Picture Arrangement after a weak start. Relative weakness was shown by Comprehension, Arithmetic, Vocabulary (after a relatively strong start), and Mazes.

Starting-age 12. Relative strength was shown by Similarities, Digit Span, and Coding. Relatively weaker abilities were shown by Information, Comprehension, Vocabulary, and Mazes which gained slightly in the fourth year. Arithmetic showed a sudden drop after a strong start, and regained a moderately strong level in the fourth year.

In each of the starting-age groups, Performance subtests showed relative strength, with possible exceptions of variable levels in Object Assembly and Mazes.

Verbal Scale subtests, with the exception of Similarities and, to some extent, Digit Span, showed relative weakness. These cognitive patterns were relatively consistent throughout the four years of longitudinal observation.

Verbal-Performance Scale Differences

Although the data presented no clear indication through the inspection of Verbal and Performance Scale IQ means in Tables 68-74 of any major Verbal-Performance IQ discrepancies, the scores were nevertheless subjected to t test analyses for differences within each of the 7 starting-age groups during each of the 4 years of longitudinal study. Table 78 presents a summary of the means, differences, t values, and probability levels obtained. Since verbal abilities are often reported as exceeding performance abilities in brain damaged children, it is pertinent to observe that no significant discrepancies were found in any of the comparisons. Further analysis was pursued on the possibility that the lack of statistical significance might have obscured large individual differences obtained in opposite directions. Accordingly, tallies were made of discrepancy values, in either direction, of 0, 1 through 9, 10 through 19, 20 through 29, and above 29 points, for each of the four years within each of the seven starting-age groups. Table 79 presents a summary of these findings. Overall comparisons revealed

Table 78

Verbal-Performance Scale IQ Discrepancies Within Each Starting-Age Group, Four-Year Longitudinal Span

Age Group	Age	D	t	p	
6	6	-0.32	-0.15	<.20	
N = 25	7	-2.60	-1.20	<.20	
	8	-3.44	-1.66	<.20	>.10
	9	-2.88	-1.26	<.20	
7	7	-0.35	-0.14	<.20	
N = 26	8	0.19	0.07	<.20	
	9	-2.35	-0.68	<.20	
	10	-1.85	-0.58	<.20	
8	8	-2.23	-0.80	<.20	
N = 22	9	-3.68	-1.59	<.20	>.10
	10	0.77	0.26	<.20	
	11	1.41	0.42	<.20	
9	9	-3.04	-1.43	<.20	>.10
N = 25	10	-2.04	-0.90	<.20	
	11	-4.08	-1.88	<.10	>.05
	12	-4.04	-2.02	<.10	.05
10	10	5.04	1.95	<.10	>.05
N = 27	11	5.07	1.75	<.10	>.05
	12	3.04	1.02	<.20	
	13	0.81	0.32	<.20	
11	11	4.66	1.88	<.10	>.05
N = 29	12	3.10	1.32	<.20	>.10
	13	-2.45	-0.94	<.20	
	14	-3.76	-1.25	<.20	
12	12	4.78	1.65	<.20	>.10
N = 23	13	-0.83	-0.30	<.20	
	14	-0.91	-0.29	<.20	
	15	-2.35	-0.65	<.20	

Note. Negative values in D column indicate that Verbal Scale is lower than Performance Scale IQ.

Table 79

Distribution of Verbal-Performance Scale IQ Discrepancies: Number of Children at Each Discrepancy Level Within Each Starting-Age Group

	Starting-Age Groups																											
Difference	6	7	8	9	7	8	9	10	8	9	10	11	9	10	11	12	10	11	12	13	11	12	13	14	12	13	14	15
V>P>+29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	0	0	0	2	0	0	2
+20 to +29	0	1	0	0	1	2	2	1	1	0	2	3	0	1	1	0	6	5	5	3	1	2	1	3	1	2	2	1
+10 to +19	2	0	3	3	4	6	4	5	2	3	3	4	2	4	3	1	2	3	2	4	8	6	5	4	4	2	3	1
+1 to +9	11	12	5	6	9	6	7	6	7	5	8	6	8	4	5	7	8	9	7	6	8	11	5	4	6	6	6	2
V = P 0	1	0	1	2	0	1	1	1	1	0	0	0	1	2	1	2	0	0	0	1	0	2	1	1	0	0	0	2
P>V -1 to -9	9	6	10	8	7	5	7	8	5	8	4	3	8	8	7	8	7	4	6	7	7	3	8	6	7	8	6	10
-10 to -19	0	4	5	4	2	3	1	3	4	5	4	4	3	4	6	5	4	4	3	5	1	3	5	5	2	4	3	1
-20 to -29	1	2	1	2	3	1	1	0	1	1	1	1	3	2	2	2	0	0	3	1	2	2	3	5	1	1	2	4
>-29	1	0	0	0	0	2	3	2	1	0	0	1	0	0	0	0	0	1	0	0	0	0	1	1	0	0	1	0

Note. Negative values in Difference column indicate that Verbal Scale is lower than Performance Scale IQ.

about as many instances of Verbal greater than Performance as Performance greater than Verbal, in general accordance with the lack of statistical significance obtained. When observation was addressed to the larger discrepancies, in the intervals of 20 through 29 points and above 29 points combined, it was found that Performance IQ exceeded Verbal IQ in 4 of the 7 starting-age groups, in starting-age groups 6, 7, 9, and 11 years. There was no difference in incidence in 2 of the starting-age groups, at 8 and 12 years. There were frequent instances of Verbal greater than Performance IQ throughout the 10-year starting-age group: There was an atypically large number of children, amounting to some 22% of the group, who showed large discrepancies in the direction of Verbal greater than Performance IQ.

Nevertheless, when the data concerning the larger discrepancies were subjected to chi-square analysis for all the starting-age groups combined, no significant difference was obtained for the comparison of Verbal-Performance IQ discrepancies: $\chi^2(1) = 0.42$, p between .50 and .75. When the 10-year starting-age group was separated from the analysis, a comparison of the larger discrepancies in the rest of the starting-age groups showed that the incidence of Performance greater than Verbal IQ was clearly significant: $\chi^2(1) = 5.81$, p between .025 and .010. However, these discrepancies were confined to a relatively small proportion of the children, a median of 8% where there were large differences in the direction of Performance greater than Verbal IQ, as compared with a median of 4.5% of the children where large differences were obtained in the opposite direction.

Discussion

One of the major findings of this longitudinal study concerns the relative stability over time of the intellectual status and cognitive development of brain damaged children. The relative stability observed in the present study represents a finding not previously available from systematic, longitudinal research with neurologically impaired children, although intellectual growth stability has been repeatedly observed in the more widely reported literature on developmental longitudinal studies of normal children. Although the present study focuses directly on the longitudinal comparisons within each starting-age group, it is notable that a similar characteristic of stability is present in all the starting-age groups. Indirectly, this finding from longitudinal comparisons suggests that a similar, albeit cross-sectional, type of inference can be made regarding the age span of 6 through 15 years, to the extent that the children who overlap in age in the separate starting-age groups are comparable in their intellectual status. Although cross-sectional characteristics of the data were not examined in the presently reported study, it seems clear that this additional comparison would be of substantial pertinence because of the increased numbers of children available at each level in further analyses of these data.

To the extent that some variations are present for the overall levels of cognitive abilities over time, the more frequent upward than downward trends appear supportive of the inference that brain damaged children, at least during the elementary years, are able to maintain antecedent levels of growth and are also capable of accelerating in certain areas. The concentration of gains in the predominantly non-verbal subtests in the older age groups is suggestive of benefits from practice with repeated administration on tasks where repetition might be expected to give access to correct solutions, particularly with Coding and Mazes where mean scores accelerated more often than on other non-verbal subtests.

Although marked variation is known to exist, there is agreement in the literature that certain characteristics are more prevalent in brain injured than in non-brain injured children. In this context, dysfunctions in visual-motor, sensory areas are widely reported. Thus, the upward trend (even if explained in terms of practice effect) of some of the perceptual-motor tasks observed in the present study seems unexpected and raises question about the typicality of the more widely reported findings to the contrary (Birch, 1964; Clements and Peters, 1962; Coleman and Dawson, 1969; Ernheart et al., 1963; Smith, 1962; Wender, 1971).

The upward trend in the verbal subtest, Similarities, which was present in 4 of the 7 starting-age groups is less suggestive of practice effect and seems even more at variance with typically reported characteristics of brain damaged children who are repeatedly described as having difficulty in abstracting (Hall and LaDriere, 1969). Neither are the downward trends observed in some of the verbal subtests, Comprehension, Vocabulary, and Arithmetic, with the possible exception of the latter, in keeping with the literature describing verbal deficits in brain damaged children. However, the overall findings of unexpected upward and downward trends may be in greater accordance with a growing body of findings which suggest that individual subtest scores, as those on the WISC, do not adequately differentiate brain damaged from normal children, or emotionally disturbed children, or both (Bortner and Birch, 1970; Caputo et al., 1963; Rowley, 1961; Schwartz and Dennerll, 1970). The heterogeneity of etiology to be found in most brain damaged children available for study--heterogeneity for such variables as age of onset, site of lesion, diffuse or focal characteristics, areas of functioning affected, and severity of deficit--all these factors continue to foster ambiguous findings with regard to a set of specific characteristics of this group, with obvious repercussion for making inferences about growth of specific abilities.

It should be generally emphasized that the highly specific growth characteristics reported here are the exception to the more general growth trends observed, namely, overall stability of intellectual development from one age to the next. The longitudinally based observation of relative consistency in weakness and strength of subtest patterning at slight variance with findings reported earlier by Bortner and Birch (1970) in their cross-sectional study of a similar population of brain damaged children where considerably more variability was observed. The relatively consistent patterning of subtest scores in the present study, with verbal subtests showing relative weakness, and performance subtests showing relative strength, suggests differences from the expected profiles of brain damaged children. This is especially important where the reported group data on mean values may obscure certain large discrepancies in either direction. Although confined to a small proportion of the children observed, the substantial size of these discrepancies again supports the growing findings of heterogeneity in such children.

In general, the absence of findings of age-specific patterns, and instead the more general observation of relative stability in overall intellectual growth of the brain damaged children with some unexpected patterning of strengths and deficits suggests that implications for educational or remedial strategies cannot yet be validly defined. Although the findings of relative stability in cognitive development are suggested by the study data, this inference should be viewed with caution and is not yet a base for optimism.

Section III: Patterns of Abilities

Chapter 5. Related Literature

Educational provisions for the educationally handicapped learning disabled are undergoing change, but the character of the change is uncertain (Gallagher, 1971). The situation is complicated by the evidence that neither regular classes nor self-contained special classes have provided an adequate education for the educable mentally retarded (Dunn, 1968; Goldstein, Moss, and Jordan, 1965).

Dunn (1968), calling for a better education for children with mild learning problems, recommended abolishing the practice of grouping children on the basis of disability labels, mainstreaming slow learners, and developing prescriptive programs as alternatives to traditional curriculum practices. In the same vein, Gallagher (1971) recommended that alternatives to categorizing children with educational handicaps be developed, and support systems be established. Lilly (1971) has suggested that policies be adopted which would make it impossible to remove the mildly educationally handicapped child from the regular classroom. In this model the special educator would provide support services and special training to the regular classroom teacher.

Other individuals, equally cognizant of the deficiencies of the self-contained special class, call attention to the fact that until recently, education has not really committed major resources to the development of needed curriculum and instructional systems specific to the needs of the mildly educationally handicapped (MacMillan, 1971).

What is the evidence on which educational changes are to be based? Some (McCarthy and Scheerenberger, 1966) have characterized the research evidence as ambiguous. Some of the ambiguity of the research can be attributed to the failure of researchers to control content, instruction, child, and teacher variables. Until such time as there is control of these important variables, a solution to the problem of what changes to introduce into classroom organization, instruction and curriculum is unlikely.

Before effective change in educational provisions for the learning disabled can be developed, research will first have to identify those characteristics within this population which are educationally relevant (Reynolds and Balow, 1971). After this is accomplished, experiments with different administrative models, curricula, and instructional strategies can then be profitably conducted (Spicker and Bartel, 1968).

One important aspect of current attempts to identify educationally relevant characteristics of the retarded and learning disabled is the concern with mental ability profiles. Mental ability profiles of the retarded have been compared with those of the non-retarded, and different underlying patterns of mental organization have been reported (Alderdice and Butler, 1952; Baumeister and Bartlett, 1962b; Belmont, Birch, and Belmont, 1967; Clausen, 1966; Meyers, Dingman, Orpet, Sitkei, and Watts, 1948). Some workers have reported mental ability profiles associated with mental retardation in general (Baroff, 1959; Sandercock and Butler, 1952; Vanderhost, Sloan, and Bensberg, 1953), others have identified specific profiles associated with different sub-categories of the retarded (Alper, 1960; Anderson, 1964; Baumeister and Bartlett, 1962a; Beck and Lam, 1955; Birch, Belmont, Belmont, and Taft, 1967; Di Carlo, 1958; Newman and Loos, 1955), and still others have been unable to confirm the existence of such profiles (Fisher, 1960; Gallagher, 1957).

The existence of reliable mental ability profiles which would differentiate subgroups of retarded and learning disabled children has important implications for the development and implementation of provisions for these children. Discovery of such characteristics would raise important questions about current practices in the placement, curriculum, and teaching provided for the educationally handicapped. For example, Clausen (1966) has stated that, if retarded children exhibited reliable mental ability profiles, then perhaps they could be grouped more effectively with educational programs designed to meet their specific needs. In the same vein, Guilford (1959) has suggested that if mental ability patterns can be identified they can be ameliorated. Indeed, it has even been suggested that highly specific educational strategies can be designed on the basis of these profiles (Meeker, 1969). Similar views have been expressed by others (Belmont, Birch and Belmont, 1967; Di Carlo, 1958; Gallagher, 1957; Sabatino and Hayden, 1970). Despite these expectations, detailed data regarding the actual nature of the mental abilities which characterize the mentally retarded and the learning disabled is still largely absent (Belmont, Birch, and Belmont, 1967; Benton, 1964).

What is the educational significance of mental ability patterns for the learning impaired? According to Mann (1971), research interest in these patterns is based on the twin assumptions that such characteristics as perceptual adequacy underlie and are basic to academic achievement, and indeed that they are susceptible to training. However he doubts that either assumption is true. On the other hand, according to Bortner (1971) knowledge of these patterns will permit the pertinent structuring of instruction to maximize the child's strengths, the hierarchical ordering of instructional objectives to coincide with the child's emerging competencies, and, if necessary, justify and provide a rational basis for the modification of educational objectives.

In part, the concern with patterns of ability stems from doubts about the educational utility of labels, such as "educable mentally retarded" (EMR) and "neurologically impaired" because they have failed to reveal educationally relevant differences (Kirk, 1964). Similarly, Gallagher (1966) concluded that such labels do nothing better than describe vague entities, and that they certainly have not led to any clear-cut educational strategies.

What are some of the findings as they relate to the notion of ability profiles? Some workers have reported that the mentally retarded have more difficulty with verbal tests than with performance tests. E.g. Sandercock and Butler (1952) reported a trend in the direction of WISC Performance Scale superiority but cautiously concluded that it was not yet possible to establish a definite pattern for the mentally defective group. Vanderhost, Sloan, and Bensberg (1953) studied the performance of the mentally retarded on the WISC and reported the Performance Scale IQ to be higher than the Verbal Scale.

Baroff (1959) analyzed the performance of mentally retarded children on the WISC. He reported that 45 percent of the subjects exhibited a WISC Subtest profile in which the Block Design and Object Assembly Subtests were the least difficult and the Similarities Subtest most difficult. In general, he inferred a trend in these children to score higher on the Performance Scale than on the Verbal Scale.

Fisher (1960) failed to confirm Baroff's findings. He reported that only 8 percent of his mentally retarded sample exhibited WISC Subtest profiles in which the Object Assembly and Block Design Subtests were the easiest and the Similarities Subtest the most difficult. Instead, his results indicated that the Picture Completion and Object Assembly Subtests were the least difficult and the Arithmetic Subtest was the most difficult.

A number of workers have compared the mental ability profiles of different categories of retardates e.g., endogenous and exogenous. According to Benton (1964) there is general agreement that Performance Scale scores are at least equal to and usually higher than Verbal Scale scores in retardates of familial or undifferentiated origin. Alper (1960) compared the mental abilities of brain damaged and non-brain damaged mentally retarded subjects. The non-brain damaged group obtained higher scores on the Performance Scale than on the Verbal Scale; the brain damaged group performed equally well on both scales. Alper concluded that different categories of mentally retarded subjects perform differently on the WISC.

Newman and Loos (1955) reported that familial mentally retarded subjects performed better on the Performance Subtests than on the Verbal Subtests of the WISC. The brain damaged group demonstrated no significant difference between their Performance Scale and Verbal Scale IQs.

Beck and Lam (1955) compared the WISC profiles of so-called organic and non-organic retarded children. They reported that the organic group had a significantly lower Performance Scale IQ than Verbal Scale IQ. The non-organic group obtained lower Verbal Scale IQs than Performance Scale IQs. Aside from these gross differences, however, they failed to find a more definitive or descriptive WISC Subtest profile which characterized either of these two groups.

Birch, Belmont, Belmont, and Taft (1967) compared the mental ability profiles of EMR children who had neurological impairments with EMR children who did not. They reported that when the subjects were classified into three groups on the basis of differential neurological findings the groups were indistinguishable on the basis of Verbal-Performance differences. Moreover, when the subjects were reclassified on the basis of medical history (at risk vs. not at risk), there were still significant differences between the WISC Verbal and Performance Scales.

Gallagher (1957) used the Binet to compare the brain injured and non-brain injured mentally retarded on mental abilities. Although there were no differences in overall IQ between the two groups, differences were exhibited on the Digit Span and the Maze Tracing items. He concluded that the similarities between the brain injured and non-brain injured groups were more striking than the differences.

The mental abilities of the retarded have also been compared with those of the non-retarded. Belmont, Birch, and Belmont (1967) reported that the subtest profiles of retarded and normal children were qualitatively different. They factor analyzed the retarded groups' performance on the WISC and concluded that mentally subnormal children not only had lower IQs than the non-retarded but also were individuals with a different patterning of strengths and weaknesses.

Myers, Dingman, Orpet, Sitkei, and Watts (1948) studied the mental factor structure of retarded and non-retarded children matched for mental ages 2, 4, and 6 years of age. They reported that the mental organization of their retarded and non-retarded children were different.

Clausen (1965) reported on patterns in the Primary Mental Abilities test for three age-consecutive retarded groups, ranging in age from 8-24 years. The groups showed no differences in their subtest patterns when compared with each other. However, all three retarded groups showed differences in pattern when compared with normal children.

Chapter 6. Relationships of Mental Abilities, Neurological Signs and Academic Achievement

There is little information on the importance of neurological impairment as it relates to intellectual deficit. Gaps exist between the research evidence concerning the nature of neurological impairments and their relation to learning on the one hand, and those practices on the other hand that have been adopted in response to these impairments and their associated deficiencies. Studies have appeared which explored the relationship between neurological characteristics, intelligence, and achievement (Birch, Belmont, Belmont, and Taft, 1967; Bortner, Hertzig and Birch, 1972; Edwards, Alley, and Snider, 1971; Freeman, 1967; Gallagher, 1957; Kirk, 1964).

More work is needed to confirm the association of neurological integrity and academic achievement so that steps may be taken to develop a rational base for the development of relevant educational provisions for learning disabled and/or neurologically impaired children. Until recently it has been commonly assumed that most children assigned to EMR special classes were free of neurological impairments which interfered with learning (Robinson and Robinson, 1965). This has been shown to be untrue. Beck (1956) reported the incidence of brain damage among a sample of mentally retarded children assigned to EMR special classes. Of the 35% examined, 75 percent of the children exhibited definite signs of neurological impairment and another 11 percent showed signs that were questionable. Generalizing from his findings, Beck estimated that approximately 60 percent of all EMR children would show evidence of neurological impairment.

Many authorities have questioned the assertion that neurological impairment interferes with academic achievement in reading and arithmetic (Edwards, Alley and Snider, 1971; Gallagher, 1957; Kirk, 1964), and indeed whether neurological diagnoses are even relevant to educational management (Grossman, 1966). Despite such reservations, medical practitioners continue to be asked by many educators to provide diagnostic and treatment information.

According to Freeman (1967), evidence of neurological impairment based on present diagnostic techniques is imprecise. Freeman listed some of the limitations of clinical neurological examinations as follows:

1. The standards and norms are not well established.
2. The interpretation of the observed behavior is subjective.

3. Related to number 2 above, the reliability of the interpretation is low.
4. Some of the observed problems are age specific, and transient.

Quite aside from the difficulties that attach to the validity of the neurological diagnosis itself and, equally important, there is no single neurological sign or combination of signs that has been shown to be related to specific learning disabilities (Freeman, 1967; Kirk, 1964). Moreover, according to Freeman, among those children who exhibit neurological signs, there is a range of behavior from complete learning incapacity to complete normality.

Birch, Belmont, Belmont, and Taft (1967) compared the mental ability profiles of EMR children with and without neurological impairment, and reported that increased variability in IQ was associated with an increase in the number of neurological signs. Moreover, the control group with no evidence of neurological impairment had significantly higher IQs than the neurologically impaired subgroup who had "hard" signs.

Edwards, Alley, and Snider (1971) studied the relationship between "soft" signs and academic achievement. In addition to a control group without impairment the children were classified either as neurologically and visual-motor impaired, neurologically impaired only, and visual-motor impaired only. The various impaired groups were not different in their achievement scores from the control group. The "neurologically impaired only" group was superior in arithmetic and spelling to the "neurologically impaired, visual-motor" group, and the "neurologically impaired only" group was superior in arithmetic to the "visual-motor impairment only" group. They concluded that achievement in arithmetic and spelling in EMR children is associated with visual-motor impairment but not with neurological signs per se.

There have been research efforts to find mental ability profiles which distinguish between mentally retarded children who achieve academically and similar children who fail to achieve. Anderson (1964) studied the intellectual organization of mentally retarded adolescents enrolled in special classes. An achiever was defined as a child who obtained an achievement score within two months of his grade expectation based on mental age. An under-achiever was defined as a child who achieved one year or more below his grade expectancy based on mental age. The under-achievers exhibited higher Performance Scale IQs than the achievers.

Di Carlo (1958) in a similar attempt to identify factors which differentiate between achieving and non-achieving mentally retarded children, found that the achievers scored higher on the verbal portions of the PMA than on the non-verbal portions. Also, they demonstrated less variability on the verbal subtests than did the non-achievers. He concluded that tasks requiring verbal problem solving and generalization behavior differentiated those mentally retarded children who achieve from those who fail to achieve.

Sabatino and Hayden (1970) identified intellectual factors which discriminated between children with IQs below 80 and those above 85, both of which groups failed to achieve satisfactorily in academic work. Despite their successful discriminations, they concluded that each of the two groups was too heterogeneous to warrant uniform educational programming.

The foregoing studies led to the following expectation: Mentally retarded, neurologically impaired children who achieve well academically will demonstrate differing mental ability profiles and neurological impairment patterns than those children who fail to achieve academically.

Subjects and Procedures

The sample was composed of seventy neurologically impaired children selected from the parent study with a CA range of 9 to 11 years, and an IQ range of 54 to 85. The children were classified according to the following system:

1. High IQ Reading Achievers
2. High IQ Reading Under-achievers
3. High IQ Arithmetic Achievers
4. High IQ Arithmetic Under-achievers
5. Low IQ Reading Achievers
6. Low IQ Reading Under-achievers
7. Low IQ Arithmetic Achievers
8. Low IQ Arithmetic Under-achievers

The children were assigned to these categories on the basis of their performance on the Metropolitan Achievement Test and the Wechsler Intelligence Scale for Children. Figure 8 presents the research design.

An achiever was defined as a child who performed between expected grade level to one year above expected grade level based on mental age. An under-achiever was defined as a child who achieved below grade level expectation based on mental age. The upper 75 percent of the achievers and the lower 75 percent of the under-achievers were selected for this study. Table 80 summarizes the MAT Reading and Arithmetic achievement scores. Table 81 shows the mean WISC Full Scale, Verbal Scale, and Performance Scale IQs for the groups.

The high IQ groups consisted of children with WISC FS IQs ranging from 70 to 85 and the low IQ groups consisted of children with WISC FS IQs ranging from 54 to 69. This IQ range was selected because it coincided with the

	Defined Achievement Groups			
Defined [illegible] Groups	High IQ Reading Achievers	High IQ Reading Under-achievers	High IQ Arithmetic Achievers	High IQ Arithmetic Under-achievers
	Low IQ Reading Achievers	Low IQ Reading Under-achievers	Low IQ Arithmetic Achievers	Low IQ Arithmetic Under-achievers

Fig. 8.--Summary of the research design

TABLE 80

Achievers and Underachievers: Achievement Scores, Discrepancies and Standard Deviations

Subjects	Reading Achievement			Arithmetic Achievement		
	Mean Score	Mean Disc.	SD	Mean Score	Mean Disc.	SD
High IQ Reading Achievers	3.09	0.42	.831			
High IQ Reading Under-achievers	2.24	-0.95	.742			
High IQ Arithmetic Achievers				3.10	0.45	.889
High IQ Arithmetic Underachievers				2.77	-0.42	.834
Low IQ Reading Achievers	2.23	0.61	554			
Low IQ Reading Under-achievers	1.95	-0.73	.416			
Low IQ Arithmetic Achievers				2.11	0.39	.606
Low IQ Arithmetic Underachievers				1.60	-0.28	.443

TABLE 81

Achievers and Underachievers: Intelligence Score Means and Standard Deviations

Subjects	Full Scale		Verbal Scale		Performance Scale	
	Mean	SD	Mean	SD	Mean	SD
High IQ Reading Achievers	74.20	4.40	75.13	10.91	77.60	10.31
High IQ Reading Under-achievers	78.42	5.19	81.52	8.32	79.00	8.33
High IQ Arithmetic Achievers	75.46	4.92	79.26	9.78	75.73	8.37
High IQ Arithmetic Under-achievers	78.90	7.72	78.52	8.28	81.47	6.94
Low IQ Reading Achievers	63.18	5.34	70.27	6.39	61.81	5.70
Low IQ Reading Underachievers	65.11	3.60	69.44	6.51	66.66	7.52
Low IQ Arithmetic Achievers	63.35	4.45	69.71	6.98	63.28	.61
Low IQ Arithmetic Under-achievers	64.33	3.59	69.83	4.52	64.50	4.50

IQs of EMR children assigned to special classes and because some investigators have reported different achievement patterns for high and low IQ retarded samples (Goldstein, Moss, and Jordan, 1965).

The Reading and Arithmetic Subtests were selected for analysis because it is believed that they represent specific academic skills which will relate directly to educational management and planning.

A clinical neurological examination was given to each child by the same physician, and consisted of evaluation of the following "soft" signs: Balance, coordination, speech, double simultaneous tactual stimulation, muscle tone, choreiatiform movement, gait, imitative movements, graphesthesias, astereognosis and position sense.

The following statistical procedures were utilized to analyze differences among the defined groups:

1. The WISC Subtest Scaled Scores were subjected to an analysis of variance, and the Scheffé multiple comparison tests. A .003 level of significance was adopted for the analysis of variance.
2. Chi square (χ^2) with Yates' correction for continuity was used to compare the proportions observed neurological soft signs among the defined groups.

3. The .003 level of confidence was chosen to guard against alpha errors. While the probability of making an alpha error for each hypothesis is .05, the probability of making an alpha error throughout the experiment is $1-(1-.05)^c$ where c is equal to the number of hypotheses that are tested (Ryan, 1959). When several hypotheses are tested, the significance level i.e., .05 can be maintained by selecting a more conservative level i.e., .003. A standard computer program was employed to analyze the data.

Results

WISC--Analysis of Variance

The analysis of variance rejected ($p < .003$) the hypothesis of no difference among the defined groups for the following WISC Subtests:

1. Information
2. Arithmetic
3. Picture Completion
4. Picture Arrangement
5. Object Assembly
6. Block Design
7. Mazes

The sources of these differences were identified with the Scheffé multiple comparison test. This test identified the source of the differences ($p < .01$) in the Picture Arrangement, Object Assembly, Block Design, and Mazes subtests. The fact that the Scheffé test failed to identify the source of the differences in the Information, Arithmetic, and Picture Completion subtests can be attributed to the very conservative nature of the test, and/or the fact that there are twenty-eight possible sources of difference among the eight defined groups and only six of the possible comparisons were studied.

Tables 82-93 summarize the means, standard deviations and analysis of variance for the defined groups on those WISC subtests in which the null hypothesis of "no difference" was rejected and where the Scheffé test was successful in identifying sources of differences. Tables 82 and 83 present mean scores and F values for the Picture Arrangement subtest. The Scheffé multiple comparison test identified the source of the differences among the defined groups as follows (see Table 84):

1. The High IQ Arithmetic Achievers had higher WISC P.A. scores than the Low IQ Arithmetic Achievers.

2. The High IQ Reading Achievers had higher scores than the Low IQ Reading Achievers.

TABLE 82

Picture Arrangement: Means and Standard Deviations for the Defined Groups

Defined Groups	N	Mean	Standard Deviation
High IQ Reading Achievers	15	7.067	2.489
High IQ Reading Under-achievers	21	7.333	2.532
High IQ Arithmetic Achievers	15	6.933	2.489
High IQ Arithmetic Under-achievers	21	7.524	2.363
Low IQ Reading Achievers	11	4.273	1.911
Low IQ Reading Under-achievers	9	5.333	1.764
Low IQ Arithmetic Achievers	13	4.000	1.664
Low IQ Arithmetic Under-achievers	5	4.800	1.327

TABLE 83

Picture Arrangement: Analysis of Variance

Source of Variation	df	Sum of Squares	Mean Squares	F
Between groups	7	202.344	28.9063	5.353*
Within groups	102	550.759	5.3996	
Total	109	753.103		

* $p < .003$

TABLE 84

Picture Arrangement: Scheffé Multiple Comparisons

Defined Groups	Difference	F-Ratio
High IQ Reading Achievers vs. High IQ Reading Under-achievers	-0.2667	0.1152
High IQ Reading Achievers vs. High IQ Arithmetic Achievers	0.1333	0.0247
High IQ Reading Achievers vs. Low IQ Reading Achievers	2.7939	9.1745 *
High IQ Arithmetic Achievers vs. High IQ Arithmetic Under-achievers	-0.5905	0.5650
High IQ Arithmetic Achievers vs. Low IQ Arithmetic Achievers	2.9333	11.0978 *
Low IQ Reading Achievers vs. Low IQ Reading Under-achievers	-1.0606	1.0312
Low IQ Reading Achievers vs. Low IQ Arithmetic Achievers	0.2727	0.0821
Low IQ Arithmetic Achievers vs. Low IQ Arithmetic Under-achievers	-0.8000	0.4280

* $p < .01$

TABLE 85

Block Design: Means and Standard Deviations for the Defined Groups

Defined Groups	N	Mean	Standard Deviation
High IQ Reading Achievers	14	7.786	2.177
High IQ Reading Under-achievers	21	7.429	2.362
High IQ Arithmetic Achievers	14	6.714	1.750
High IQ Arithmetic Under-achievers	21	8.190	2.481
Low IQ Reading Achievers	11	5.273	1.355
Low IQ Reading Under-achievers	9	5.778	1.548
Low IQ Arithmetic Achievers	13	5.615	1.595
Low IQ Arithmetic Under-achievers	6	5.167	1.344

TABLE 86

Block Design: Analysis of Variance

Source of Variation	df	Sum of Squares	Mean Squares	F
Between groups	7	131.777	18.8253	4.309*
Within groups	101	441.248	4.3688	
Total	108	573.025		

* $p < .003$

TABLE 87

Block Design: Scheffé Multiple Comparisons

Defined Groups	Difference	F-Ratio
High IQ Reading Achievers vs. High IQ Reading Under-achievers	0.3571	0.2452
High IQ Reading Achievers vs. High IQ Arithmetic Achievers	1.0714	1.8393
High IQ Reading Achievers vs. Low IQ Reading Schievers	2.5130	8.9042*
High IQ Arithmetic Achievers vs. High IQ Arithmetic Under-achievers	-1.4762	4.1898
High IQ Arithmetic Achievers vs. Low IQ Arithmetic Achievers	1.0989	1.8632
Low IQ Reading Achievers vs. Low IQ Reading Under-achievers	-0.5051	0.2890
Low IQ Reading Achievers vs. Low IQ Arithmetic Achievers	-0.3427	0.1601
Low IQ Arithmetic Achievers vs. Low IQ Arithmetic Under-achievers	0.4487	0.1892

* $p < .01$

TABLE 88

Object Assembly: Means and Standard Deviations for the Defined Groups

Defined Groups	N	Mean	Standard Deviation
High IQ Reading Achievers	15	7.133	2.655
High IQ Reading Under-achievers	21	6.333	2.189
High IQ Arithmetic Achievers	15	6.133	2.986
High IQ Arithmetic Under-achievers	21	7.524	1.867
Low IQ Reading Achievers	11	4.273	2.004
Low IQ Reading Under-achievers	8	4.375	2.118
Low IQ Arithmetic Achievers	13	4.846	2.070
Low IQ Arithmetic Under-achievers	6	4.500	1.607

TABLE 89

Object Assembly: Analysis of Variance

Source of Variation	df	Sum of Squares	Mean Squares	F
Between groups	7	155.342	22.1918	4.009*
Within groups	102	564.621	5.5355	
Total	109	719.963		

* $p < .003$

TABLE 90

Object Assembly: Scheffé Multiple Comparisons

Defined Groups	Difference	F-Ratio
High IQ Reading Achievers vs. High IQ Reading Under-achievers	0.8000	1.0117
High IQ Reading Achievers vs. High IQ Arithmetic Achievers	1.0000	1.3549
High IQ Reading Achievers vs. Low IQ Reading Achievers	2.8606	9.3814*
High IQ Arithmetic Achievers vs. High IQ Arithmetic Under-achievers	-1.3905	3.0562
High IQ Arithmetic Achivers vs. Low IQ Arithmetic Achievers	1.2872	2.0845
Low IQ Reading Achievers vs. Low IQ Reading Under-achievers	-0.1023	0.0088
Low IQ Reading Achievers vs. Low IQ Arithmetic Achievers	-0.5734	0.3539
Low IQ Arithmetic Achievers vs. Low IQ Arithmetic Under-achievers	0.3462	0.0889

* $p < .01$

TABLE 91

Mazes: Mean and Standard Deviations for the Defined Groups

Defined Groups	N	Mean	Standard Deviation
High IQ Reading Achievers	15	6.200	2.638
High IQ Reading Under-achievers	21	6.524	2.239
High IQ Arithmetic Achievers	15	5.933	2.081
High IQ Arithmetic Under-achievers	21	6.571	2.280
Low IQ Reading Achievers	11	3.182	1.466
Low IQ Reading Under-achievers	9	5.111	2.131
Low IQ Arithmetic Achievers	14	3.571	1.720
Low IQ Arithmetic Under-achievers	6	4.333	1.247

TABLE 92

Mazes: Analysis of Variance

Source of Variation	df	Sum of Squares	Mean Squares	F
Between groups	7	176.962	25.2803	5.269*
Within groups	104	499.002	4.7981	
Total	111	675.964		

* p < .003

TABLE 93

Mazes: Scheffé Multiple Comparisons

Defined Groups	Difference	F-ratio
High IQ Reading Achievers vs. High IQ Reading Under-achievers	-0.3238	0.1912
High IQ Reading Achievers vs. High IQ Arithmetic Achievers	0.2667	0.1112
High IQ Reading Achievers vs. Low IQ Reading Achievers	3.0182	12.0485*
High IQ Arithmetic Achievers vs. High IQ Arithmetic Under-achievers	-0.6381	0.7425
High IQ Arithmetic Achievers vs. Low IQ Arithmetic Achievers	2.3619	8.4193*
Low IQ Reading Achievers vs. Low IQ Reading Under-achievers	-1.9293	3.8400
Low IQ Reading Achievers vs. Low IQ Arithmetic Achievers	-0.3896	0.1949
Low IQ Arithmetic Achievers vs. Low IQ Arithmetic Under-achievers	-0.7619	0.5081

* $p < .01$

Tables 85 and 86 present the mean scores and F values for the WISC Block Design subtest. The Scheffé multiple comparison test identified the source of the differences among the defined groups as follows (Table 87): The High IQ Reading Achievers had higher WISC Block Design scores than the Low IQ Reading Achievers.

Tables 88 and 89 present the mean scores and F values for the WISC Object Assembly subtest. The Scheffé multiple comparison test identified the source of the differences among the defined groups as follows (see Table 90): The High IQ Reading Achievers had higher WISC Object Assembly scores than the Low IQ Reading Achievers.

Tables 91 and 92 present mean scores and F values for the WISC Mazes subtest. The Scheffé multiple comparison test identified the source of the differences among the defined groups as follows (see Table 93): 1. The High IQ Reading Achievers had higher WISC Maze scores than the Low IQ Reading Achievers. 2. The High IQ Arithmetic Achievers had higher scores than the Low IQ Arithmetic Achievers.

Neurological Status--Chi Square Analysis

Comparisons were made between all possible pairs of defined groups to determine whether any single neurological sign differentiated one group within a given pair from another. A Chi Square analysis was used to compare the frequencies of the observed neurological signs among the defined groups. None of the comparisons reached the required level of significance ($p < .003$), and the null hypothesis of "no difference" between defined groups was not rejected. Therefore, it cannot be inferred that the presence of any of these neurological signs in a child directly influences his academic functioning.

In summary, the findings are:

1. High IQ Reading Achievers differ from Low IQ Reading Achievers in mean scores on the following WISC Subtests: Picture Completion, Picture Arrangement, Block Design, Object Assembly, and Mazes. The High IQ group had higher scores than the Low IQ group.
2. High IQ Arithmetic Achievers differ from Low IQ Arithmetic Achievers on the following WISC Subtests: Arithmetic, Picture Completion, Picture Arrangement, and Mazes, but the Scheffé multiple comparison test was only able to identify where the differences existed for the Picture Arrangement and Mazes Subtests. The High IQ group had higher mean scores than the Low IQ group.
3. The various defined groups do not differ from each other in the frequency with which soft neurological signs occur among them.

In summary, the results of this investigation failed to show that High IQ and Low IQ children who achieve relatively well in reading and arithmetic differ significantly in mental abilities from similar children who under-achieve. The High IQ Achievers do differ significantly from the Low IQ achievers on the following WISC Subtests: Picture Arrangement, Block Design, Object Assembly and Mazes. The High IQ Achievers do better on these subtests. Moreover, the various defined groups are not different from each other with respect to the number of soft neurological signs present.

Chapter 7. Age-Specific Relationships of Neurological Signs and Intellectual Status

Introduction

Since the 1940's when the idea was first advanced that certain mentally retarded children could be distinguished from others on the basis of "brain damage" (Strauss and Lehtinen, 1947) this label has acquired wide clinical usage and has come to be applied to increasing numbers of aberrantly functioning children for whom the labels, mental retardation, deaf, and emotionally disturbed, are inappropriate. The research dealing with these children reveals that a variety of new labels are now being applied to these children which include "learning disabilities" (Kirk, 1963), "psychoneurological learning disorders" (Myklebust, 1968), and "minimal brain dysfunction" (Clements, 1966). A common factor among the children so designated is the fact that they suffer from major learning difficulties, thus suggesting the need for inquiring into their cognitive status.

In consequence, although these children exhibit a diversity of problems most workers have emphasized psychological factors and school achievement, and little attention has been focused on the neurological status of these children. In fact, the most recent term "minimal brain dysfunction" was selected precisely to "avoid (italics mine) the implication that all individuals with this group of symptoms necessarily have demonstrable brain damage" (Chalfant and Scheffelin, 1969). The suspicion has grown, therefore, that these children do not really have neurological damage, or that if they do it is subtle and not readily objectified. Following this lead, many parents have stated a preference for the term "learning disabled" over the term "brain damaged." The latter has somewhat more permanent implications. There is, therefore, an absence of systematic information on the neurological status per se of these children. In addition, there is a need to relate this information to their intellectual status.

A comprehensive evaluation of these children's neurological status would proceed from the use of different assessment procedures, and should include 1. evidence of risk, 2. clinical examination and 3. electroencephalography. If such information were then related to the intellectual, behavioral, emotional and academic achievement of the children, links between organic pathology and behavioral disorders could be established. The present study is limited to the use of the clinical examination.

Recent evidence based on the data from the parent study of which this is a part (Hertzig, Bortner and Birch, 1969) has demonstrated that a group of children administratively and educationally designated "brain damaged" did indeed demonstrate clear evidence of central nervous system abnormality. Moreover, the neurological status of these children was related to certain aspects of their intellectual status.

The present report addresses itself to the issue of identifying the clinical neurological characteristics of school-age children who were diagnosed as "brain damaged" and who were attending a special school designed for the education of such children. This report focuses on the following questions: 1. What are the neurological signs and patterns of signs observed in children educationally designated as "brain damaged"? 2. How do these findings compare with a sample of age matched normal controls? 3. What is the frequency of hyperkinesis in brain damaged children, and what is the relation between hyperkinesis and presence of neurological signs? 4. What is the intelligence status of these children as a group and on an age-specific basis? and 5. What are the inter relations between neurological signs, hyperkinesis and intellignece?

Subjects

The subjects of this study included 198 subjects who were educationally and administratively designated as brain damaged, and 36 children in normal school placement who served as controls. The age range of the total group of children was from 8 through 12 years of age.

The special school for brain damaged children from which the present sample was drawn serves an entire suburban county which includes 56 school districts and a total of approximately 350,000 children. For the purposes of the larger project from which the present study stems, different age groups were neurologically examined in one of three successive years. That is, in the first year of the study, children aged 10, 11 and 12 years were seen; in the second year children aged 9 and a second group of 10 year old children were seen, and in the third year children aged 8 and a second group of 9 year old children were seen. This resulted in the following distribution of children: Age 8 N=26, Age 9 N=56, Age 10 N=56, Age 11 N=30, and Age 12 N=30.

The screening procedures at the school for brain damaged children was in accordance with the county policy that the clinical diagnostic category be the most relevant label applicable. To this end, children who exhibited both learning and/or behavior difficulties were assigned to this school rather than a school for the emotionally disturbed or the educable retarded when a qualified neurologist submitted a report describing positive evidence of neurological impairment. To be sure, such evidence was not uniform and relied variously on 1. history, 2. the clinical neurological examination and 3. electroencephalography. Since the evidence could come from any one of these three sources, some children came to the school with a history of seizures, others with pathological reflex status, others with positive EEG, and still others with some combination of these signs. Of course, all children came with a history of difficulty in school achievement since this always constituted the original basis for referral. After the initial referral which could emanate from any school in the county, this school conducted its own educational, psychological and social evaluations which resulted in the rejection of those children who were psychotic or seriously emotionally disturbed.

There were 148 boys and 50 girls in the study sample. The male-female ratios were approximately 3 to 1 at each age level. The thirty-six control children (5 children at each age level, 6 at age 9) were selected from a regular educational facility in the same county, and were similar to the subjects with respect to social class and ethnic origin. The social class status of the families whose children attend this school has been described in detail elsewhere (Bortner and Birch, 1970) but can be summarized briefly here as having representation at all levels with a predominance in the middle class.

Methods

Each child was given a clinical neurological examination during school hours. Interspersed among the subjects were the 36 children who attended a regular school and who served as controls. The examiner did not know whether a given child came from the special school or the regular school.

The neurological evaluation was limited to a clinical examination and included the study of cranial nerve intactness, reflex organization and the presence of pathological reflexes, muscle strength and tone, balance and gait, motor coordination and sensory organization. In addition, the examination included measures designed to provide information about responses to double simultaneous tactile stimulation, the presence or absence of adventitious motor overflow, the ability to engage in imitative motor activity as well as clinical assessment of speech and language functions and behavioral organization.

The nature of this examination was described in detail in an earlier publication (Hertzig, Bortner and Birch, 1969) and thus will be only briefly re-stated here.

In general, two types of abnormality were separately considered in the evaluation of the neurologic findings. The first type, to be referred to as "hard signs," represented findings that have been classically employed in neurologic diagnosis, and include abnormalities in reflex, cranial nerve and motor organization, lateralized dysfunctions, and the presence of pathological reflexes.

The second variety of abnormal findings consisted of what were called "soft signs" of cerebral dysfunction (Clements and Peters, 1963; Rutter, Graham and Yule, 1970; Wikler et al., 1970) and included language and speech disturbances that fell short of frank aphasia and dysarthria, clumsiness as reflected in inadequacies of balance, coordination, and gait, the presence of adventitious motor overflow, difficulties in the execution of fine motor imitative movements, manifestations of extinction to double simultaneous tactile stimulation, and inadequate graphesthetic and stereognostic responses.

In addition to the identification of hard and soft signs, the behavior of the child was evaluated with respect to the presence of hyperkinesis. It was recognized that this disorder, frequently identified with brain damage in children, is a complex set of behaviors and subsumes high activity, poor attention, and impulsive behavior. Note was made when a child appeared to be excessively restless, when it was necessary to devise special techniques to retain a child's attention, the need to repeat directions, and the need to actively prevent the child from engaging in extraneous activities. On the basis of such observations, a clinical judgment was made at the conclusion of each examination as to the presence or absence of hyperkinesis. The judgment was based upon the extent as well as the number of the above described symptoms. Thus, the child who demonstrated many or only one of the above disturbances to a marked degree was classified as hyperkinetic.

The findings on clinical neurologic examination made it possible to classify cases as: (1) Cases with "hard" signs whose disturbances constituted an identifiable classical neurologic syndrome, (2) Cases in whom no identifiable classical syndrome were present, but in whom "soft signs" of central nervous system dysfunction were found, (3) Cases in whom no abnormal findings of either type were observed.

Clearly the presence of a neurologic syndrome such as spastic hemiplegia does not exclude the possibility that the child can also have "soft signs" of central nervous system dysfunction. However, in such cases, primary classification was based upon a consideration of the major handicap. Thus, a disturbance of gait in a hemiplegic child was viewed as a reflection of his hemiplegia and not considered to constitute an additional soft sign.

In addition to the neurological examination each child was administered the Wechsler Intelligence Scale for Children. Neurological sub-groupings could thus be compared with respect to levels and patterns of intelligence.

Results

Neurological Status

Forty-two children (21%) of the children educationally and administratively designated as "brain damaged" did indeed have "hard signs" of central nervous system abnormality. The various neurological syndromes represented among all these children are shown in Table 94. Residual hemiplegia (right and left) was the most frequently observed syndrome, 30 (71%) of the 42 cases with hard signs classified as such. The remainder were distributed among a variety of plegias and athetosis. In all cases the motor impairment was mild.

The findings in the control group of children were very different. None of these children had any hard signs which would have resulted in their being classified as having the neurological syndromes that were characteristic of a little more than one-fifth of the study sample. These results are shown in Table 95. As this table shows, hard signs rarely occurred in the absence of soft signs; only 4 children (2%) fell into this category. On the other

Table 94

Distribution of Syndromes

	Age in Years					
Neurologic Syndromes	8	9	10	11	12	Total
Residual Quadriplegia	0	0	0	2	1	3
Resident Diplegia	0	0	1	1	0	2
Residual Hemiplegia (L)	2	5	2	3	5	17
Residual Hemiplegia (R)	2	3	4	2	2	13
Residual Monoplegia	1	0	1	1	1	4
Athetosis	0	0	1	1	1	3
Total	5	8	9	10	10	42

Table 95

Frequency of Different Types of Syndrome

	Neurologic Syndrome				
	Hard Signs Only	Hard & Soft Signs	Soft Signs Only	No Signs	Total
Subjects	4	38	148	8	198
Controls	0	0	13	23	36

hand, 148 children (75%) showed soft signs only. When children with both hard and soft signs are combined, 190 children or 96% of the total sample had one or more signs of primary neurological dysfunction. This figure is consistent with previous findings reported for a smaller sample (Hertzig, Bortner & Birch, 1969) in which 94% of 90 children educationally designated as brain damaged were found to have similar evidence of CNS dysfunction.

Of those children with soft signs only, we may now indicate the number of signs which characterized different children. In Table 96 it can be seen, e.g. that of the 148 children who had only soft signs, 19 children (13%) had only one sign, 24 children (16%) had three signs, and 14 children (9%) had, respectively, as many as six, seven or eight signs.

Findings in the normal control children were in marked contrast to those reported for the educationally designated brain damaged children, with 64% of the controls showing no neurological signs, with only two children (6%) showing as many as two signs and the remainder showing only one sign.

An age specific analysis of the distribution of soft signs associated with each age level in children without hard signs is shown in Table 97. In order to test the relationship between age and number of soft signs, a

Table 96

Number of Soft Signs in Children Without Hard Signs and in Controls

Number of Soft Signs	Subjects (N=156)	Controls (N=36)
0	8	23
1	19	11
2	16	2
3	24	
4	17	
5	20	
6	14	
7	14	
8	14	
9	7	
10	2	
11	1	

Table 97

Age Specific Distribution of Number of Soft Signs in Children without Hard Signs

Number of Soft Signs	Number of Subjects				
	Age 8	Age 9	Age 10	Age 11	Age 12
0	1	1	3	0	3
1	1	5	4	6	3
2	3	5	5	1	2
3	3	9	6	1	5
4	1	5	7	2	2
5	2	6	5	5	2
6	4	4	4	1	1
7	2	6	4	1	1
8	3	5	6	0	0
9	1	2	2	2	0
10	0	0	1	1	0
11	0	0	0	0	1
Total	21	48	47	20	20

Pearson coefficient of correlation was calculated between these two variables in the soft-sign group of children which confirmed a non-significant relationship (r = -.169) between age and number of soft signs.

In Table 98 it can be seen that the most frequently occurring soft signs among children without hard signs involved disturbances in the ability to discriminate double simultaneous tactile stimulation (DSS), coordination and balance. The least frequent sign was an abnormality of position sense.

When the distribution of soft signs was analyzed according to age, as in Table 99, it was seen that DSS, coordination, balance and tone were the most frequently occurring signs at all ages. In order to determine whether the patterns of signs were essentially similar at the various age levels, the frequency of the soft signs were ranked for every age level, and Spearman correlations between pairs of age levels were calculated. The correlations were significant for most pairs of age levels suggesting that the patterns of soft signs were not different from each other at these ages. However, when the pattern of soft signs at age 8 was compared with the pattern of soft signs at ages 10, 11 and 12, the coefficients of correlation were respectively only .366, .098 and .193. Since these correlations were not significant, it was concluded

Table 98

Nature of Soft Signs in Children Without Hard Signs

	Children N=156	
Soft Sign	Number	Percentage
DSS	95	60.9
Coordination	92	59.0
Balance	83	53.2
Tone	73	46.8
Speech	64	41.0
Choreatiform Movement	61	39.1
Graphesthesia	60	38.5
Gait	59	37.8
Imitative Movement	53	34.0
Astereognosis	35	22.4
Position Sense	4	2.6
No Soft Signs	8	5.1

Table 99

Nature of Soft Signs in Children without Hard Signs: Age Specific

	Age 8			Age 9			Age 10			Age 11			Age 12		
oft Sign	# of Ss	%	Rank	# of Ss	%	Rank	# of Ss	%	Rank	# of Ss	%	Rank	# of Ss	%	Rank
SS	16	76.2	1	32	66.7	1	30	63.8	2	8	40.0	6	9	45.0	2
oordination	13	61.9	2	30	62.5	2	31	66.0	1	10	50.0	4	8	40.0	3
alance	8	38.1	8	24	50.0	4	26	55.3	3	13	65.0	2	12	60.0	1
one	10	47.6	4.5	26	54.2	3	20	42.6	6	14	70.0	1	3	15.0	8.5
peech	7	33.3	10	16	33.3	9	23	48.9	4	11	55.0	3	7	35.0	5
horeatiform Movement	8	38.1	8	18	37.5	7	19	40.4	7	9	45.0	5	7	35.0	5
raphesthesia	12	57.1	3	22	45.8	5	18	38.3	8	5	25.0	8	3	15.0	8.5
ait	8	38.1	8	17	35.4	8	21	44.7	5	6	30.0	7	7	35.0	5
mitative Movement	9	42.9	6	19	39.6	6	15	31.9	9	4	20.0	9.5	6	30.0	7
stereognosis	10	47.6	4.5	11	22.9	10	9	19.1	10	4	20.0	9.5	1	5.0	10.5
osition Sense	0	0	11	1	2.1	11	1	2.1	11	1	5.0	11	1	5.0	10.5

that the pattern of soft signs associated with age 8 was different from that found at the later ages of 10, 11 and 12 years.

Of the 198 children studied, a total of 39 children were found to have hyperkinesis compared to 159 who did not show signs of hyperkinesis. Of the children who had hard signs, approximately the same proportion of children were hyperkinetic as were not hyperkinetic. (The chi square of .295 was not significant.) However, soft signs were found with greater frequency in hyperkinetic children than in non-hyperkinetic children. The mean number of soft signs in the hyperkinetic group was 5.31 compared to 4.08 for the non-hyperkinetic group. This difference was significant (t = 2.48). Thus, in this group of brain damaged children, hyperkinesis appeared not to be associated with the presence or absence of hard signs. On the other hand, hyperkinesis did seem to be accompanied by a general increase in the number of soft signs of central nervous system dysfunction. Finally, the age distribution of hyperkinetic children (see Table 100) suggested that hyperkinesis is found most frequently among the youngest children (age 8).

Table 100

Age Specific Distribution of Children with and without Hyperkinesis

Age in years	Hyperkinesis		No Hyperkinesis	
	Number of Subjects	Percentage	Number of Subjects	Percentage
8	8	30.8	18	69.2
9	8	14.3	48	85.7
10	15	26.8	41	73.2
11	5	16.7	25	83.3
12	3	10.0	27	90.0

Intelligence Status

The mean Verbal, Performance and Full Scale IQs for the total group were in the borderline range of intelligence, as may be seen in Table 101. Table 101 also presents IQ status for the children on an age-specific basis. Analysis on an age-specific basis revealed strikingly little variation in ability at different age levels, with Verbal, Performance and Full Scale IQs suggesting borderline intelligence for the ages studied.

When the total group is divided into those with and those without hard signs (see Table 102), the resulting mean IQs for the two groups are essentially the same and remain in the borderline range of intelligence. Children with hard signs are not significantly different (as indicated by t tests) from those without hard signs in Verbal, Performance or Full Scale IQ.

Analysis of the IQ data for children with and without hard signs on an age-specific basis revealed that at no age level were the Verbal, Performance or Full Scale IQ scores different in children with hard signs from those without hard signs (see Tables 103-104). Although intelligence level, per se, did not appear to be differentially influenced by the presence or absence of hard signs, it remained to be determined whether the number of soft signs was systematically related to intelligence level. As may

Table 101

Intelligence Status of All Children

	Total Group N = 198		Age 8 N = 26		Age 9 N = 56	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Verbal IQ	76.29	13.30	72.38	13.65	73.39	13.29
Performance IQ	75.93	17.03	74.85	13.56	76.11	20.53
Full Scale IQ	73.81	14.90	71.04	13.79	72.32	16.93

	Age 10 N = 56		Age 11 N = 30		Age 12 N = 30	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Verbal IQ	76.16	12.38	82.37	15.69	79.23	9.63
Performance IQ	74.93	16.15	79.03	17.91	75.30	13.52
Full Scale IQ	73.23	14.03	78.87	16.88	75.20	10.60

Table 102

Intelligence Status of Children with and without Hard Signs

	Children with Hard Signs N = 42		Children without Hard Signs N = 156	
	Mean	S.D.	Mean	S.D.
Verbal IQ	77.14	13.36	76.06	13.32
Performance IQ	74.62	12.13	76.28	18.14
Full Scale IQ	73.71	12.57	73.86	15.58

Table 103

Intelligence Status on an Age-Specific Basis of All Children With Hard Signs

	Age 8 N = 5		Age 9 N = 8		Age 10 N = 9		Age 11 N = 10		Age 12 N = 10	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Verbal IQ	68.20	13.57	71.50	8.49	73.00	10.63	89.30	14.31	77.70	10.77
Performance IQ	70.00	11.77	73.63	6.02	67.44	14.93	82.80	12.98	76.00	8.55
Full Scale IQ	66.20	12.91	70.00	7.37	67.67	12.38	84,90	12.15	74.70	9.94

Table 104

Intelligence Status on an Age-Specific Basis for All Children Without Hard Signs

	Age 8 N = 21		Age 9 N = 48		Age 10 N = 47		Age 11 N = 20		Age 12 N = 20	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
rbal IQ	73.38	13.81	73.71	13.97	76.77	12.70	78.90	15.52	80.00	9.20
rformance IQ	76.00	13.96	76.52	22.06	76.36	16.12	77.15	19.97	74.95	15.62
ll Scale IQ	72.19	14.03	72.71	18.06	74.30	14.19	75.85	18.34	75.45	11.15

be seen in Table 105, the number of soft signs is systematically related to level of intelligence both in children with and without hard signs. The greater the number of soft signs, the lower the intelligence score.

It is necessary to ask what it was in the history or behavior of the eight children who displayed no hard or soft signs that caused them to be referred to and accepted by this school. Table 106 summarizes the intelligence status and relevant neurological history from the school records of these children. It is noteworthy that of the eight children, six were in the normal range of intelligence and only two were in the borderline range of intelligence. Two children (numbers 1 and 7) had no reported histories of medical risk to explain their presence in the school, three children (numbers 2, 3 and 4) had histories of risk before or after birth, and three children were reported as having neurological symptoms (numbers 5, 6, and 8) although this could not be confirmed in the clinical neurological examination described in the present report.

Discussion

It is clear that the children educationally designated as brain damaged in the school system under study do indeed have evidence of central nervous system dysfunction. Ninety-six percent of the total sample displayed either hard

Table 105

Relationship of Number of Soft Signs to Intelligence

Correlation of Soft Signs and:	In Children with Hard Signs	In Children Without Hard Signs
Verbal IQ	0.409*	0.537**
Performance IQ	0.403*	0.627**
Full Scale IQ	0.453*	0.643**

*Significant at .01 level of confidence

**Significant at .001 level of confidence

Table 106

Children Without Observed Neurological Signs

Child	WISC Full Scale IQ	School Record History of Risk or Symptoms
1	93	No neurological signs; "perceptual impairment."
2	80	Premature birth, birth weight 4 lb. 6 oz.; in incubator 5 weeks.
3	72	Post chicken pox meningococcal meningitis at age 7 months.
4	85	Post mumps encephalitis, age not specified.
5	96	Intention tremor and slurred speech.
6	82	Convulsions at age 1-1/2 years; severe emotional outbursts and uncontrollable behavior.
7	91	No neurological signs; half-brother in Creedmore State Hospital.
8	72	Convulsions at age 2 years.

or soft signs of CNS damage. Approximately one-fifth of the sample displayed hard signs, and three-quarters of the sample displayed soft signs. In fact, only eight children or 4% of the sample showed no signs. This contrasts sharply with the normal comparison group in whom no hard signs were found and who displayed no more than two signs in any individual case.

The discussion of numbers of signs would be misleading if we failed to emphasize the variety of signs found among different sub-groups of children. E.g. within that 1/5 of the sample in whom hard signs were present it is essential to note that all kinds of plegias were represented in addition to Athetosis. Heterogeneity was equally evident in the soft sign group both in the sense that some children had as few as one sign whereas others had as many as ten or eleven signs, and in the variety of signs present.

One may also examine the frequency with which particular signs occur in this group of children. Certain signs (e.g. DSS and Coordination) appeared in as many as almost two-thirds of the study sample whereas other signs (e.g. astereognosis and position sense) appeared appreciably less often. Moreover, the pattern of signs were, in general, not appreciably influenced by age. The exception to this was at age 8 years where the children displayed a pattern of signs different from that found for children at later age levels.

The classification of these children into subgroups of hyperkinetic and non-hyperkinetic children did not reveal differences in propensity for hard signs, but did show that hyperkinetic children had more soft signs than non-hyperkinetic children. Moreover, the age analysis of hyperkinesis showed a tendency for this disorder to be most frequent among the youngest children, occurring three times more often among the eight year olds than among the twelve year olds. These findings are consistent with common clinical observation.

Evaluation of the intellectual status of these children shows them to function, as a group, in the borderline level of intelligence. This is true whether one considers separately verbal, performance or overall intelligence. Moreover, the age analysis of intellectual ability in these children shows strikingly little variation among the age levels studied.

Comparison of the children with and without hard signs established clearly that the presence of hard signs did not influence the child's level of intellectual functioning. That is, those children with classical neurological syndromes did not function differently (i.e. less well) than those without such symptoms. However the situation was different with regard to soft signs. The number of soft signs was inversely related to intelligence, and those children with the greater number of soft signs tended to function at lower levels of intelligence than those with less signs.

The findings of this study support the conclusion that the educational designation "brain damage" is not merely an administrative convenience for admitting into special classes those children who have vaguely defined learning disorders. It is clear that these children do suffer from objectively observable CNS disorders. However, it would be unfortunate if the confirmation of presence of organic pathology acted to sustain the stereotyped view of the "brain damaged child" as an entity. On the contrary, the findings support the notion that these children are, from a neurological point of view, quite heterogeneous with respect to nature and pattern of symptoms. Perhaps most striking is the fact of differences in patterning of soft signs and the presence of hyperkinesis in the youngest children as compared with the older children. What is suggested here is that both the nature of the soft signs that children exhibit and the presence of hyperactivity are not merely a consequence of CNS damage per se, but rather of an interaction between CNS damage and age. Such a conclusion based as it is on cross-sectional data needs to be tentative, and would be more firmly based on longitudinal data.

Chapter 8. A Graphic View of Patterns of Intellectual Functioning

It is still an open question as to whether the organization or patterning of abilities in brain damaged children remains the same or whether it changes in meaningful ways over the crucial span of the school years. This question is herein dealt with by comparing the graphic subtest profiles of the WISC that characterized successive years of a given age group.

For a given age group each subtest mean was plotted in terms of its deviation above or below the mean value of the 12 subtests which served as the abscissa. This procedure resulted in four sets of deviation scores, one for each of four successive years in the progress of a given age group. For example, in Fig. 9 the mean scaled score for all 12 subtests for 6 year olds in the first year of the study was 5.38; this served as the abscissa for 6 year old children in the first year of the study. The mean scaled score for Information was 5.47. The difference between these two figures (+.09 or .1) is the required deviation value and was plotted one-tenth of a scaled value point above the abscissa for six year old children in the first year of the study. The mean scaled value for all 12 subtests done by the six year olds in the second year of the study (they are now 7 years old) was 5.44; this served as the abscissa for six year old children in the second year of the study. The mean scaled score for Information was 5.36. The difference between these two figures (-.08 or -.1) is the required deviation value and was plotted one-tenth of a scaled value point below the abscissa for six year old children in the second year of the study. The same procedure was followed for six year olds in the third and fourth years of the study. Problems of interpretation resulting from differences in level of ability among the four groups were overcome since each member of a set of four scores was plotted around its own mean. The resulting graph is therefore presumed to depict relative rather than absolute subtest strength and weakness.

Fig. 9 shows the patterns of subtest variation for six year old brain damaged children in the first year of the study compared with themselves in the second, third and fourth year of the study at ages 7, 8 and 9 respectively. Inspection of this graph shows that on five of the 12 subtests (Information, Comprehension, Digit Span, Picture Arrangement and Coding) the four age groups varied in opposite directions. For Information and Comprehension the trend appears to be regressive with the children doing relatively more poorly as they grow older; for Coding the trend is clearly toward relative improvement with increasing age.

No clear pattern emerges when one scans the remaining Figures 10-15. At age 7 (in the first year of the study) there are four instances where age groups vary in opposite direction. At age 8 there are three instances, at age 9 there are only two such instances. At ages 10-12 years there are either 5 or 6 instances. There are no particular subtests in which this kind of disparity exists at every age. Only in Similarities does this variation in opposite directions never occur.

The remaining seven subtests showed variation, but these variations were in the same direction, i.e. subtest performance better than own average performance for the test as a whole. It can, therefore, be concluded that for these seven subtests there was directional similarity in the patterning of subtest performance for the six year olds over a four year period. In general such directional similarity exists for all subsequent age groups (see Figs. 2-7).

The pattern of subtest variation suggests a general tendency for verbal abilities as a whole to lag behind mean performance on the test as a whole for the six year olds in the first year of the study. It can be quickly noted (Fig. 9) that four of the six verbal subtests do lag behind mean overall test performance. A rough and ready indicator of such a lag or directionality may be inferred when any three of a set of four years (1st, 2nd, 3rd and 4th years) is either above or below the abscissa. Hence, in Fig. 9 for Information, three of the set of four scores (2nd, 3rd and 4th years) are below the abscissa and may therefore be described as lagging behind mean performance for the test as a whole. A similar trend is observed for seven and eight year olds (Figs. 10-11) where four verbal subtests again lag behind. However, it is interesting to note that from age 9 years of age through 12 years the tendency toward verbal inferiority ends, and there are about as many verbal as non-verbal subtests above the mean as below. It may be concluded from this that the younger children (6-8 years in the first year of the study) showed (and maintained for four consecutive years) a relative weakness in the verbal areas of intellectual functioning; whereas the older children (9-12 years in the first year of the study) showed no such pattern. There is nothing in the data to account for this difference, and one can only speculate about changes in screening and admissions procedures that may have permitted a greater tolerance for verbal dysfluency among younger than among older children at the time this study was begun.

It is relevant to the above findings to note that at every age level, and despite the general verbal weakness of the younger children in the first year of the study (6-8 years), there was a consistent superiority in relative subtest score for Similarities--that subtest which measures the ability to think abstractly. It is not at all clear why this most difficult of verbal abilities compares so favorably with the test scores in general and the verbal scores in particular, but it is certainly a hopeful note since abstract ability is of presumably considerable importance.

One might view the fact of directional variation in a given subtest in a given group of children over a period of years as indirect evidence that this subtest is subject to the vicissitudes of environmental input, or put more simply that it is subject to change and perhaps responsive to teaching input. If this is so, then it is noteworthy that <u>all</u> subtests (except Similarities, which was consistently above mean test performance anyway) showed this kind of directional fluctuation at various ages. One might thereby conclude that almost all of the elements of intellectual functioning are amenable to change in these children. Of course, it must be added that such change can go in either direction. Of those instances where directional change occurred one can look at the direction of the child's score (above or below the abscissa) in the fourth year of the study on the assumption that his score at this time is a rough indicator of his amenability to educational input. By inspection of Figs. 9-15 one can observe roughly an equal number of instances where the direction of change was either up or down. Clearly, some children were deriving benefit from their experiential input whereas others failed to do so.

What is it, specifically, that these children have failed to improve in over the four year span? One may note from Figs. 9-15 those subtests in which 3 of 4 consecutive age groups (same children over 4 year span) performed poorly (relative to mean test score) on a given subtest. For example, in Fig. 9 at least three of the four age groups and sometimes all four age groups performed more poorly on Information, Comprehension, Arithmetic, Vocabulary, and Object Assembly. When one performs this kind of inspection on all of the Figures 9-15, it can be seen that certain subtests recur with great frequency below the abscissa. These subtests include: Information (4 times, Figs. 9, 10, 11, 15), Comprehension (6 times), Arithmetic (6 times), Vocabulary (7 times; all Figures!).

It seems important to note that Information and Vocabulary were among the deficient areas. Moreover, Vocabulary becomes progressively and relatively worse as the children grow older. Hence, children age 6 in the first year of the study (Fig. 9) do relatively more poorly in Vocabulary by age 9 than they did at age 6. Similarly for all later age levels (Figs. 10-15) the children grow (relative to their own overall performance) less capable in Vocabulary, i.e. they improve less in this area. It must be noted that the failure to show improvement in Vocabulary does not represent an absolute standing still in raw score, but merely indicates that raw scores did not improve sufficiently to cause a concomitant increase over the previous year's scaled score level. Hence, from one year to the next, a child could remain at the same raw score level but thereby decrease in his scaled score level; or increase slightly in his raw score level without this being sufficient to be reflected in his scaled score level since the scaled scores are standardized by age group.

Four years of progress for children age 6 in first year of study

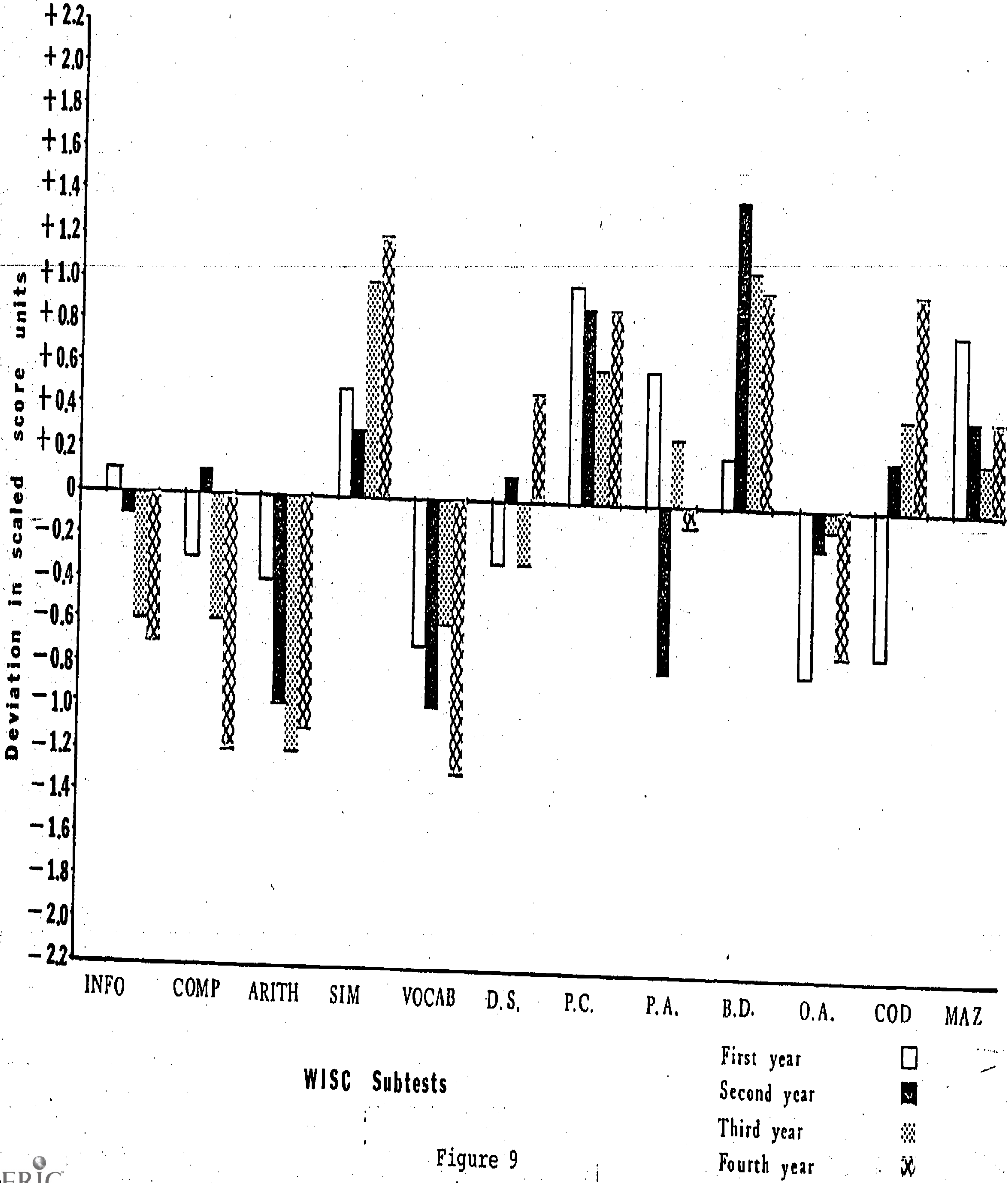


Figure 9

Four years of progress for
children age 7 in first year of study

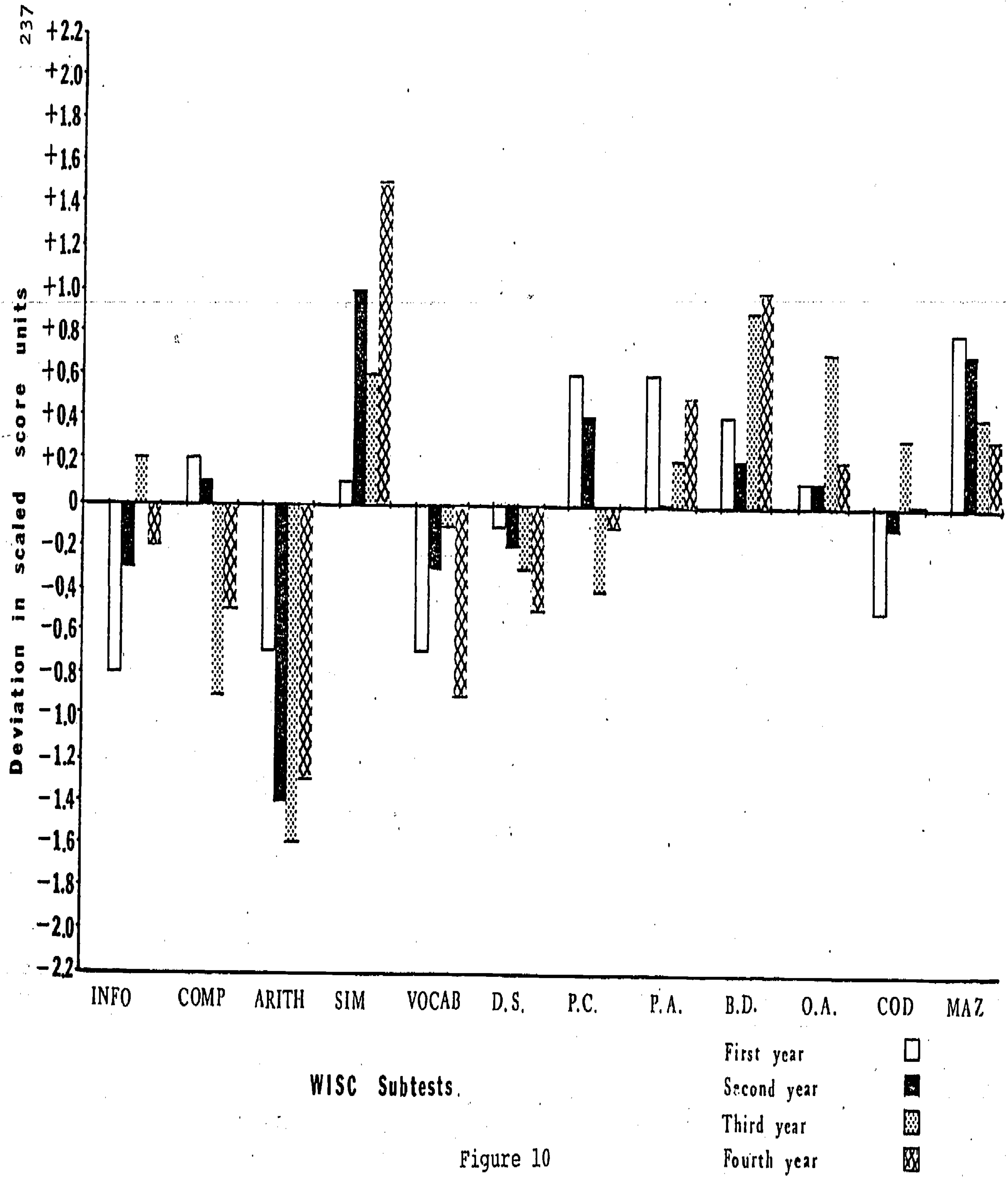


Figure 10

Four years of progress for
children age 8 in first year of study

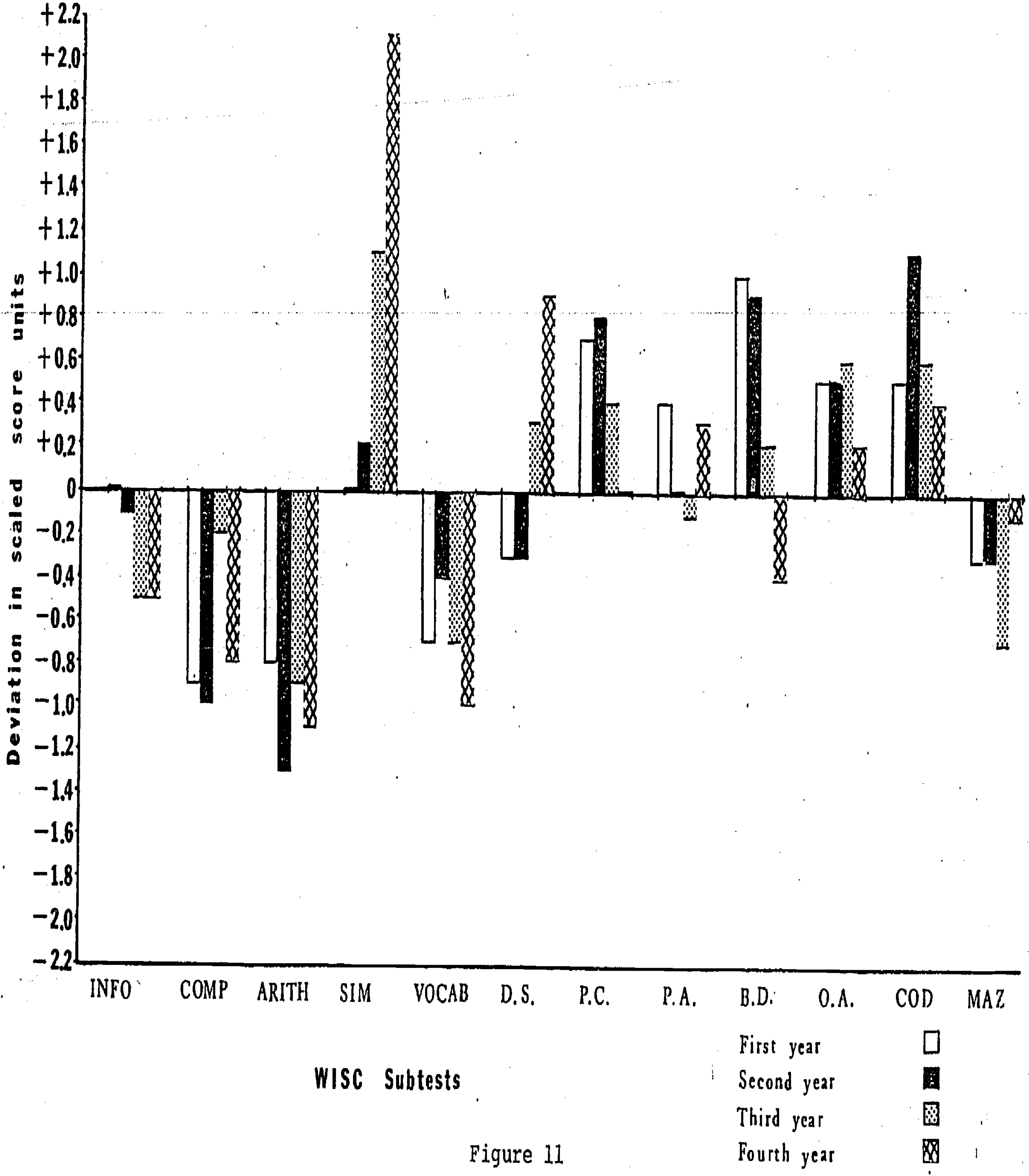


Figure 11

Four years of progress for children age 9 in first year of study

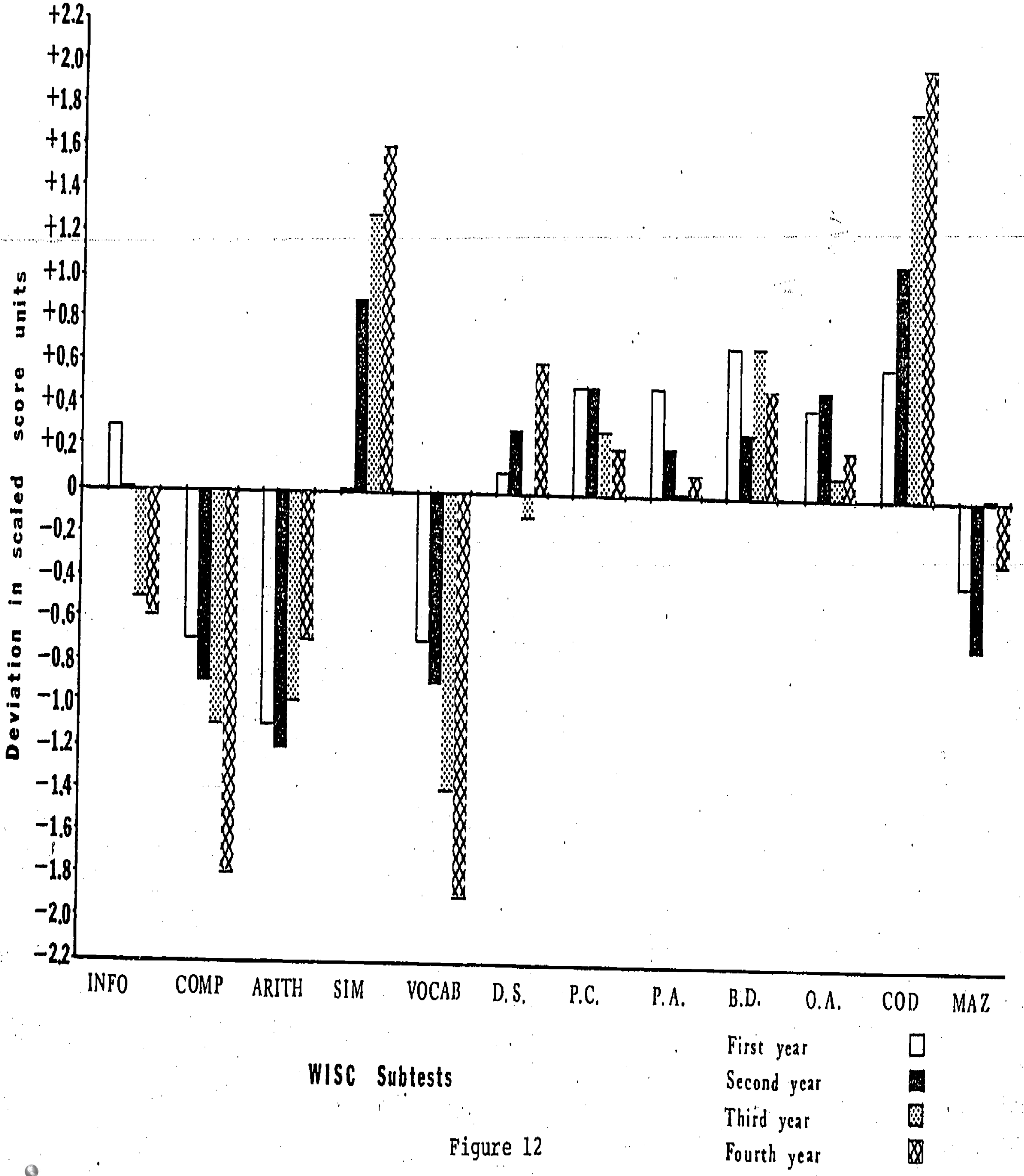


Figure 12

Four years of progress for children age 10 in first year of study

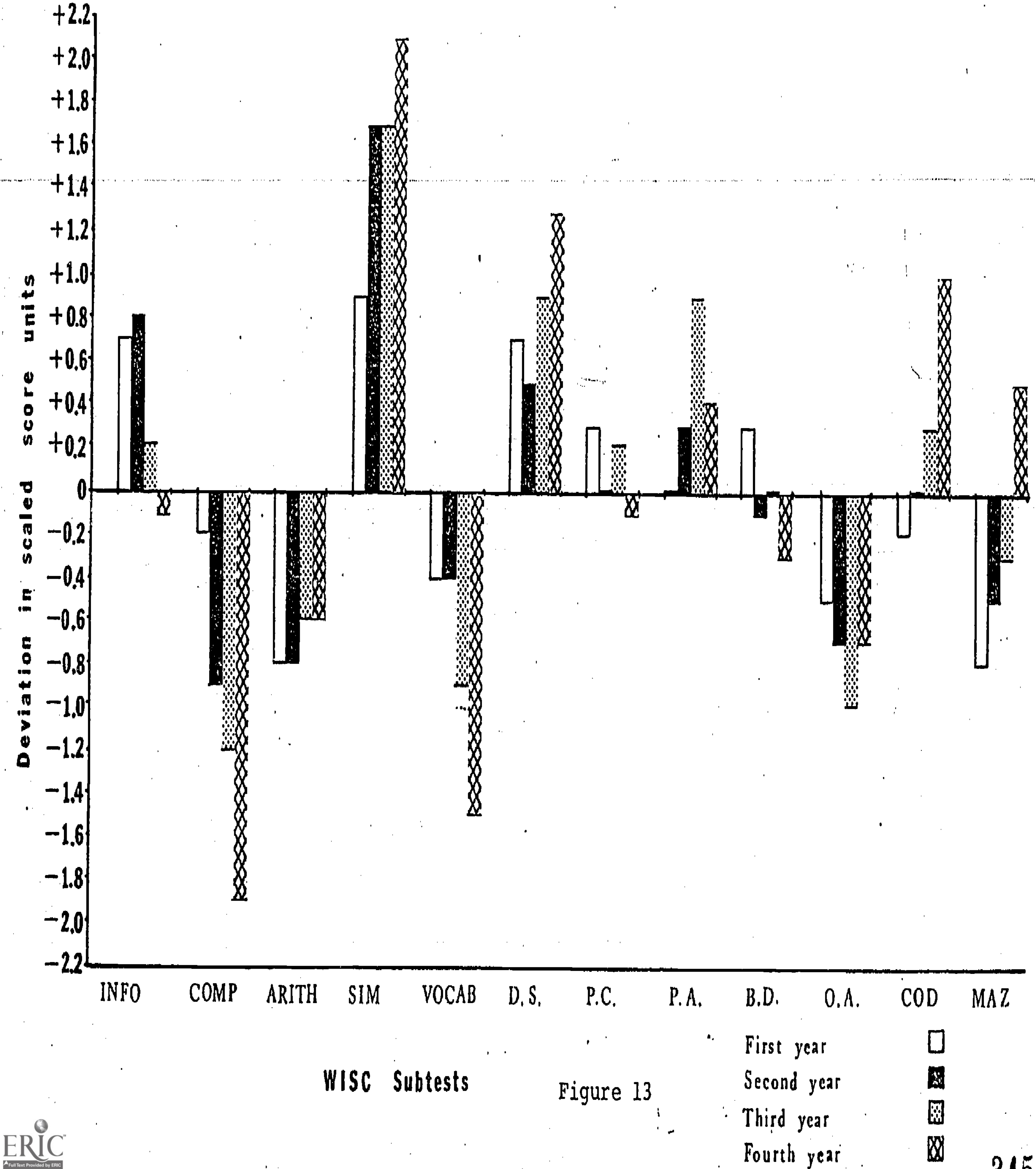


Figure 13

children age 11 in first year of study

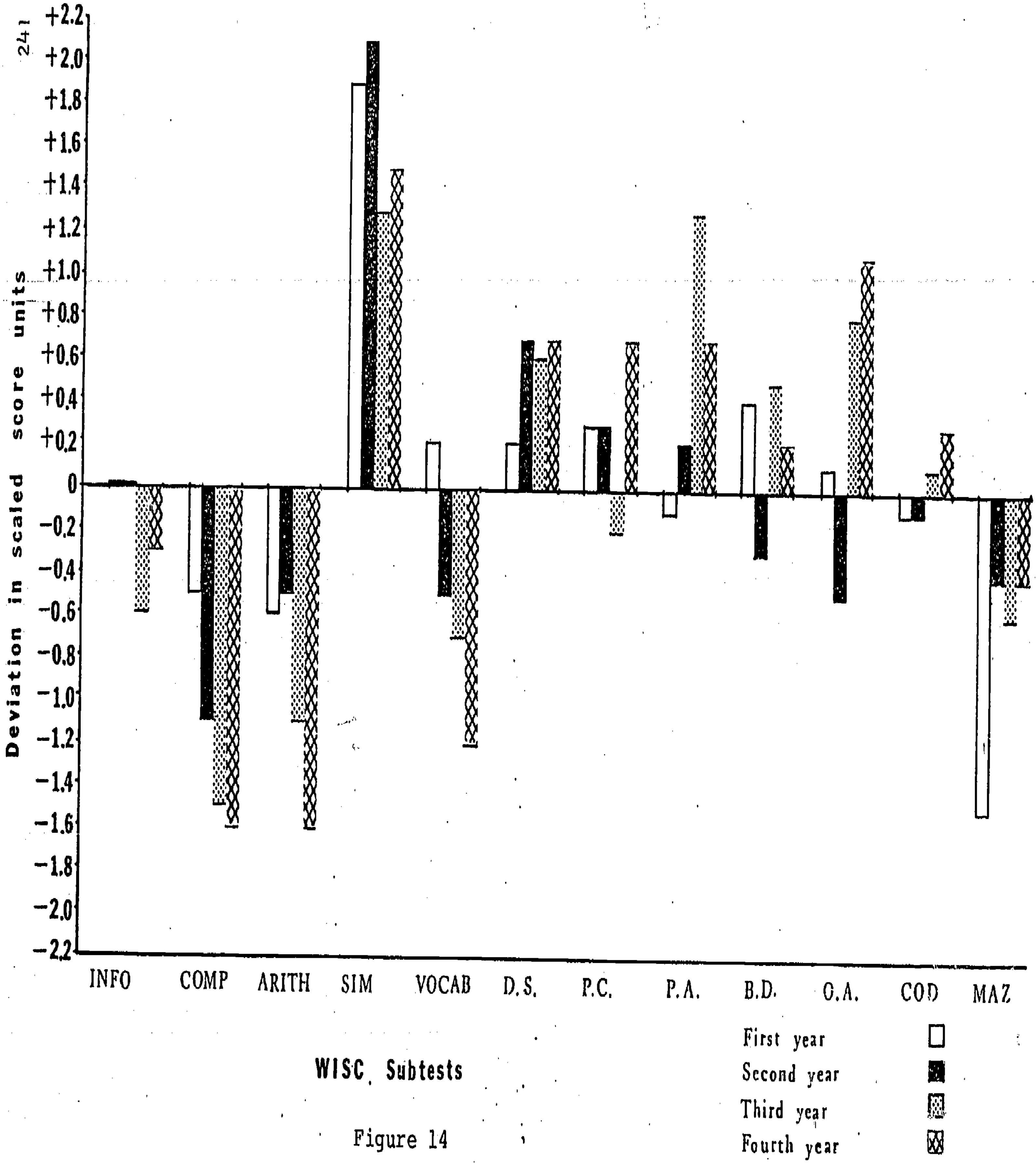


Figure 14

Four years of progress for children age 12 in first year of study

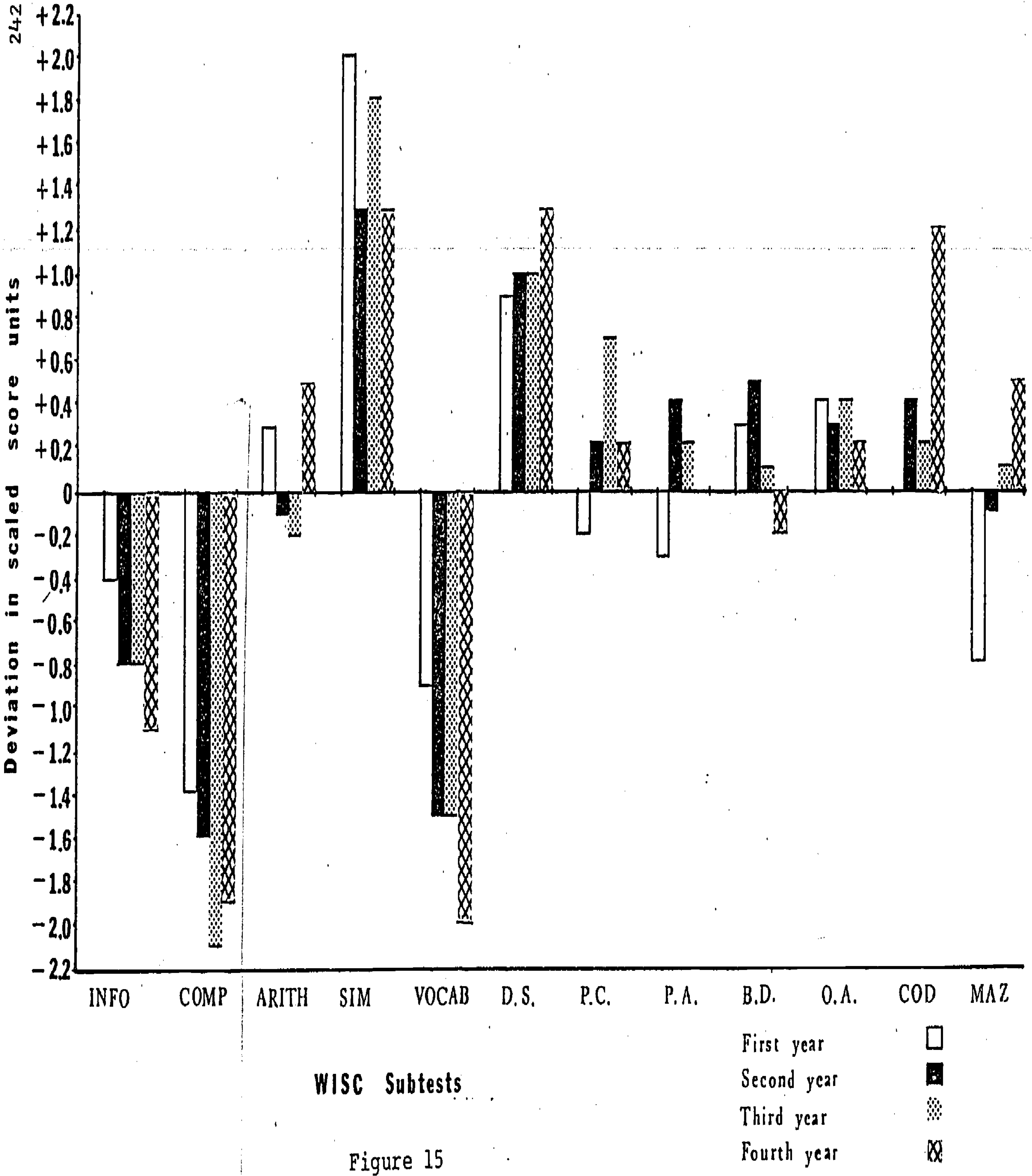


Figure 15

Chapter 9. Consecutive Factor Analyses of the WISC for Four Years: R Analyses of Test Variables

Factor analysis was another method used to determine the presence of subtest patterns on the WISC. The factor analyses reported here were based on the intercorrelations of 11 subtests (Mazes were excluded) using the principal component method of extraction with the highest coefficients in each column serving as communality estimates. This method was used in conjunction with the equimax method of rotation which yields an oblique solution (Harman, 1960).

The results of the factor analyses are presented in Tables 107-111. The symbols assigned to the factors are consistent with those reported by Cohen (1959) where "A" refers to a verbal factor, "B" a performance factor and "C" an attention, distractibility or memory factor. The verbal factor (A) and the performance factor (B) emerged with equal clarity in the first year of the study and in each succeeding year for the group as a whole (Table 107). Thus, these identified patterns showed stability over a four year period.

Tables 108-109 report the results when the group was divided into a younger age group (6-9 years in year 1 of the study) and an older age group (7-10 years in year 1 of the study). A difference in patterning or factors emerges. The younger age group continues to show the two major factors already reported (see Table 108). However, the older age group manifests a third factor, the "C" factor of attention, distractibility or memory that had earlier been reported by Cohen for the standardization group (see Table 109). This factor changes in its composition over the four year period studied, but most frequently (three out of the four years) contains Arithmetic and Digit Span.

Both Digit Span and Arithmetic appear in the Performance factor in the younger children (Table 108), and one might interpret its emergence as the separate C factor in the older children (Table 109) as a confirmation of the differentiation hypothesis of intelligence in young children where it is posited that intelligence is relatively global initially and differentiates with increasing age. However, a closer look at these results militates against such an easy interpretation.

Most importantly, the differentiation hypothesis is supported only if one refers to the cross-sectional data, i.e. if one compares younger and older children as defined by Table 108 compared with Table 109. However, within Table 108 are the longitudinal data and children who start out as age 6-9 years in the first year of the study are followed for four years until they become age 9-12 years. These data show no tendency for the same children to differentiate in the number of factors they manifest as they grow older. Quite the contrary, the stability of their two factors is indicated by their proportion of the total variance among all subtests. Table 110 shows these proportions. Factor A never varies during the four years beyond a range of 53.1% of the variance (in year 3) to 54.4% (in year 4). Factor B shows the same stability and varies within the narrow range of 10.3% of the variance (in year 1) and 12.2% (in year 3).

The same stability is shown for the three factors in the older children (Table 109) and the proportion of the variance accounted for by these three factors is given in Table 110. Again, the proportion of the variance accounted for by any one of the three factors varies within a very narrow range during the four years of the study and Factor A, e.g. varies from a low of 48.2% of the variance (in year 1) to a high of 49.8% (in year 4).

Such stability in these two groups of children (younger and older) in the longitudinal data hardly argues for the differentiation hypothesis. Instead, it suggests that the difference in the number of factors obtained is a function of the fact that the two groups are in some important way uniquely different from each other. If the cross-sectional data were the criterion, and we were to infer the differentiation of intelligence as one proceeded from younger to older children, then this should have been corroborated in the longitudinal data where the children proceed from being younger (in the first year of the study) to being older (in the fourth year of the study). After all, why should children aged 10-12 years ("older" children in the first year of the study, Table 109) show three factors, whereas children aged 9-12 ("younger" children in the fourth year of the study, Table 108) only show two factors? If differentiation of intelligence occurred, then the 9-12 year olds who are the defined "younger" groups (6-9 years in the first year of the study) and who have now been studied for four years will have had time to differentiate. Moreover, one could expect them to be factorially similar to the so-called "older" group who were 10-12 years in the first year of the study. That they were factorially different is an argument both against the differentiation hypothesis and the use of the cross-sectional method as a means of studying this issue.

Since an earlier paper (Bortner and Birch, 1970) reported a factor analysis of brain damaged children in the age range 7-11 years, the present age groups were reconstituted in order to provide comparable data. In the first year of the study, the 6 and 12 year olds were eliminated, and in the second year of the study the 12 and 13 year olds were eliminated. This provided us with a first group of children identified as 7-11 years, First Year and a second group 7-11 years, Second Year. The factor analyses for these two groups of children are presented in Table 111 and may be compared with the work reported earlier (Bortner and Birch, 1970). The three factors reported earlier are confirmed in these results, i.e. Factors A (Verbal), B (Performance) and C (Attention, Distractibility, Memory). Again, it will be noted that the proportion of the variance accounted for by these three factors is extremely stable. The bottom of Table 110 shows that the proportion of the variance (accounted for by the three factors) changes within a very narrow range over the two years.

Three factors were rotated in these last two analyses only in order to permit direct comparison with the earlier reported work. However, if we had performed these last two analyses in the same manner as those reported in Tables 107-109, only two factors would have appeared. In Tables 107-109 the decision as to how many factors to rotate was based on the Eigen value. When this value did not reach or exceed 1.0 the factor was not rotated. It should therefore be understood that the reporting of three factors here as contrasted with the reporting of only two factors in Table 107 (for the 6-12 year group over the four year period) is not in conflict; it merely represents a difference in the underlying technical decision as to when to stop rotating for additional factors. Use of the Eigen value of 1.0 or higher is a commonly accepted procedure. It was simply not followed in Table 111 in order to make the results more directly comparable with those reported in an earlier paper.

Despite the difference in the technical decision as to when to rotate in these last two analyses, the significance of the C Factor does not change much from what was reported in Tables 107-109. The proportion of the total variance attributable to the C Factor whether we refer to the 7-11 year groups (where the C Factor was rotated) or the 6-12 year groups (where the C Factor was not rotated) the proportion of the variance attributable to this third factor prior to rotation was roughly equivalent (a range of 7.3% to 9.0% over the four years for the children 6-12 years in the first year of the study) versus 5.8% and 7.3% for the two 7-11 year old groups. In all cases, the substantive significance of this C Factor appears to be marginal.

Table 107

Factor Loadings on WISC Subtests for Brain Damaged Children Age 6-12 Years in First Year of Study Followed for Four Year Period

WISC ubtest	Year 1 Age Span 6-12 N = 210			Year 2 Age Span 7-13 N = 203			Year 3 Age Span 8-14 N = 193			Year 4 Age Span 9-15 N = 177		
	A	B	h^2	A	B	h^2	A	B	h^2	A	B	h^2
Info.	-76	03	63	88	13	65	75	00	56	81	01	67
Comp.	-51	20	44	52	-17	41	62	08	46	67	05	49
Arith.	-45	38	57	49	-39	63	45	34	52	42	37	51
Sim.	-78	-08	54	70	00	50	81	-07	59	78	01	63
Vocab.	-85	-04	69	77	00	60	86	-08	66	89	-08	70
D.S.	-42	26	40	41	-29	40	45	19	35	25	33	28
P.C.	-22	56	54	18	-57	49	23	49	44	13	60	47
P.A.	-08	67	54	35	-52	62	40	44	58	35	50	60
B.D.	06	79	56	-06	-85	66	-08	85	64	-15	93	71
O.A.	10	88	67	-11	-88	67	-07	88	70	-04	84	67
Cod.	-18	51	42	11	-59	45	22	51	45	26	43	40

Table 108

Factor Loadings on WISC Subtests for Brain Damaged Children Age 6-9 Years in First Year of Study Followed for Four Year Period

WISC Subtest	Year 1 Age Span 6-9 N = 120			Year 2 Age Span 7-10 N = 114			Year 3 Age Span 8-11 N = 107			Year 4 Age Span 9-12 N = 98		
	A	B	h^2	A	B	h^2	A	B	h^2	A	B	h^2
1. Info.	70	14	64	84	00	71	-62	26	63	-84	06	78
2. Comp.	50	23	47	63	11	50	-74	06	59	-73	01	53
3. Arith.	33	52	62	32	59	69	-32	59	67	-42	49	68
4. Sim.	76	-05	53	58	11	43	-78	-03	58	-78	03	63
5. Vocab.	84	-03	67	86	-07	66	-86	-06	68	-84	-02	68
6. D.S.	26	46	44	25	50	48	-34	39	42	-20	41	31
7. P.C.	26	56	58	17	56	47	-25	50	42	-09	60	44
8. P.A.	-05	80	59	16	67	62	-19	65	61	-28	60	65
9. B.D.	-06	80	58	-09	85	64	19	92	67	18	96	74
10. O.A.	-08	87	66	-14	89	65	06	79	57	06	81	60
11. Cod.	15	56	45	02	68	48	-10	64	49	-24	42	36

Table 109

Factor Loadings on WISC Subtests for Brain Damaged Children Age 10-12 Years in First Year of Study Followed for Four Year Period

WISC Subtest	Year 1 Age Span 10-12 N = 90				Year 2 Age Span 11-13 N = 89				Year 3 Age Span 12-14 N - 86				Year 4 Age Span 13-15 N = 79			
	A	B	C	h^2	A	B	C	h^2	A	B	C	h^2	A	B	C	h^2
1. Info.	46	-06	47	59	62	-21	-32	57	65	16	16	46	69	02	03	52
2. Comp.	79	17	-20	-7	00	18	-65	55	56	-20	-02	46	60	12	06	50
3. Arith.	06	26	64	68	68	29	00	69	05	-09	72	64	11	-03	83	76
4. Sim.	60	00	18	49	51	-02	-39	57	68	-05	12	61	70	01	16	64
5. Vocab.	71	00	23	72	10	01	-84	81	94	00	-08	81	95	-08	-02	81
6. D.S.	00	07	72	58	68	14	10	49	06	01	68	51	08	06	54	39
7. P.C.	27	54	02	53	-10	58	-40	62	27	-61	-15	55	25	75	-21	68
8. P.A.	28	48	09	51	22	37	-40	62	53	-25	09	57	41	38	08	55
9. B.D.	-13	72	14	53	18	78	08	70	-02	-71	17	60	-18	76	29	71
10. O.A.	00	91	-12	75	-07	82	-09	70	-04	-94	04	86	00	88	01	78
11. Cod.	10	49	10	37	24	49	-05	43	11	-40	33	47	24	39	17	44

Table 110

Proportion of Variance Accounted for by Each Factor

	Younger Children (6-9 Years in First Year) (2 factors)		Older Children (10-12 Years in First Year) (3 factors)	
	Factor	% Variance	Factor	% Variance
Year 1	A	54.4	A	48.2
	B	10.3	B	11.9
			C	9.3
Year 2	A	53.5	A	49.1
	B	11.7	B	12.9
			C	9.9
Year 3	A	53.1	A	49.1
	B	12.2	B	11.7
			C	9.5
Year 4	A	53.9	A	49.8
	B	11.2	B	11.9
			C	9.9

Children 7-11 Years, First Year

Factor	% Variance
A	82.0
B	12.2
C	5.8

Children 7-11 Years, Second Year

Factor	% Variance
A	78.1
B	14.6
C	7.3

Table 111

Factor Loadings on WISC Subtests for Brain Damaged Children Age 7-11 in First and Second Year of Study

WISC Subtest	Year 1 Age Span 7-11 N = 150				Year 2 Age Span 7-11 N = 143			
	A	B	C	h^2	A	B	C	h^2
1. Info.	58	11	24	59	65	-12	-42	74
2. Comp.	59	34	-26	60	48	30	00	45
3. Arith.	37	37	25	61	23	27	-54	71
4. Sim.	76	-04	09	59	50	06	-22	44
5. Vocab.	76	07	04	68	86	10	06	76
6. D.S.	16	27	52	59	15	10	-63	59
7. P.C.	21	59	08	58	22	65	07	55
8. P.A.	19	67	00	62	28	57	-11	64
9. B.D.	-02	69	15	56	-07	70	-24	65
10. O.A.	-02	92	-11	76	00	84	00	70
11. Cod.	01	58	20	48	-08	47	-43	53

Chapter 10. Factor Analyses of the WISC: Q Analyses of Person Variables

A Q-Group analysis was done on the WISC data as part of the overall strategy of data analysis designed to characterize meaningful sub-groups of children according to patterns of cognitive performance. However, since Q analysis has not been reported for intelligence data before, it is discussed here in some detail.

The question may be asked whether the children we are studying represent a homogeneous or heterogeneous group with respect to their cognitive performance. If they represent a homogeneous entity, then we are justified in describing their performance on cognitive tasks in terms of a single set of average scores based on the behavior of the group as a whole. If, on the other hand, they are not homogeneous but represent instead an amalgam of differing styles, modes, or patterns of cognitive behavior, then the use of average scores based on the total group's performance will be unrevealing at best and misleading at worst. In an attempt to discover whether the cognitive behavior of our subjects can best be described in terms of a single group, whose members all behave in a similar way, or instead whether it should be described in terms of several different, uniquely performing subgroups. Q-group analyses were made of the subjects' first and second year WISC scores.

The Technique

The typical use of correlation coefficients enables us to measure the degree to which two sets of scores rank a group of individuals in the same way. If, for example, a reading comprehension test and a verbal aptitude test, administered to the same group of students, display a high (and positive) correlation, we know that students with relatively high scores on one measure will tend to have relatively high scores on the other and vice versa. In this case we have a correlation between two tests. However, it is also possible to correlate two persons. For example, suppose we have given a group of students six tests. If two students, A and B, have a high (and positive) correlation with each other, it means that they have performed in a similar manner on the six tests. If student A has a relatively high score on test 1, for example, and a relatively low score on test 2, then student B will tend to have a relatively high score on test 1 and a relatively low score on test 2. The higher the correlation between two persons the more similar their pattern of performance on a series of measures, and conversely, the lower the correlation, the less similar their performance. A hypothetical example in which five students take the same six tests is presented in Table 112, which displays the students' scores on all tests. Note that subjects A and B do not receive the same score on any one test. For example, on test 1, subject A's score is 10 and subject B's score is 8. However, A's and B's performance are perfectly correlated inasmuch as A and B both rank the tests in the same way: the tests on which A does best (1, 4, 5) are the ones on which B does best; the tests on which A does least well (2, 3) are the ones on which B does least well; and finally the test on which A performs in an intermediate way (6) is the one on which B performs in an intermediate way. Thus if we correlated A with B we would obtain a product-moment coefficient of +1.0. Similarly, note that A and C are perfrectly correlated but in the opposite direction. That is, on the tests on which A performs best, C performs worst, and vice versa. If we correlated A with C, we would obtain a coefficient of -1.0. Whereas A, B, and C are perfectly correlated with each other (either positively or negatively), none of them has a substantial correlation with D, whose scores are essentially unrelated to theirs. Note, however, that D's and E's performances are perfectly (and positively) related to each other.

Just as we can group together variables, e.g., tests, through factor analysis, we can also group persons together. In an R factor analysis, variables are grouped together which have a high relationship to each other and a low relationship to other variables. Thus the clusters of variables which result are maximally independent of (unrelated to) each other. Thus, for example, tests of arithmetic computation, arithmetic reasoning, and numerical problem solving might tend to form one cluster or factor, and tests of vocabulary knowledge, paragraph reading, and verbal reasoning might tend to form another cluster or factor if all six tests were administered to the same group of people. Similarly, subjects can be grouped together in such a way that they form maximally independent groups. The subjects forming a given group would perform in a similar fashion and the performance which characterizes one group would bear only a minimal relationship to the performance which characterizes another. One group of persons, for example, might be characterized in terms of a difference between their reading and arithmetic scores, these persons obtaining high scores on the former and low scores on the latter, whereas another group might be characterized in terms of a tendency to perform bette on tests of clerical ability than on tests of spatial relationships.

An example of the way in which subjects cluster together can be seen in Table 113, which presents the product-moment correlation coefficients computed on the basis of the performance of our five hypothetical subjects on six tests (Table 112). Note that subjects A, B, and C are perfectly related to one another but have very low correlations with subjects D and E. Subjects D and E, on the other hand, are perfectly related to each other, but, as we have seen, have very low correlations with subjects A, B, and C. On the basis of these coefficients we can construct two groups. Subjects A, B, and C would form one group, and subjects D and E would form the other. Note, however, that although A, B, and C form one group (inasmuch as their performances are perfectly correlated), A's and B's are directly opposite of that of C. Thus, the ABC group can be subdivided into two subgroups, A and B on the one hand and C on the other.

When dealing with only a few subjects, as in our example, we can group the subjects together on the basis of inspection. Where larger numbers of subjects are involved, however, a Q-group analysis--or factor analysis based on subject correlations--must be used if we are to obtain the most accurate clustering of subjects.

The Procedure

For purposes of data analysis, the children were divided into two age groups: a "younger" group, who were aged 6-9 during the first year of testing and an "older" group, who were aged 10-12 during the first year of testing. For each of these groups, two Q analyses were performed: one on its first year WISC subtest scaled scores and one on its second year WISC subtest scaled scores. In addition, two other Q analyses of WISC scaled scores were made: one on the first year scores of children who were 7-10 during the first year of testing and one on the second year scores of children who were 10-12 during the second year of testing. Thus, six Q analyses of WISC scaled scores were performed: (1) year 1 scores of ages 6-9 (N=120), (2) year 2 scores of ages 7-10 (N=109), (3) year 1 scores of ages 7-10 (N=120), (4) year 1 scores of ages 10-12 (N=90), (5) year 2 scores of ages 11-13 (N=89), and (6) year 2 scores of ages 10-12 (N=85). The relationships among these analyses are shown in Table 114. Note that except for attrition the children in analyses (1) and (2) are the same. Similarly, the children in analyses (4) and (5) are the same. Note also that there is only a partial overlap between the children in analysis (3) and those in (1) or (2) and only a partial overlap between the children in analysis (6) with those in (4) or (5). That is, the 7-, 8-, and 9-year-olds in (1) and (3) are the same, and the 11- and 12-year-olds in (5) and (6) are the same. However, the 6-year-olds in (1) are not in (3), and the 10-year-olds of (3) are not in (1). Similarly, the 12-year-olds in (5) are not in (6), and the 10-year-olds in (6) are not in (5). Thus, a comparison between (1) and (3) or between (5) and (6) would involve groups that contained some but not all of the same subjects. It should be noted that analyses (2) and (3) are of subjects of the same age (7-10) and analyses (4) and (6) are of subjects of the same age (10-12). Thus, the use of six analyses makes it possible to compare results for the <u>same</u> children over a one-year interval (by comparing (1) with (2) and (4) with (5)) as well as to compare results obtained for identical <u>age</u> groups (by comparing (2) with (3) and (4) with (6)).

The coefficients which were factor analyzed were not product-moment coefficients but cross-products. (A cross-product is the sum of the products of one subject's score on each test multiplied by another subject's score on each test.)

Thus, where A_1, A_2, . . . A_{12} represents subject A's scores on tests 1, 2, . . . 12 and where B_1, B_2, . . . B_{12} represent subject B's scores on tests 1, 2, . . . 12, the cross-product for AB would be A_1xB_1 plus A_2xB_2 plus

. . . $A_{12}xB_{12}$. The rationale for using cross-products instead of product-moment coefficients can be summarized as follows. If product-moment coefficients are employed, the children who define a type, i.e., have the highest loadings on the factor, can display grossly discrepant means and standard deviations, thus making it difficult to characterize the cluster as a whole. When cross-products are used, on the other hand, it is necessary that children who define a cluster be alike both in mean and standard deviation. Hence, cross-products were the coefficients which were factored.

For each analysis, three centroids were extracted, but only the second and third centroids were rotated. The first centroid was omitted from the rotation in order to obtain clusters in which total IQ did not prove to be the defining feature. If all three centroids had been rotated, high IQ children would have defined each cluster because their cross-products were the largest ones. Since the first centroid essentially ordered the children in terms of their total IQ score, and since the second and third centroids were by definition minimally related to the first, by rotating only the second and third centroids, clusters could be obtained in which the total IQ was not the defining feature. The resulting clusters would still, however, be defined by children whose means and standard deviations were alike.

Correlational Analyses

Pearson product-moment correlation coefficients were obtained between year 1 and year 2 Q group loadings for the children who entered Q analyses (1) and (2) and for the children who entered into Q analyses (4) and (5). This information will permit conclusions about the stability of the Q groups.

Results of Q Analysis

For each age group, two clusters of children or groups were obtained. Each Q group in turn consisted of two subgroups, each of which was the mirror image of the other--in much the same way as, in our example (Tables 112 and 113), C's performance was the mirror image of A's and B's. Thus, for each age group, four subgroups were obtained.

Just as an R factor (a cluster of scores) is defined or characterized by its loading items, a Q group (a cluster of subjects) is defined or characterized by its highest loading subjects. To make possible an interpretation of the Q analyses, for each Q group the scores of the six children with the highest positive loadings and the scores of the six children with the highest negative loadings were examined. If the cluster of children who constitute a Q group can be viewed as varying along some trait or dimension, then the six children with the highest positive loadings can be considered as archetypes of one pole of the dimension and the six children with the highest negative loadings can be considered as archetypes of the other pole. Thus, for each Q group, two subgroups of archetypal subjects were identified, one with positive loadings and one with negative loadings on the group.

For each subgroup of archetypes, the mean and standard deviation of the scaled scores obtained on each subtest were calculated as well as the mean and standard deviation based on all 12 subtests. The means and standard deviations for each subgroup's scores are presented in Table 115 (younger children) and Table 116 (older children). It was possible to identify for each archetypal subgroup those subtests on which it was relatively strong and those subtests on which it was relatively weak. The criterion of "strength" and "weakness" which was employed was an arbitrary one--namely, a difference of at least one scaled score point from the archetypal subgroup's overall mean score. (This criterion was chosen because the standard deviation of each subtest's scaled scores is three, and hence one scaled score point represents one-third of a standard deviation. A difference from the mean of one-third of a standard deviation seemed large enough to provide a reasonably reliable rough and ready index of strength or weakness.) Thus, for example, in Table 115 we can see that for the Q analysis performed on the 6-9 year olds' scores, the positive archetypes of Q group I subgroup A had an average scaled score of 7.3. The subtests on which these children performed relatively well therefore were those on which they obtained scores equal to or higher than 8.3, whereas the subtests on which they performed relatively poorly were those subtests on which they obtained scores equal to or lower than 6.3. The tests, then, on which they performed well relative to their overall average were Picture Arrangement (10.5), Block Design (9.3), Object Assembly (10.7), Coding (9.7), and Mazes (9.0). The tests on which they performed relatively poorly were Information (4.5), Comprehension (4.7), Similarities (3.8), and Vocabulary (2.8). Similarly, for the same Q analysis, the negative archetypes of Q group I subgroup B performed relatively well (in comparison to their average scaled score of 6.4) on Similarities (10.7), and relatively poorly on Digit Span (5.3), Picture Arrangement (5.3), Block Design (5.3), Object Assembly (4.3), Coding (4.0), and Mazes (5.2).

These differences, relative to the overall scaled score average, are summarized for the archetypal subjects in Table 119. Note that for the analysis of 6-9 year olds' scores obtained in the first year, there are six subtests on which subgroups IA and IB performed in opposite ways: Similarities, Picture Arrangement, Block Design, Object Assembly, Coding, and Mazes. On each of these tests if one archetypal subgroup performed relatively well, the other performed relatively poorly. Note also that whereas subgroup IA obtained relatively better scores on the performance subtests, subgroup 1B obtained its better scores on the verbal subtests.

Both archetypal subgroups had about the same average total IQ (79 and 72) but each displayed a marked discrepancy between their verbal and performance IQ scores. Archetypal subgroup IA's average verbal IQ score was 30 points lower than its average performance IQ score, and archetypal subgroup IB's average verbal IQ score was 16 points higher than its average performance IQ score. This 6-9 year old Q-group appears to be defined, therefore, in terms of a general verbal-performance discrepancy. Each of its archetypal subgroups displayed a discrepancy, but each subgroup's discrepancy was the mirror image of the other. Although this Q group can be defined in terms of a general verbal-performance discrepancy, it can also be defined more specifically in terms of the six subtests on which the two subgroups performed in opposite directions. In a similar fashion, each Q group obtained in each Q analysis can be defined by identifying those subtests on which the archetypal positive and negative subgroups performed in opposite directions.

While characterizations arrived at in this manner seem clear when only the archetypal subjects are considered, it might be argued that such characterizations would not hold for the Q-group as a whole--for all the subjects entering it. In order to check whether the characterizations determined by the archetypal students would also apply when subjects with lower or marginal loadings were included, the procedure followed with the highest loading subjects was also followed with (1) all subjects having loadings equal to or greater than .0200 (which excluded about one-third of the subjects entering each Q group) and (2) all subjects entering the Q group. Substantially the same results were obtained. That is to say, the same relative strengths and weaknesses were observed on most of the same tests for each Q subgroup whether based on the highest loading subjects, or on the subjects with loadings equal to or higher than .0200, or on all subjects. This can be seen graphically in Figures 16 and 17. Figure 16 shows the average subtest performance of the 6-9 year old subgroups IA and IB when obtained in each of the three ways mentioned above. Figure 17 presents the same information for the 6-9 year old subgroups IIA and IIB. Note that the configuration of subtest performance based on the highest loading subjects (Figures 16.1 and 17.1) is repeated not only when subjects with loadings as low as .0200 are added (Figures 16.2 and 17.2) but also when the most marginal subjects are added (Figures 16.3 and 17.3). For both Q groups, it can be seen that when more marginal subjects are added, the contour becomes less attenuated, i.e., the intersubject discrepancies become less sharp. However, the relative positions of the various subtests are about the same when all subjects are included (Figures 16.3 and 17.3) as when only the archetypal subjects are included (Figures 16.1 and 17.1). Thus, for example, subgroup IA's four highest and four lowest scores were obtained on subtests 8, 9, 10, 11 and 1, 2, 4, 5 respectively, whether computed for the highest loading subjects, the next highest loading subjects, or all the subjects entering the group.

Corresponding graphs for the other Q analyses are not presented here, but they show a similar progression. That is, the configuration displayed by the highest loading children is maintained, although in a less extreme fashion, when the averages of all subjects comprising the group are included.

For each Q analysis, the performance of all subjects is summarized in Tables 117 and 118, which present the means and standard deviations obtained by each subgroup on each subtest. A comparison of these means with those of Tables 115 and 116 indicated again that in general the pattern of performance displayed by the archetypal subjects was maintained even when the scores of the students most marginal to the subgroup were included. The difference between means are smaller, but each subtest's relative rank is about the same.

Stability of Subtest Patterning

Comparisons among the Q group profiles obtained by the three analyses for the younger children (age 6-9, year 1; age 7-10, year 2; age 7-10, year 1) and comparison among the Q group profiles obtained by the three analyses for the older children (age 10-12, year 1; age 11-13, year 2; age 10-12, year 2) indicate whether the pattern of strengths and weaknesses, identified by an analysis of one year's scores were also found in an analysis of the same children's scores in the other year (age 6-9, year 1 v. age 7-10, year 2 or age 10-12, year 1 v. age 11-13, year 2) and whether the pattern of strengths and weaknesses, identified by an analysis of one age group's scores was also found in an analysis of the scores of another, partially overlapping group of children of the same age (ages 7-10, year 1 v. ages 7-10 year 2 or ages 10-12, year 1 v. ages 10-12 year 2). An examination of the three sets of profiles for the archetypal younger children (Table 119) and the three sets of profiles for the archetypal older children (Table 120) indicates that, with the exception of the younger children's second Q group, these patterns were maintained in broad outline from one year to the next and for equivalent age groups. The stability of patterning can be seen in Figures 18-21, which present the mean subtest configurations for each archetypal subgroup.

Characterization of Children

We can characterize the younger and the older children in terms of those features of the subtest profiles which are found in all three analyses. Based on the archetypal profiles summarized in Tables 120-121 we can characterize briefly (and grossly) the groups into which the older and younger children are divided as follows. For the younger children, only the QI group maintained a stable subtest configuration, which can be characterized in terms of a general Verbal-Performance discrepancy, there being a difference of at least one standard deviation between PQ and VQ for the Q subgroups on all three analyses. Children with positive loadings in this Q group tended to have higher Performance than Verbal Scale scores, with the reverse being true for children with negative loadings. In addition, these children varied in terms of their performance on the Similarities and Object Assembly subtests, with positive loadings associated with low Similarities and high Object Assembly scores, the reverse being true for children with negative loadings. For the older children, the QI group was characterized by differences on the Comprehension and Vocabulary subtests, with positive QI loadings associated with high Comprehension and Vocabulary scores, and by differences on the Object Assembly, Coding and Mazes subtests, with positive QI loadings associated with low scores on the Object Assembly, Coding, and Mazes subtests. As for the older children's QII group, it can be characterized in terms of a verbal-performance discrepancy, inasmuch as five out of six of the QII subgroup extreme subjects had VQ-PQ discrepancies larger than 20 points, and inasmuch as the smallest discrepancy of the six was 12 points. Children with positive loadings in this Q group tended to have higher verbal than performance subscores, with the reverse true for children with negative loadings. The older QII children also differed in terms of the Information and Digit Span subtests, with positive loading associated with relatively higher scores. Note that the older children with positive QII loadings obtained about the same average verbal score as those with negative loadings. Thus, the higher total IQ scores observed for the children with negative loadings was due to the fact that in absolute terms, their performance scores were substantially higher than those of the children with positive loadings.

Whereas Tables 119 and 120 summarize Q group profiles in terms of the archetypal subjects, Tables 121 and 122 summarize each Q group in terms of all the children whose highest loadings were found on that group. A comparison of Tables 119 and 120 with 121 and 122 indicates that the characterization made in terms of archetypal subjects holds up fairly well for all the subjects entering each Q group.

The graphs of the Q group profiles or configurations, exhibited in Figures 18-21, can now be compared to the graph of the profile of all children combined in the younger group (ages 6-9), and the graph of the profile of all children combined in the older group (ages 10-12) obtained during the first year of testing. The latter profiles are shown in Figure 22. It can be seen that these profiles are quite flat. For the younger children (N=120), not one of the subtest averages differed from the overall mean score (6.0) by as much as one scaled score point. For the older children (N=90) only two subtests were at least one scaled score point above or below the overall mean (6.5). These were Similarities, which was 1.5 points above the mean and Mazes, which was 1.0 point below the mean. The means and standard deviations computed for each of these age groups as a whole are presented in Table 123. If one had only the information which is presented in this table, one would conclude that these children could be characterized as subnormal, and that their performance was uniformly and unrelievedly poor across all or almost all subtests.

It is now clear that such a characterization would be grossly misleading since it would not reflect the marked differences that have been found to exist in uniquely performing subgroups. The use of Q analyses has revealed the existence of markedly different clusters of children whose different patterns of cognitive performance are obscured by more simplistic analyses.

Stability of Q Group Loadings

The correlations between Q group loadings in year 1 with those in year 2 for the younger and for the older children are presented in Table 124. For the older children (ages 10-12 in year 1), the correlation between the loadings on Q group I in years 1 and 2 and the correlation between the loadings on Q group II in years 1 and 2 were substantial (r = .67 and .76 respectively). Thus, the older children tended to maintain their rank in each Q group from one year to the next. The younger children (ages 6-9 in year 1), however, displayed a substantial correlation only between loadings on Q group I in years 1 and 2 (r = .66). Although the correlation between year 1 and 2 loadings on Q group II was statistically significant ($p < .01$) it was at a much lower order of magnitude (r = .37) and was about the same as the correlation between the loadings on Q group I in year 1 and the loading on Q group II in year 2 (r = .36). Thus the second Q group was not very stable for the younger children, either in terms of the children who entered it (Table 124) or in terms of the subtest profiles characterizing it (Tables 119 and 121). However, Q group I for the younger children and both Q groups for the older children, were stable in terms of the children entering them as well as in terms of the subtest profiles.

Table 112

Performance of Five Subjects on Six Tests - Hypothetical Example

Test	Subject A	B	C	D	E
1	10	8	5	5	6
2	5	4	10	6	7
3	5	4	10	7	8
4	10	8	5	7	8
5	10	8	5	6	7
6	8	4	8	5	6

Table 113

Intercorrelations of Five Subjects - Hypothetical Example

Subject	Coefficient				
	A	B	C	D	E
A		+1.0	-1.0	-.18	-.18
B			-1.0	-.18	-.18
C				.18	.18
D					+1.0
E					

Table 114

Ages of Children Entering Each of Six Q Analyses

Q Analysis	Age							N	Year
1	6	7	8	9				120	1
2	7	8	9	10				109	2
3		7	8	9	10			120	1
4					10	11	12	90	1
5					11	12	13	89	2
6				10	11	12		90	2

Note. The children represented by a given age column are, except for attrition, the same, e.g., children who were 6 years old in year 1, were 7 years old in year 2.

Table 115

WISC Performance of Archetypal Younger Subjects

Test	Statistic	Q Group I					
		Age 6-9,Yr 1		Age 7-10,Yr 2		Age 7-10,Yr 1	
		A	B	A	B	A	B
		Scaled Score					
Information	X̄	4.50	7.33	3.50	8.67	6.17	6.17
	SD	2.17	3.20	2.51	1.86	2.93	3.31
Comprehension	X̄	4.67	7.17	4.00	7.33	6.17	5.17
	SD	4.18	1.94	2.53	2.34	4.07	1.72
Arithmetic	X̄	6.50	6.00	5.17	7.00	6.00	6.00
	SD	3.27	2.10	3.19	2.53	2.53	4.47
Similarities	X̄	3.83	10.67	4.50	9.17	5.83	8.83
	SD	1.72	4.27	3.39	2.64	3.31	2.93
Vocabulary	X̄	2.83	7.17	2.50	8.33	6.50	4.50
	SD	2.23	2.40	2.26	2.34	5.05	2.07
Digit Span	X̄	6.33	5.33	6.00	7.33	6.00	7.33
	SD	3.72	1.75	5.83	2.42	2.76	2.34
Picture Comp.	X̄	7.83	7.33	8.17	7.83	8.33	5.67
	SD	3.87	4.32	2.99	3.76	3.78	3.01
Picture Arrang.	X̄	10.50	5.33	7.67	5.17	10.83	4.83
	SD	3.08	3.01	2.81	2.32	2.64	1.94
Block Design	X̄	9.33	5.33	10.00	5.50	8.17	5.33
	SD	4.08	2.07	2.19	2.74	3.06	1.97
Object Assem.	X̄	10.67	4.33	11.17	4.17	11.17	2.33
	SD	3.08	2.25	2.56	2.23	3.37	1.97
Coding	X̄	9.67	4.00	9.50	6.83	10.67	2.83
	SD	4.03	3.79	4.o8	3.12	3.83	2.48
Mazes	X̄	9.00	5.17	8.17	4.67	9.00	5.17
	SD	1.79	2.86	2.93	2.25	1.41	2.93
Total	X̄	7.30	6.40	6.70	6.85	7.88	5.35
	SD	2.68	2.81	2.67	1.91	2.53	2.06

Table 115 (continued)

WISC Performance of Archetypal Younger Subjects

Test	Statistic	Q Group I					
		Age 6-9,Yr 1		Age 7-10,Yr 2		Age 7-10,Yr 1	
		A	B	A	B	A	B
		Quotients					
Verbal	$\overline{X}$	67.17	82.83	64.33	87.50	75.33	77.17
	SD	16.22	14.11	18.34	12.39	18.02	14.05
Performance	$\overline{X}$	96.67	67.00	93.67	70.33	98.33	61.33
	SD	18.39	19.68	17.41	13.16	17.49	12.96
Full Scale	$\overline{X}$	79.33	72.33	76.33	77.33	85.00	66.00
	SD	18.84	18.21	19.48	13.91	18.73	14.78

Table 115 (continued)

WISC Performance of Archetypal Younger Subjects

Test	Statistic	Q Group II					
		Age 6-9,Yr 1		Age 7-10,Yr 2		Age 7-10,Yr 1	
		A	B	A	B	A	B
		Scaled Score					
Information	$\bar{X}$	6.67	4.67	7.17	6.50	8.33	4.00
	SD	1.75	3.50	2.23	2.17	2.88	1.26
Comprehension	$\bar{X}$	4.83	6.33	5.50	6.50	6.00	3.50
	SD	1.17	3.72	1.38	2.88	2.19	2.88
Arithmetic	$\bar{X}$	4.83	4.00	6.00	4.33	5.67	5.83
	SD	1.72	2.76	1.27	2.07	3.56	2.93
Similarities	$\bar{X}$	8.33	4.83	5.00	9.50	9.17	3.67
	SD	3.72	2.40	0.89	1.05	3.25	1.63
Vocabulary	$\bar{X}$	5.50	4.67	5.67	7.83	7.50	3.17
	SD	2.74	3.61	0.82	2.40	3.67	1.84
Digit Span	$\bar{X}$	8.67	4.00	7.17	4.50	6.50	7.67
	SD	2.66	2.19	2.71	1.38	2.43	3.50
Picture Comp.	$\bar{X}$	6.50	7.00	6.67	8.17	5.67	7.50
	SD	1.52	3.52	2.25	3.06	3.98	2.43
Picture Arrang.	$\bar{X}$	5.83	8.83	6.33	6.83	6.17	7.17
	SD	0.98	3.87	2.87	3.66	2.23	3.13
Block Design	$\bar{X}$	6.00	6.67	7.50	7.17	4.17	11.17
	SD	2.28	3.08	2.67	2.14	3.87	2.32
Object Assemb.	$\bar{X}$	5.67	5.50	6.17	8.67	4.00	9.33
	SD	1.63	4.04	2.79	2.87	2.97	3.14
Coding	$\bar{X}$	11.17	2.00	12.33	4.33	5.67	6.50
	SD	1.17	2.45	3.72	1.86	3.39	2.81
Mazes	$\bar{X}$	6.00	6.00	7.00	5.50	3.17	7.67
	SD	1.67	1.67	2.97	1.23	2.99	1.86
Total	$\bar{X}$	6.67	5.35	6.88	6.65	6.05	6.42
	SD	1.14	2.81	1.43	1.86	2.44	1.70

Table 115 (continued)

WISC Performance of Archetypal Younger Subjects

Test	Statistic	Q Group II					
		Age 6-9,Yr 1		Age 7-10,Yr 2		Age 7-10,Yr 1	
		A	B	A	B	A	B
		Quotients					
Verbal	X̄	78.17	67.00	75.67	78.00	82.50	66.67
	SD	8.57	17.88	4.68	10.86	13.16	11.36
Performance	X̄	78.00	71.83	83.67	77.83	63.83	87.67
	SD	8.15	19.53	16.79	14.73	20.16	13.41
Full Scale	X̄	76.17	66.50	77.50	76.00	71.00	74.33
	SD	8.70	20.22	10.25	13.39	17.29	12.79

Table 116

WISC Performance of Archetypal Older Subjects

Test	Statistic	Q Group I					
		Age 10-12,Yr 1		Age 11-13,Yr 2		Age 10-12,Yr 2	
		A	B	A	B	A	B
				Scaled Score			
Information	$\bar{X}$	7.50	5.83	8.67	6.67	8.17	5.67
	SD	2.26	1.33	0.82	1.21	1.47	2.25
Comprehension	$\bar{X}$	7.17	4.17	10.00	4.33	9.17	4.00
	SD	3.71	2.14	4.05	2.16	2.99	2.76
Arithmetic	$\bar{X}$	5.67	6.00	7.17	9.67	6.50	5.83
	SD	3.08	2.90	2.71	3.45	1.38	3.37
Similarities	$\bar{X}$	10.83	3.83	11.17	9.00	10.83	8.50
	SD	2.14	1.83	1.83	0.89	0.98	2.35
Vocabulary	$\bar{X}$	9.00	3.67	9.83	4.00	9.83	4.50
	SD	4.86	3.01	2.48	2.45	2.40	2.51
Digit Span	$\bar{X}$	6.83	7.17	6.50	11.33	6.50	8.00
	SD	3.43	2.86	2.59	1.75	2.07	4.43
Picture Comp.	$\bar{X}$	5.50	7.00	8.50	6.67	8.33	5.50
	SD	3.89	1.67	3.02	1.37	3.39	2.07
Picture Arrang.	$\bar{X}$	6.33	6.83	9.33	7.33	9.00	6.50
	SD	4.32	3.25	2.50	2.07	2.90	3.08
Block Design	$\bar{X}$	4.00	9.50	6.67	9.33	7.00	8.83
	SD	4.34	2.59	3.39	1.37	1.90	2.56
Object Assem.	$\bar{X}$	3.67	8.50	6.50	9.00	6.00	9.50
	SD	2.88	1.97	3.51	1.67	3.03	3.39
Coding	$\bar{X}$	4.50	8.17	6.00	9.67	5.67	10.33
	SD	3.73	2.93	2.76	3.93	2.34	3.83
Mazes	$\bar{X}$	2.50	7.67	5.00	8.50	4.67	8.33
	SD	1.97	2.16	2.61	2.74	2.73	1.97
Total	$\bar{X}$	6.12	6.53	7.93	7.98	7.63	7.12
	SD	2.95	1.63	2.11	1.08	1.75	2.44

Table 116 (continued)

WISC Performance of Archetypal Older Subjects

Test	Statistic	Q Group I					
		Age 10-12, Yr 1		Age 11-13, Yr 2		Age 10-12, Yr 2	
		A	B	A	B	A	B
		Quotients					
Verbal	$\overline{X}$	86.67	69.17	92.50	84.17	90.50	75.17
	SD	18.29	11.69	11.36	7.57	8.76	17.21
Performance	$\overline{X}$	61.00	85.67	79.33	88.67	77.50	86.83
	SD	22.14	10.78	16.91	8.66	16.27	15.75
Full Scale	$\overline{X}$	72.17	79.83	85.17	85.17	83.00	79.00
	SD	21.59	9.30	14.77	8.03	12.70	17.85

Table 116 (continued)

WISC Performance of Archetypal Older Subjects

Test	Statistic	Q Group II					
		Age 10-12, Yr 1		Age 11-13, Yr 2		Age 10-12, Yr 2	
		A	B	A	B	A	B
				Scaled Score			
Information	$\bar{X}$	8.83	6.17	9.50	5.67	9.00	7.33
	SD	2.14	1.72	1.97	1.03	2.19	2.34
Comprehension	$\bar{X}$	4.67	7.00	2.50	6.83	2.17	6.50
	SD	1.51	1.79	0.84	2.32	0.41	1.64
Arithmetic	$\bar{X}$	9.50	5.50	6.00	7.33	6.00	7.17
	SD	3.21	1.76	2.83	1.03	2.83	1.83
Similarities	$\bar{X}$	7.50	8.83	9.00	9.17	8.67	8.33
	SD	2.26	1.17	1.79	0.41	1.97	1.75
Vocabulary	$\bar{X}$	7.00	6.83	5.67	7.83	5.67	8.00
	SD	1.79	2.79	2.87	2.64	2.87	3.52
Digit Span	$\bar{X}$	11.33	5.33	9.50	6.83	8.33	6.67
	SD	1.37	1.03	2.67	1.83	3.33	1.97
Picture Comp.	$\bar{X}$	5.17	8.33	3.50	12.00	3.33	11.50
	SD	2.93	2.25	1.52	0.89	1.37	1.87
Picture Arrang.	$\bar{X}$	6.00	9.33	4.83	9.83	4.17	10.17
	SD	2.37	2.34	2.79	2.99	3.43	3.13
Block Design	$\bar{X}$	5.67	8.33	4.33	12.17	4.17	11.33
	SD	2.16	1.63	1.75	2.14	1.94	2.16
Object Assem.	$\bar{X}$	3.17	11.33	1.50	11.50	1.50	11.83
	SD	2.40	2.66	1.38	2.43	1.38	2.79
Coding	$\bar{X}$	6.00	6.67	4.50	9.50	4.00	9.83
	SD	1.41	2.50	2.67	2.88	2.83	2.71
Mazes	$\bar{X}$	4.00	8.00	3.83	10.50	3.83	10.67
	SD	2.76	2.68	3.37	2.34	3.37	2.34
Total	$\bar{X}$	6.73	7.63	5.42	9.12	5.08	9.13
	SD	1.48	1.10	1.40	0.77	1.65	1.20

Table 116 (continued)

WISC Performance of Archetypal Older Subjects

Test	Statistic	Q Group II					
		Age 10-12, Yr 1		Age 11-13, Yr 2		Age 10-12, Yr 2	
		A	B	A	B	A	B
		Quotients					
Verbal	$\overline{X}$	88.33	78.50	81.50	83.00	79.00	83.50
	SD	8.36	8.04	8.64	4.20	10.45	7.66
Performance	$\overline{X}$	65.50	91.00	56.33	106.67	54.50	106.50
	SD	11.57	8.27	11.41	7.58	12.68	9.23
Full Scale	$\overline{X}$	75.17	83.00	66.67	93.67	64.17	93.67
	SD	9.04	7.87	10.61	5.89	12.42	8.87

Table 117

WISC Performance of All Subjects - Younger Group

Test	Statistic	Q Group I					
		Age 6-9,Yr 1		Age 7-10,Yr 2		Age 7-10,Yr 1	
		A N=28	B N=37	A N=30	B N=32	A N=30	B N=29
		Scaled Score					
Information	$\bar{X}$	5.21	6.64	4.97	7.28	5.87	5.83
	SD	2.28	2.79	2.41	2.77	2.27	2.30
Comprehension	$\bar{X}$	5.14	5.78	5.13	6.91	5.83	5.38
	SD	3.11	1.97	2.75	2.62	2.72	2.04
Arithmetic	$\bar{X}$	5.67	5.37	5.23	5.22	4.83	5.62
	SD	2.61	2.45	2.76	2.91	2.47	2.54
Similarities	$\bar{X}$	4.78	7.62	5.63	7.53	5.33	6.83
	SD	2.08	3.28	2.95	2.75	2.54	2.45
Vocabulary	$\bar{X}$	4.03	6.37	4.47	6.16	6.03	5.03
	SD	2.67	2.95	2.64	2.14	3.42	1.78
Digit Span	$\bar{X}$	6.17	5.62	6.30	6.06	5.30	6.52
	SD	2.75	2.07	3.41	2.56	2.51	2.67
Pic. Comp.	$\bar{X}$	7.17	6.45	7.77	6.13	6.80	6.72
	SD	3.59	2.92	2.53	3.05	3.43	2.67
Pic. Arrang.	$\bar{X}$	8.00	5.18	7.60	5.16	7.83	4.97
	SD	3.51	2.87	3.35	3.05	3.16	2.44
Block Design	$\bar{X}$	8.50	6.00	8.60	5.53	6.27	6.28
	SD	3.34	3.05	2.82	2.70	3.22	2.51
Object Assem.	$\bar{X}$	8.53	4.51	9.07	4.13	8.53	3.65
	SD	3.46	2.79	3.34	2.24	3.06	1.82
Coding	$\bar{X}$	7.85	4.67	8.10	6.34	7.47	4.48
	SD	3.34	2.93	3.29	3.22	3.60	3.13
Mazes	$\bar{X}$	7.28	5.43	7.33	5.13	6.43	5.38
	SD	2.07	2.43	2.12	2.35	2.31	2.21
Total	$\bar{X}$	6.53	5.82	6.68	5.96	6.37	5.55
	SD	2.20	2.19	2.20	2.12	2.27	1.70

Table 117 (continued)

WISC Performance of All Subjects - Younger Group

Test	Statistic	Q Group I					
		Age 6-9,Yr 1		Age 7-10,Yr 2		Age 7-10,Yr 1	
		A N=28	B N=37	A N=30	B N=32	A N=30	B N=29
				Quotients			
Verbal	$\overline{X}$	69.78	76.32	70.57	78.13	71.87	74.10
	SD	12.93	13.27	14.40	13.24	13.26	10.16
Performance	$\overline{X}$	85.53	67.78	86.57	68.13	80.70	66.90
	SD	18.18	16.25	16.36	15.60	18.33	13.77
Full Scale	$\overline{X}$	75.14	69.43	76.17	70.91	73.93	67.72
	SD	15.97	15.81	16.12	15.39	16.50	12.32

Table 117 (continued)

WISC Performance of All Subjects - Younger Group

Test	Statistic	Q Group II					
		Age 6-9,Yr 1		Age 7-10,Yr 2		Age 7-10,Yr 1	
		A N=25	B N=30	A N=20	B N=27	A N=31	B N=30
				Scaled Score			
Information	$\bar{X}$	6.60	4.40	6.00	5.74	7.19	5.20
	SD	2.00	2.27	1.89	2.52	2.45	2.38
Comprehension	$\bar{X}$	5.40	5.63	4.95	5.78	6.07	5.47
	SD	1.87	2.57	1.67	2.53	2.29	2.99
Arithmetic	$\bar{X}$	5.36	4.46	5.80	3.55	5.13	5.17
	SD	2.40	2.57	1.67	2.14	3.09	2.55
Similarities	$\bar{X}$	6.64	4.90	5.75	7.63	8.10	4.83
	SD	2.90	2.15	1.71	3.10	3.19	2.27
Vocabulary	$\bar{X}$	6.52	3.96	4.95	6.11	7.19	3.53
	SD	2.86	2.77	0.95	3.15	2.94	2.37
Digit Span	$\bar{X}$	7.64	4.33	7.60	5.11	6.29	6.73
	SD	2.66	2.07	2.68	2.85	2.43	2.66
Pic. Comp.	$\bar{X}$	7.00	6.10	6.05	7.41	6.13	6.97
	SD	2.36	3.34	1.96	2.82	3.07	3.27
Pic. Arr.	$\bar{X}$	6.16	6.86	5.40	5.85	6.29	6.70
	SD	1.95	2.86	2.56	3.82	2.83	3.35
Block Design	$\bar{X}$	5.36	6.30	7.60	6.48	5.77	8.33
	SD	2.36	2.67	2.52	3.35	3.56	3.19
Object Assem.	$\bar{X}$	6.08	5.30	5.40	7.00	5.45	7.00
	SD	2.74	2.81	2.60	3.49	2.90	3.35
Coding	$\bar{X}$	8.64	3.10	9.20	4.33	6.65	5.80
	SD	2.45	2.15	3.17	2.68	3.23	2.61
Mazes	$\bar{X}$	5.88	6.26	6.40	5.55	4.68	7.10
	SD	2.07	1.86	2.06	1.91	2.61	2.01
Total	$\bar{X}$	6.43	5.13	6.26	5.88	6.25	6.06
	SD	1.57	2.07	1.27	2.45	2.26	2.08

Table 117 (continued)

WISC Performance of All Subjects - Younger Group

Test	Statistic	Q Group II					
		Age 6-9, Yr 1		Age 7-10, Yr 2		Age 7-10, Yr 1	
		A N=25	B N=30	A N=20	B N=27	A N=31	B N=30
		Quotients					
Verbal	$\bar{X}$	77.32	66.17	74.15	72.70	79.07	69.83
	SD	10.63	12.88	6.51	15.09	13.40	12.70
Performance	$\bar{X}$	75.80	69.83	76.60	72.81	70.90	79.17
	SD	11.23	15.32	12.24	18.10	17.65	16.64
Full Scale	$\bar{X}$	74.40	64.86	72.90	70.26	72.81	71.70
	SD	11.87	15.11	9.28	17.73	16.31	15.21

Table 118

WISC Performance of All Subjects - Older Group

Test	Statistic	Q Group I					
		Age 10-12, Yr 1		Age 11-13, Yr 2		Age 10-12, Yr 2	
		A N=22	B N=28	A N=22	B N=16	A N=23	B N=17
		Scaled Score					
Information	$\overline{X}$	6.95	6.10	7.36	5.94	7.70	5.71
	SD	2.61	1.81	2.24	1.98	2.42	2.14
Comprehension	$\overline{X}$	6.90	4.85	7.64	4.06	7.52	3.82
	SD	2.58	1.80	3.36	1.84	3.03	2.16
Arithmetic	$\overline{X}$	5.36	6.42	6.00	7.50	6.26	5.77
	SD	3.00	2.70	3.04	3.14	3.00	2.36
Similarities	$\overline{X}$	9.77	6.64	9.23	7.44	9.35	7.18
	SD	2.67	2.93	2.93	2.00	2.79	2.38
Vocabulary	$\overline{X}$	7.09	5.03	7.55	4.06	7.61	4.12
	SD	3.83	2.52	3.03	2.38	3.01	2.39
Digit Span	$\overline{X}$	6.22	7.75	6.41	9.25	6.83	7.82
	SD	2.39	1.90	3.35	3.87	3.34	3.21
Picture Comp	$\overline{X}$	6.00	6.96	7.59	6.56	8.04	6.29
	SD	3.95	1.81	3.17	1.37	3.21	1.69
Picture Arrang.	$\overline{X}$	6.50	6.25	7.64	7.44	8.09	6.35
	SD	3.45	2.38	3.58	2.39	3.65	2.50
Block Design	$\overline{X}$	5.09	7.75	5.45	8.37	6.04	7.59
	SD	2.94	2.90	2.63	2.00	2.67	2.57
Object Assem.	$\overline{X}$	4.54	7.71	5.73	7.87	5.78	7.59
	SD	2.96	2.84	3.28	2.83	2.89	2.87
Coding	$\overline{X}$	5.40	7.53	5.86	8.25	6.26	8.77
	SD	3.40	2.41	2.64	3.47	2.73	3.67
Mazes	$\overline{X}$	3.72	6.96	4.96	7.25	5.13	7.41
	SD	2.00	2.08	2.75	2.57	2.73	1.91
Total	$\overline{X}$	6.13	6.64	6.78	7.01	7.06	6.53
	SD	2.38	1.69	2.47	1.78	2.42	1.71

Table 118 (continued)

WISC Performance of All Subjects - Older Group

Test	Statistic	Q Group I					
		Age 10-12, Yr 1		Age 11-13, Yr 2		Age 10-12, Yr 2	
		A N=22	B N=28	A N=22	B N=16	A N=23	B N=17
		Quotients					
Verbal	$\overline{X}$	81.68	75.78	83.36	77.25	84.52	73.18
	SD	14.22	11.68	16.01	12.01	15.69	11.58
Performance	$\overline{X}$	67.04	80.53	73.64	83.25	76.13	81.18
	SD	18.47	12.16	17.39	12.30	17.21	12.10
Full Scale	$\overline{X}$	72.13	75.92	76.73	78.25	78.65	76.77
	SD	17.39	12.24	17.92	12.89	17.63	12.45

Table 118 (continued)

WISC Performance of All Subjects - Older Group

Test	Statistic	Q Group II					
		Age 10-12,Yr 1		Age 11-13,Yr 2		Age 10-12,Yr 2	
		A N=19	B N=21	A N=25	B N=26	A N=22	B N=23
				Scaled Score			
Information	$\bar{X}$	8.00	5.80	7.80	5.77	8.00	5.91
	SD	2.43	1.78	2.80	1.77	2.47	1.93
Comprehension	$\bar{X}$	4.57	7.09	4.36	5.89	4.45	6.48
	SD	1.50	2.70	2.43	2.41	2.75	2.04
Arithmetic	$\bar{X}$	7.47	5.33	6.44	5.73	5.95	5.39
	SD	3.20	1.96	2.50	1.89	2.70	2.33
Similarities	$\bar{X}$	8.26	8.04	8.96	8.11	8.82	7.52
	SD	2.71	2.87	1.67	1.99	2.11	2.64
Vocabulary	$\bar{X}$	6.68	6.28	5.48	6.31	5.73	6.26
	SD	2.45	2.88	2.18	2.19	2.60	2.62
Digit Span	$\bar{X}$	9.05	5.52	8.56	6.39	7.95	6.48
	SD	2.97	2.52	3.01	1.98	3.18	1.67
Picture Comp.	$\bar{X}$	5.68	7.85	5.32	8.31	4.64	8.74
	SD	2.83	2.80	2.53	2.74	2.17	2.36
Picture Arrang.	$\bar{X}$	5.47	7.42	6.44	7.00	5.00	8.04
	SD	3.39	2.66	3.37	2.79	3.15	3.70
Block Design	$\bar{X}$	6.26	7.80	5.16	8.58	5.14	8.17
	SD	2.51	2.23	2.51	3.00	2.71	2.77
Object Assem.	$\bar{X}$	4.57	8.57	3.44	9.11	3.64	8.96
	SD	2.59	3.49	2.20	2.72	2.40	3.31
Coding	$\bar{X}$	6.36	6.14	6.40	7.35	6.45	7.13
	SD	1.83	2.95	3.20	2.88	3.03	3.36
Mazes	$\bar{X}$	4.47	6.33	5.36	8.46	4.91	7.39
	SD	2.29	2.33	2.56	2.96	2.96	3.39
Total	$\bar{X}$	6.37	6.76	6.15	7.23	5.89	7.22
	SD	1.89	1.85	1.91	1.73	2.07	1.99

Table 118 (continued)

WISC Performance of All Subjects - Older Group

Test	Statistic	Q Group II					
		Age 10-12, Yr 1		Age 11-13, Yr 2		Age 10-12, Yr 2	
		A N=19	B N=21	A N=25	B N=26	A N=22	B N=23
				Quotients			
Verbal	$\overline{X}$	83.15	77.14	80.72	77.35	80.09	77.26
	SD	12.93	12.54	11.92	9.57	13.79	10.33
Performance	$\overline{X}$	68.36	81.66	67.68	87.08	65.05	86.65
	SD	14.04	13.47	15.52	15.11	15.11	17.40
Full Scale	$\overline{X}$	73.78	77.42	72.16	80.19	70.41	79.91
	SD	13.79	13.48	14.07	12.54	15.26	14.47

Table 119

Profile of Mean WISC Subtest Performance of Q Subgroups - Archetypal Younger Subjects

Score	Age 6-9 Yr 1		Age 7-10 Yr 2		Age 7-10 Yr 1		Age 6-9 Yr 1		Age 7-10 Yr 2		Age 7-10 Yr 1	
	QIA	QIB	QIA	QIB	QIA	QIB	QIIA	QIIB	QIIA	QIIB	QIIA	QIIB
Inform.	L		L	H	L						H	L
Comp.	L		L		L		L		L			L
Arith.			L		L		L	L		L		
Simil.	L	H	L	H	L	H	H		L	H	H	L
Vocab.	L		L	H	L		L		L	H		L
D.S.		L			L	H	H	L		L		H
P.C.			H					H		H		H
P.A.	H	L		L	H			H				
B.D.	H	L	H	L				H			L	H
O.A.	H	L	H	L	H	L	L			H	L	H
Coding	H	L	H		H	L	H	L	H	L		
Mazes	H	L	H	L	H					L	L	H
VQ	67	83	64	88	75	77	78	67	76	78	83	67
PQ	97	67	94	70	98	61	78	72	84	78	64	88
FSQ	79	72	76	77	85	66	76	67	78	76	71	74

Note: H = subtest mean ≥ one scaled score point above mean of all subtests for subgroup.

L = subtest mean < one scaled score point below mean of all subtests for subgroup.

Table 120

Profile of Mean WISC Subtest Performance of Q Subgroups - Archetypal Older Subjects

Score	Age 10-12 Yr 1		Age 11-13 Yr 2		Age 10-12 Yr 2		Age 10-12 Yr 1		Age 11-13 Yr 2		Age 10-12 Yr 2	
	QIA	QIB	QIA	QIB	QIA	QIB	QIIA	QIIB	QIIA	QIIB	QIIA	QIIB
Inform.	H			H		L	H	L	H	L	H	L
Comp.	H	L	H	L	H	L	L		L	L	L	L
Arith.				H	L	L	H	L		L		L
Simil.	H	L	H	H	H	H		H	H		H	
Vocab.	H	L	H	L	H	L				L		L
D.S.			L	H	L		H	L	H	L	H	L
P.C.				L		L	L		L	H	L	H
P.A.			H		H			H				H
B.D.	L	H	L	H		H	L		L	H		H
O.A.	L	H	L	H	L	H	L	H	L	H	L	H
Coding	L	H	L	H	L	H					L	
Mazes	L	H	L	H	L	H	L		L	H	L	H
VQ	87	69	93	84	91	75	88	79	82	83	79	84
PQ	61	86	79	89	78	87	66	91	56	107	55	107
FSQ	72	80	85	85	83	79	75	83	67	94	64	94

Note: H = subtest mean ≥ one scaled score point above mean of all subtests for subgroup.
L = subtest mean < one scaled score point below mean of all subtests for subgroup.

Table 121

Profile of WISC Subtest Performance of Q Subgroups - All Younger Children

Score	Age 6-9 Yr 1		Age 7-10 Yr 2		Age 7-10 Yr 1		Age 6-9 Yr 1		Age 7-10 Yr 2		Age 7-10 Yr 1	
	QIA	QIB	QIA	QIB	QIA	QIB	QIIA	QIIB	QIIA	QIIB	QIIA	QIIB
N =	28	37	30	32	30	29	25	30	20	27	31	30
Inform.	L		L	H								
Comp.	L		L				L		L			
Arith.			L		L		L			L	L	
Simil.	L	H	L	H	L	H				H	H	L
Vocab.	L		L					L	L			L
D.S.					L		H		H			
P.C.			H			H				H		
P.A.	H				H			H				
B.D.	H		H				L	H	H			
O.A.	H	L	H	L	H	L				H		
Coding	H	L	H		H	L	H	L	H	L		
Mazes								H			L	H
VQ	70	76	71	78	72	74	77	66	74	73	79	70
PQ	85	68	87	68	81	67	76	70	77	73	71	79
FSQ	75	69	76	71	74	68	74	65	73	70	73	72

Note: H = subtest mean ≥ one scaled score point above mean of all subtests for subgroup.
L = subtest mean < one scaled score point below mean of all subtests for subgroup.

Table 122

Profile of WISC Subtest Performance of Q Subgroups - All Older Children

Score	Age 10-12 Yr 1		Age 11-13 Yr 2		Age 10-12 Yr 2		Age 10-12 Yr 1		Age 11-13 Yr 2		Age 10-12 Yr 2	
	QIA	QIB	QIA	QIB	QIA	QIB	QIIA	QIIB	QIIA	QIIB	QIIA	QIIB
N =	22	28	22	16	23	17	19	21	25	26	22	23
Inform.				L			H	L	H	L	H	L
Compr.		L		L		L	L		L	L	L	
Arith.							H	L		L		L
Simil.	H		H		H		H	H	H		H	
Vocab.		L		L		L						
D.S.		H		H		H	H	L	H		H	
P.C.								H		H	L	H
P.A.					H							
B.D.	L	H	L	H	L	H				H		
O.A.	L	H	L		L	H	L	H	L	H	L	H
Coding				H		H						
Mazes	L		L		L		L			H		
VQ	82	76	83	77	85	73	83	77	81	77	80	77
PQ	67	81	74	83	76	81	68	82	68	82	65	87
FSQ	72	76	77	78	79	75	73	77	72	80	70	80

Note: H = subtest mean ≥ one scaled score point above mean of all subtests for subgroup.
L = subtest mean < one scaled score point below mean of all subtests for subgroup.

Table 123

Average Subtest Performance, All Subjects Combined, Year 1

Subtest	Statistic	Age 6-9 N=120	Age 10-12 N=90
		Scaled Score	
Information	$\bar{X}$	5.74	6.64
	SD	2.55	2.27
Comprehension	$\bar{X}$	5.52	5.82
	SD	2.40	2.44
Arithmetic	$\bar{X}$	5.22	6.13
	SD	2.52	2.83
Similarities	$\bar{X}$	6.07	8.08
	SD	2.93	3.00
Vocabulary	$\bar{X}$	5.26	6.18
	SD	3.04	3.02
Digit Span	$\bar{X}$	5.85	7.13
	SD	2.60	2.72
Picture Comp.	$\bar{X}$	6.65	6.65
	SD	3.09	2.87
Picture Arrang.	$\bar{X}$	6.47	6.42
	SD	3.03	2.98
Block Design	$\bar{X}$	6.53	6.80
	SD	3.08	2.88
Obj. Assembly	$\bar{X}$	5.97	6.48
	SD	3.29	3.43
Coding	$\bar{X}$	5.89	6.44
	SD	3.49	2.79
Mazes	$\bar{X}$	6.15	5.48
	SD	1.75	2.54
Total	$\bar{X}$	5.94	6.49
	SD	2.10	1.94
		Quotient	
VQ	$\bar{X}$	72.49	79.10
	SD	13.19	12.95
PQ	$\bar{X}$	74.19	74.93
	SD	16.93	15.85
FSQ	$\bar{X}$	70.66	74.90
	SD	15.27	14.14

Table 124

Correlations Between Year 1 and Year 2 Q Group Loading

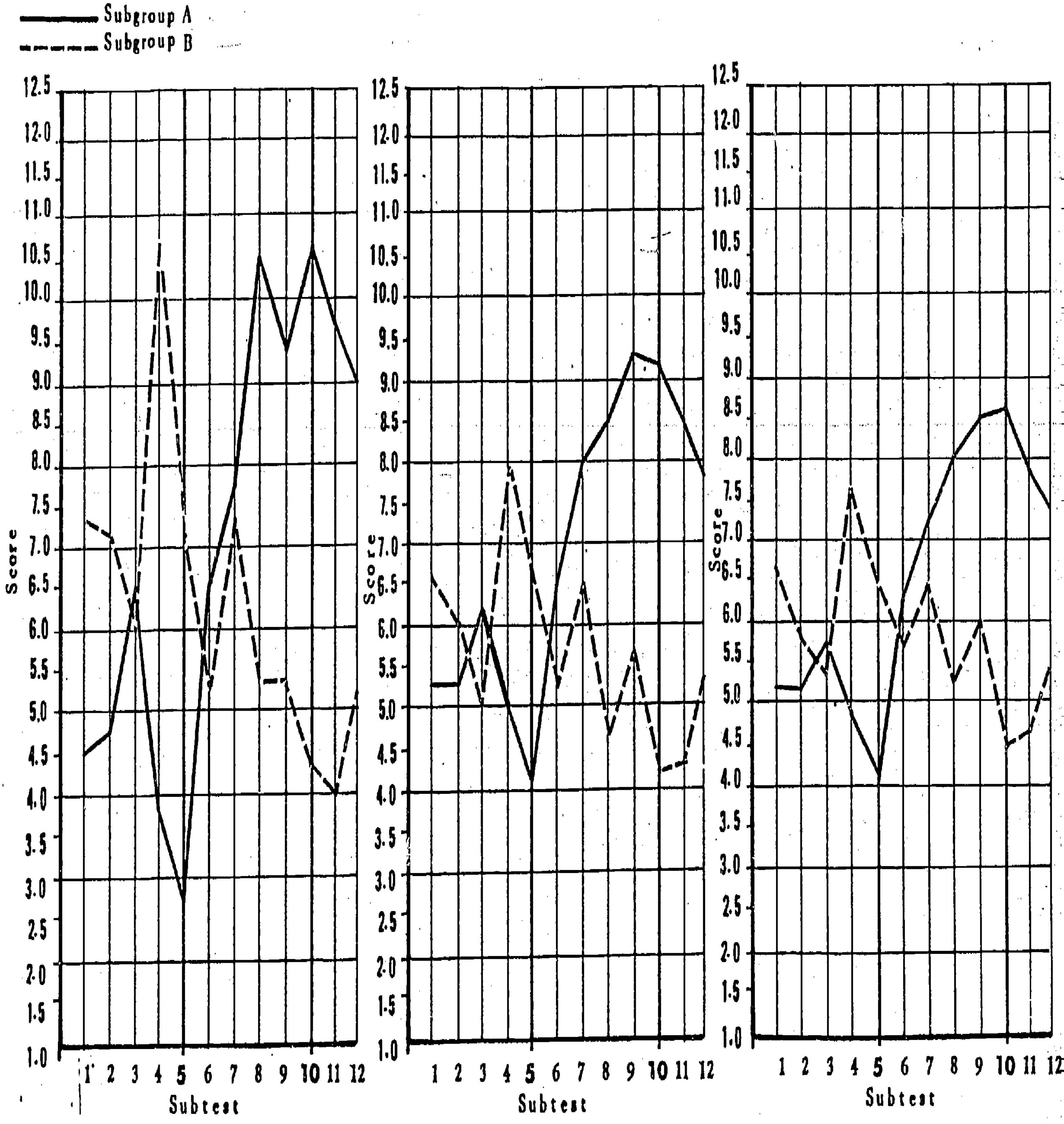
Variable	Group			
	Younger Year 2		Older Year 2	
	QI	QII	QI	QII
QI loading, year 1	.66**	.36**	.67**	-.37**
QII loading, year 1	-.23*	.37**	.01	.76**

* $p < .05$

** $p < .01$

Figure 16

Average WISC subtest performance of QI subgroups ages 6 to 9



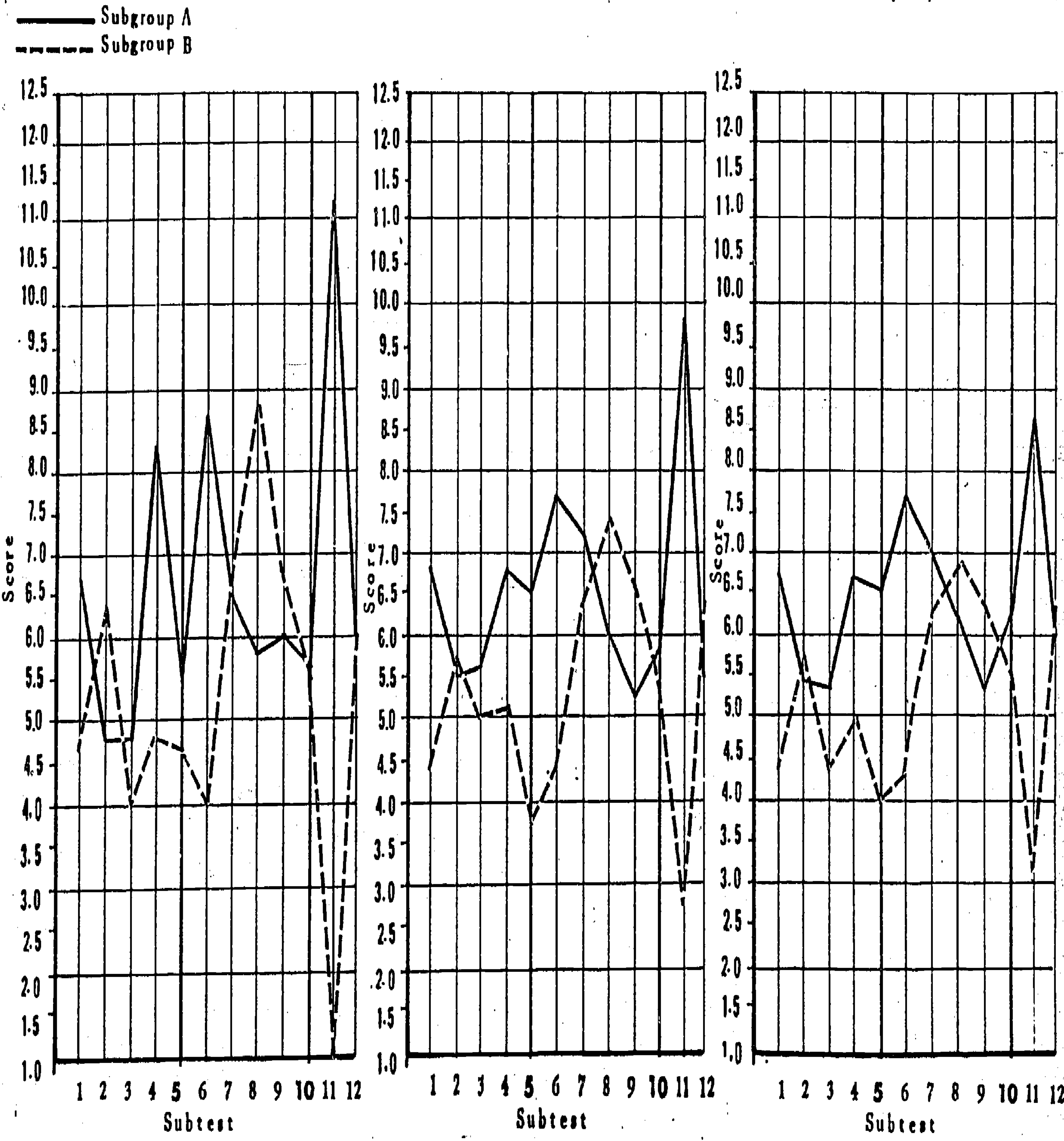
Highest loading subjects (A:N: 6; B:N: 6)

Subjects with loadings ≥.002 (A:N:22; B:N:26)

All subjects in Q group (A:N: 28; B:N:37)

Figure 17

Average WISC subtest performance of QII subgroups ages 6 to 9



Highest loading subjects (A:N=6; B:N=6)

Subjects with loadings ≥.002 (A:N=20; B:N=20)

All subjects in Q group (A:N=25; B:N=30)

Figure 18

Younger archetypal children, mean WISC subtest performance of QI subgroups

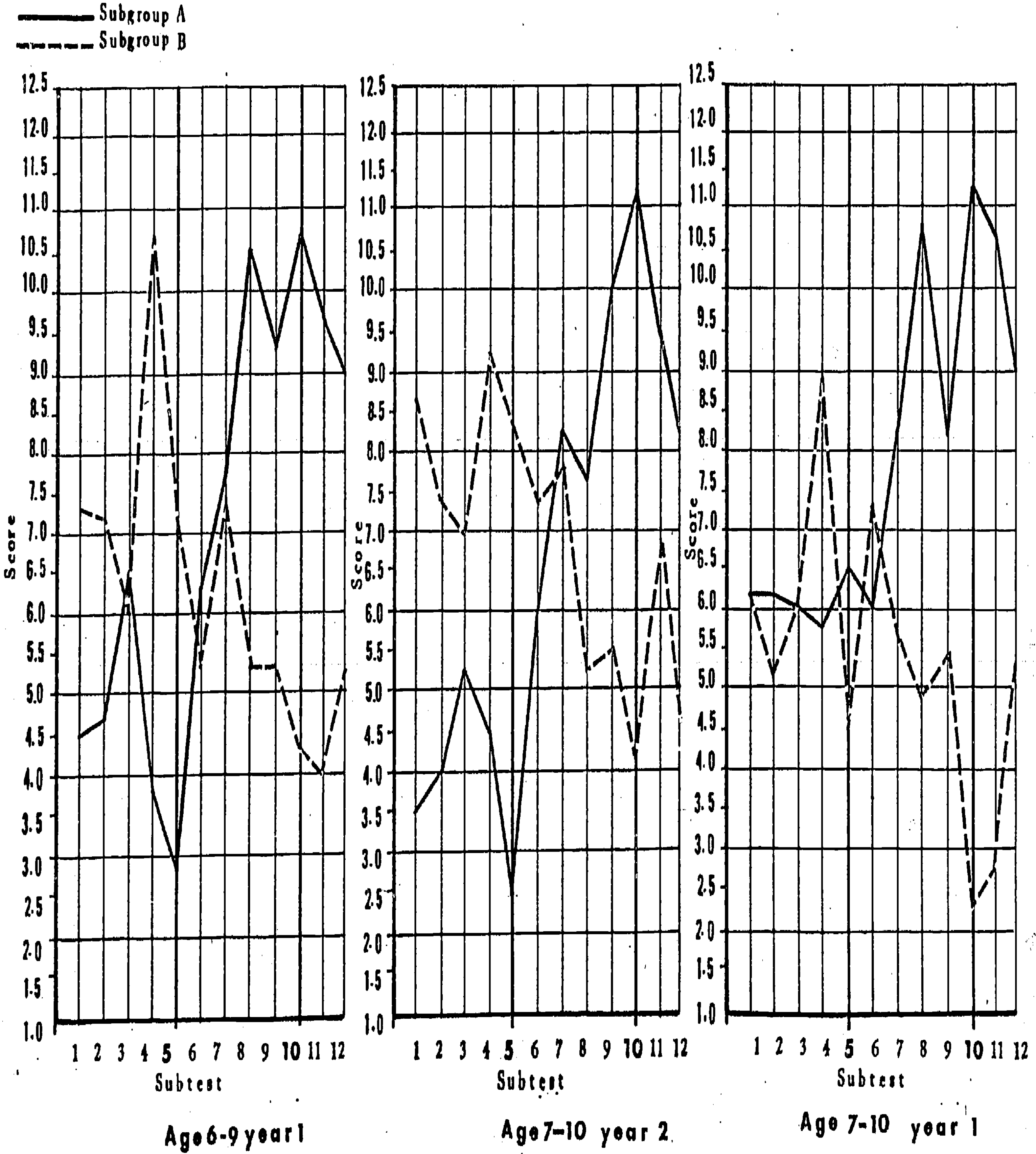
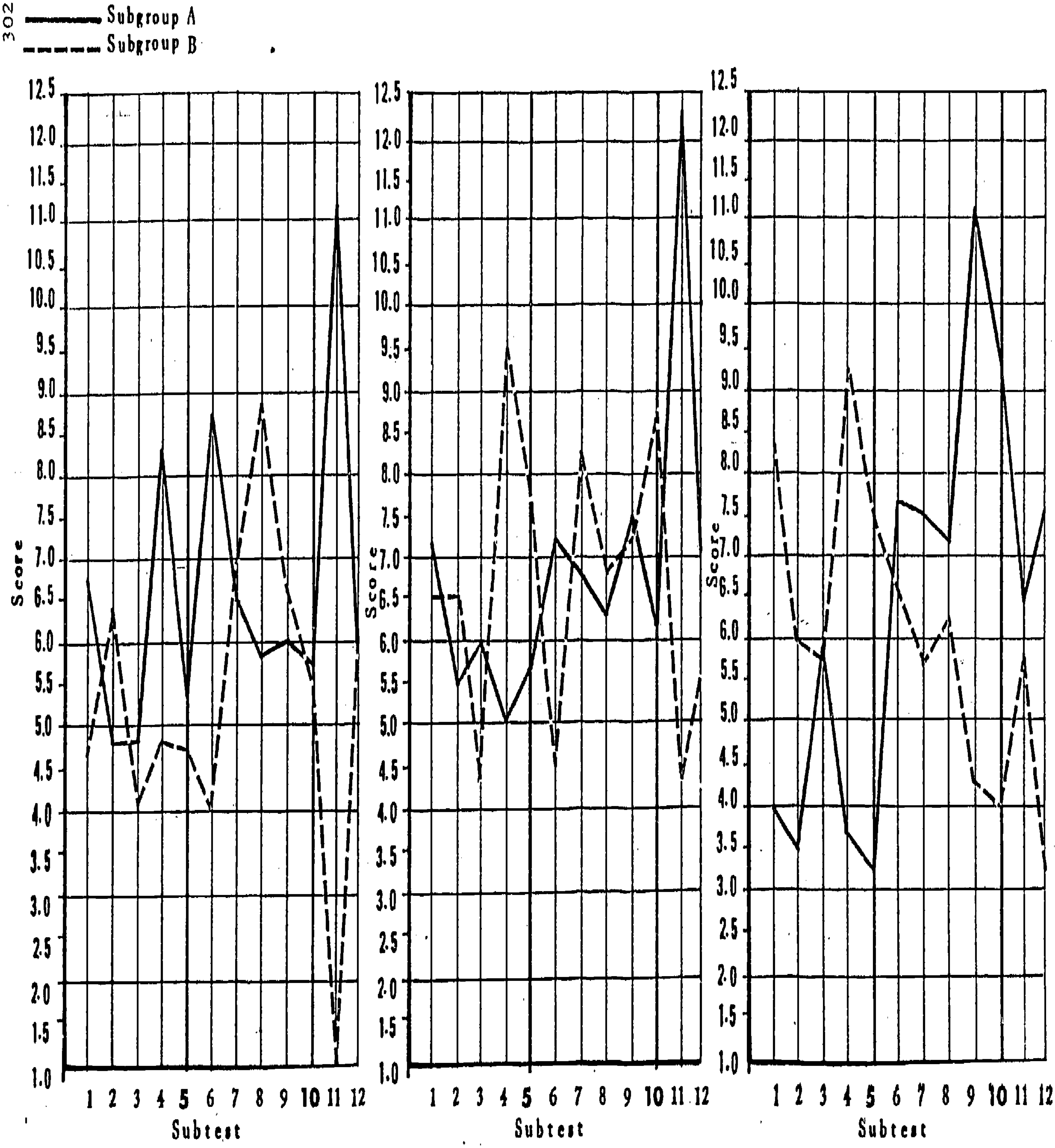


Figure 19

Younger archetypal children, mean WISC subtest performance of QII subgroups



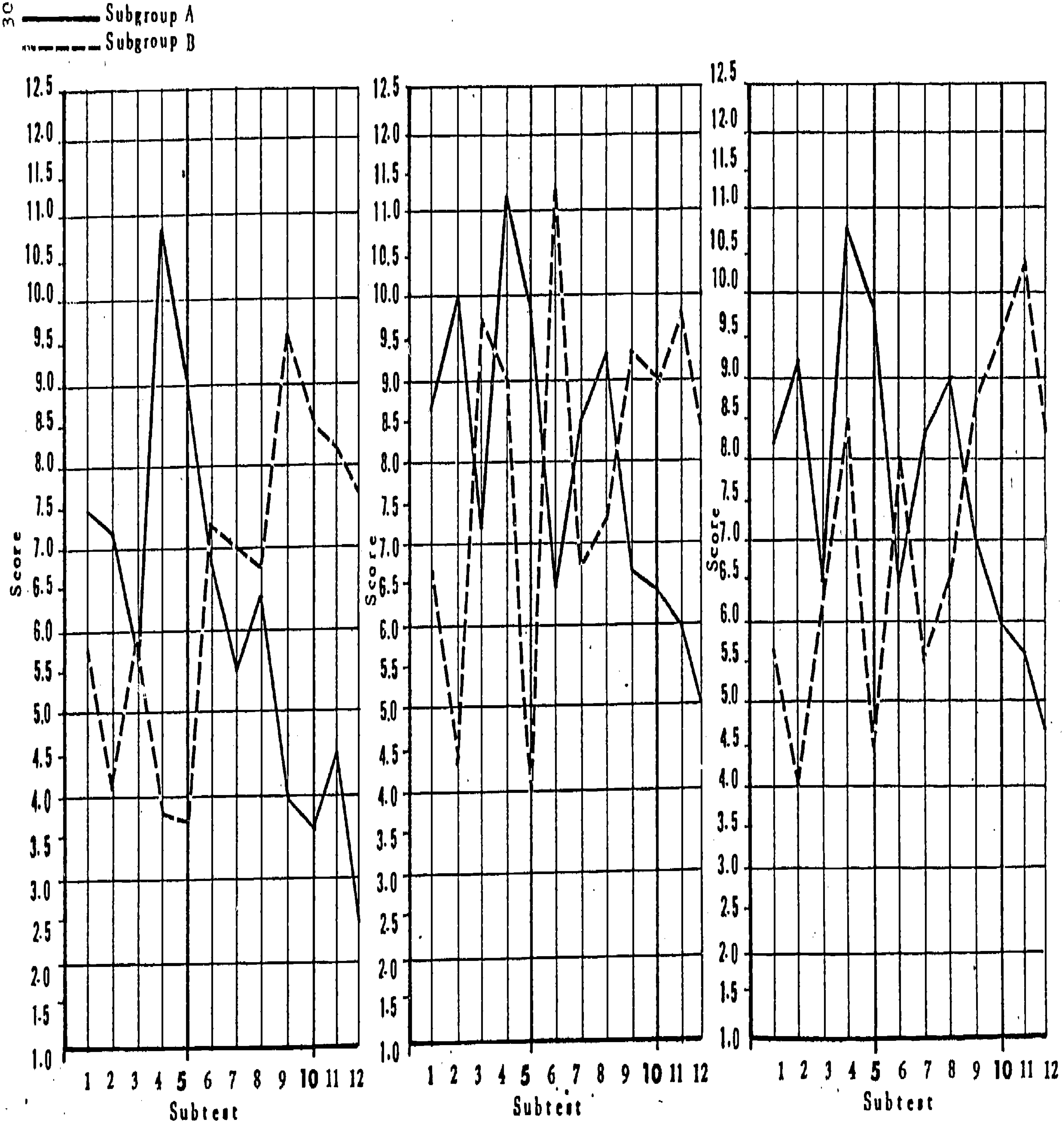
Age 6–9 year 1

Age 7–10 year 2

Age 7–10 year 1

Figure 20

Older archetypal children, mean WISC subtest performance of QI subgroups

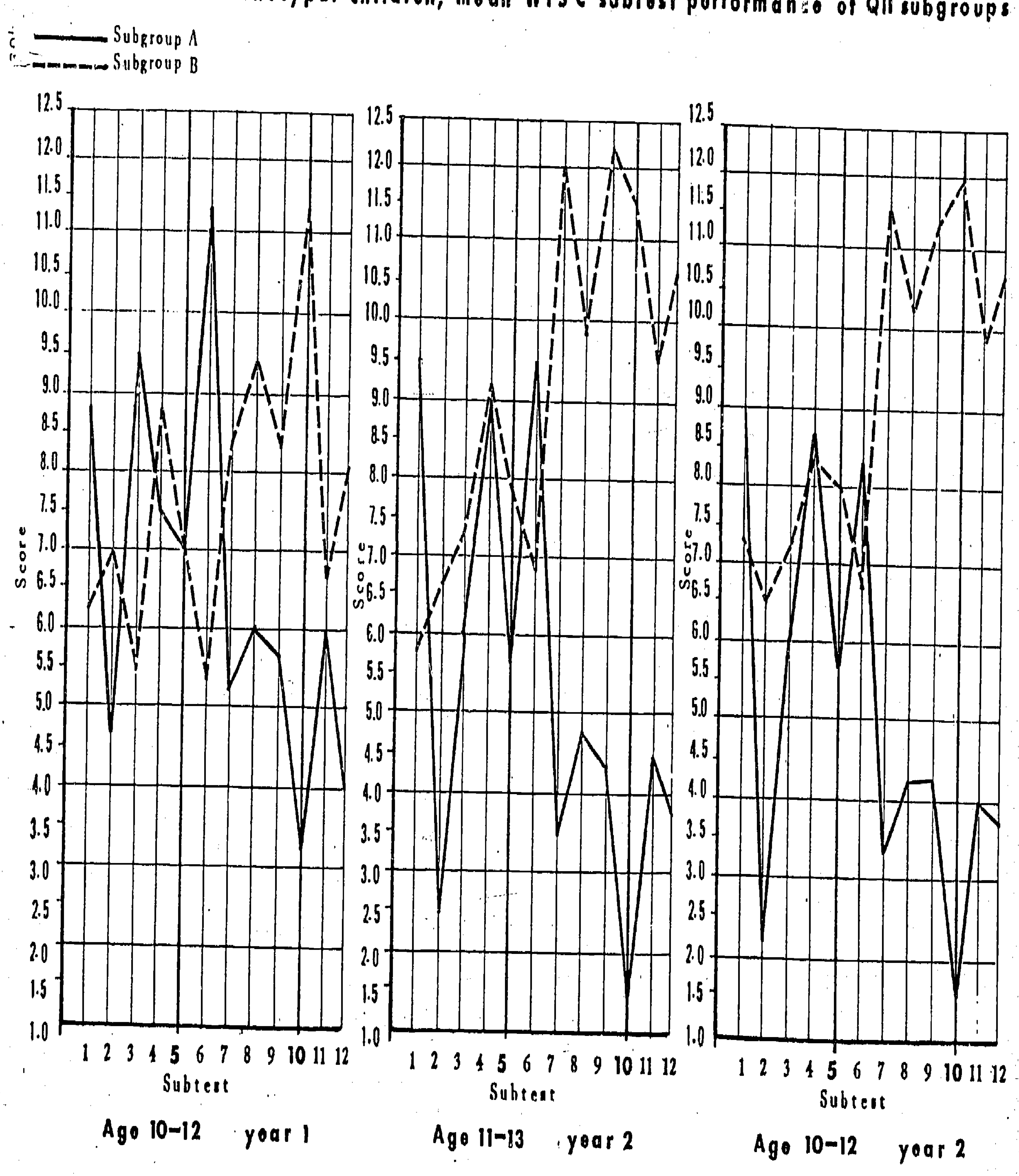


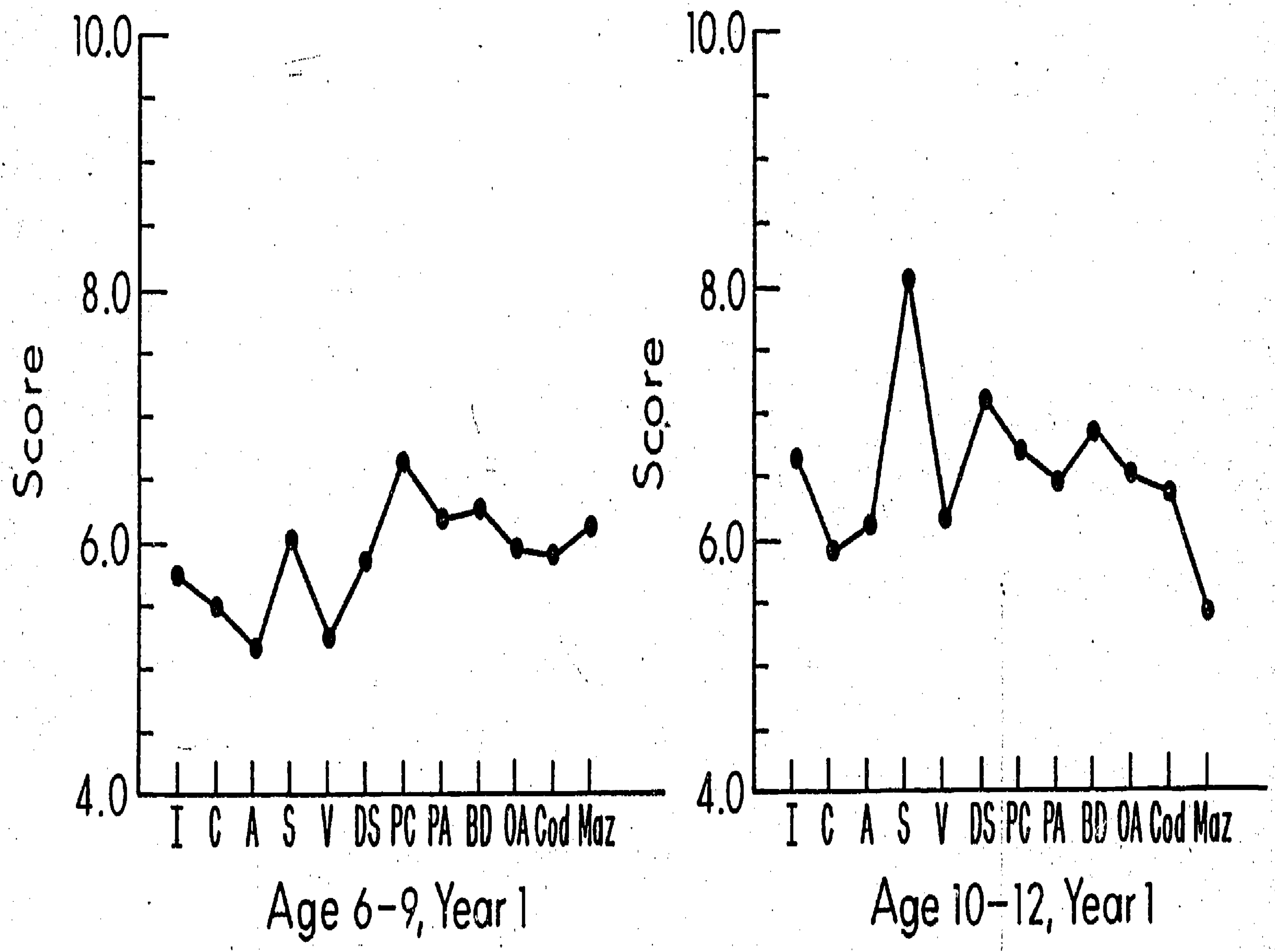
Age 10–12 year 1

Age 11–13 year 2

Age 10–12 year 2

Figure 21


Older archetypal children, mean WISC subtest performance of QII subgroups
Subgroup A
Subgroup B
Score
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
1 2 3 4 5 6 7 8 9 10 11 12
Subtest
Age 10–12 year 1
Age 11–13 year 2
Age 10–12 year 2



Age 6–9, Year 1

Age 10–12, Year 1

Mean WISC Subtest Performance, All Subjects Combined, Year 1

Figure 22

Chapter 11. PMA Patterns of Mental Ability: A Regression Analysis

It has been frequently asserted that the structure of intelligence changes with age. Bayley (1970) in a detailed review of the literature concluded that there are "multiple mental abilities which develop in different ways." However, the work that has been reported has been largely based on studies of normal children. Little, if anything, can be found that deals with this problem through the study of neurologically impaired children.

The present set of data lent itself admirably to such a study. The PMA contains a number of subtests which purport to measure independent aspects of intelligence--verbal, perceptual speed, numerical, spatial and reasoning abilities. If the structure of intelligence does, indeed, change with age, then such changes might be expected to be manifested in the PMA by the differences in subtest patterns that characterize different age levels. Hence, the problem was simply one of determining whether the pattern of test scores on the four subtests of the PMA (since only the oldest children took the Reasoning subtest this was omitted) differed across the age dimension. Since a traditional two-way analysis of variance was not possible due to the number of subjects in the design, it was decided to do an analysis of variance computed through the application of regression procedures with code numbers. Dummy code numbers from a table of orthogonal polynomials were entered to represent each cell in the design on the independent variables. The appropriate orthogonal polynomials were drawn from Kirk (1968) which contains a relevant discussion of analysis of trend. Fifteen independent variables were conceptualized in this fashion. These include a linear, quadratic and cubic term for age; a linear, quadratic and cubic term for the PMA patterns; and finally, and most importantly, the nine interaction terms. It is these latter interaction terms that will determine the presence of pattern differences across age.

Subjects

The subjects included all the children in all four years of the study. In the first year of the study there were thirty children at each age level from 6 years through 12 years. The second, third and fourth years of the study (despite attrition) permitted the development of overlapping cohorts and the repeated testing of all (or almost all of the) children previously tested in the first year. Hence, children who became 9 in the second, third and fourth year of the study could be added to those who were 9 in the first year. In this manner, the size of the N at each age level was greatly increased.

Results

Table 125 shows the mean scores that characterize each age cohort for each subtest of the PMA. The IQ scores range from a low of 65 (Numerical, age 7) to a high of 94 (Spatial, age 15). The scores, in the main, hover in the 70's and 80's and indicate a range of ability in all four areas of function within the borderline to dull-normal levels. It is also apparent that scores in all four areas of function increase steadily with age; that at earlier ages the children function at borderline levels, and that by age 15 years, the intellectual ability of these children has reached into the normal range for three of the four areas of function tested and into dull-normalcy for the fourth area.

Table 126 presents those findings of the regression analysis that are significant. In the top half of the table the significant trends for age and for pattern are shown. It is clear from these results that the factor of age is dominant and that it alone is responsible for more than 68% of the observed variation, and that the age trend is linear, i.e. regardless of the subtest or combination of subtests considered, all scores increase regularly with age. This is shown graphically in Figs. 23 and 24 (which also include the Reasoning subtest). However, significant portions of the variation may also be attributed to a linear, quadratic and cubic trend in the pattern of the subtests regardless of age. That is, there is a general tendency for scores in the spatial and numerical areas of function to be lower than those in the perceptual speed and verbal areas.

In the lower half of Table 126 the interactions that proved to be significant are presented. A linear trend for age interacted significantly with a linear trend for pattern, but this accounted for only 2% of the observed variation and while statistically significant does not appear to be psychologically meaningful. The same appears to hold for the three other significant interactions reported. In fact, as can be seen from this table the combined effect of all four significant interactions does not account for more than 5% of the observed variation. Hence, it must be inferred that while there is an overwhelming age trend, and while there are certain general trends in the overall patterning of subtests, there are not patterns of subtest scores that characterize particular age groupings. That is, despite the frequently reported findings (Honzik, Macfarlane and Allen, 1948; Sontag, Baker and Nelson, 1958; Bayley, 1949) that large IQ shifts occur with increasing age in normal children, the present findings failed to identify any systematic changes, i.e. age-specific patterns in children with brain damage. Fig. 25 illustrates the relative proportions of variation attributable to age, pattern and interactions of age and pattern.

Table 125

PMA Subtest Scores For Age Cohorts

		Age									
Subtest		6	7	8	9	10	11	12	13	14	15
Verbal	N	30	58	84	110	105	105	111	82	46	20
	$\bar{x}$	73.77	76.36	80.66	84.79	85.86	89.97	91.33	86.19	87.63	92.65
	S.D.	15.14	19.85	20.18	17.15	16.90	15.17	13.90	17.56	17.13	15.14
Perceptual	N	30	58	84	110	105	105	111	82	46	20
	$\bar{x}$	77.73	76.75	76.19	82.45	86.23	87.19	89.15	86.19	87.63	92.65
	S.D.	18.16	20.15	19.35	19.19	18.51	17.62	16.26	17.56	17.71	15.14
Numerical	N	30	58	84	110	105	105	111	85	57	23
	$\bar{x}$	68.27	65.06	67.02	70.29	73.81	78.28	81.55	80.42	84.14	86.95
	S.D.	14.07	14.05	14.22	16.05	17.02	17.38	17.46	15.57	16.30	17.56
Spatial	N	30	58	84	110	105	105	111	85	57	23
	$\bar{x}$	68.30	70.75	72.17	77.47	79.38	84.61	87.30	88.00	92.61	94.13
	S.D.	16.70	20.26	21.00	19.94	21.11	20.14	19.20	20.36	18.67	21.11

Table 126

PMA Test:

Regression Analysis for Pattern Differences

Independent Variable	F Value	% F Variation
Linear (Age)	$F_{1,38} = 82.7^*$	68.5%
Linear (Pattern)	$F_{1,35} = 14.1^*$	8.7%
Quadratic (Pattern)	$F_{1,34} = 10.6^*$	5.2%
Cubic (Pattern)	$F_{1,33} = 39.1^*$	9.0%
		91.4%

Pattern Differences Across Age

Linear (Age) x Linear (Pattern)	$F_{1,32} = 12.0^*$	2.1%
Linear (Age) x Quadratic (Pattern)	$F_{1,31} = 4.8^*$	0.7%
Quadratic (Age) x Linear (Pattern)	$F_{1,29} = 6.7^*$	0.8%
Quadratic (Age) x Quadratic (Pattern)	$F_{1,28} = 4.7^*$	0.5%
		5.1%

* $p < .01$ ≃ 96.5%

Age trend of PMA scores: Semi-longitudinal data

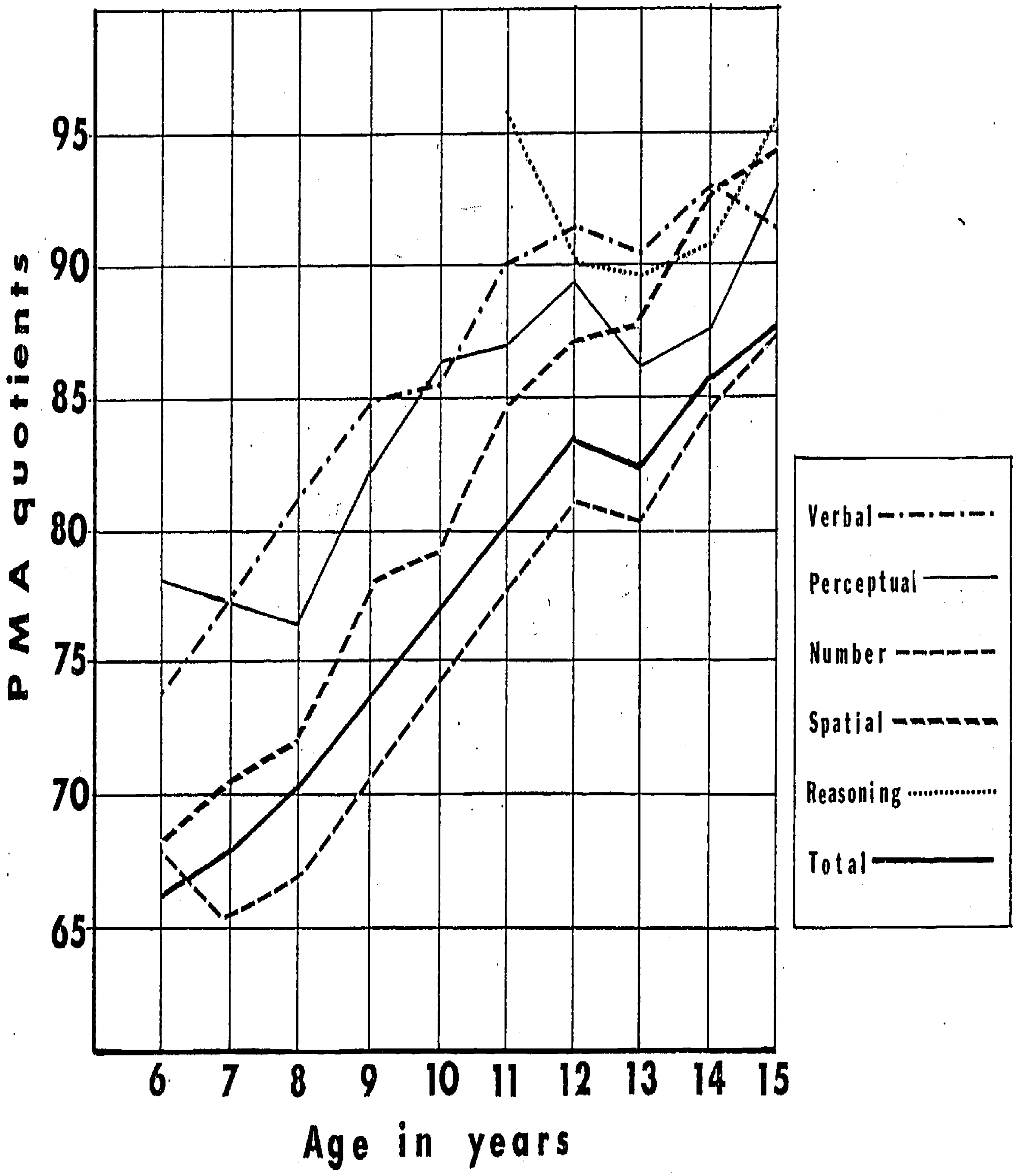
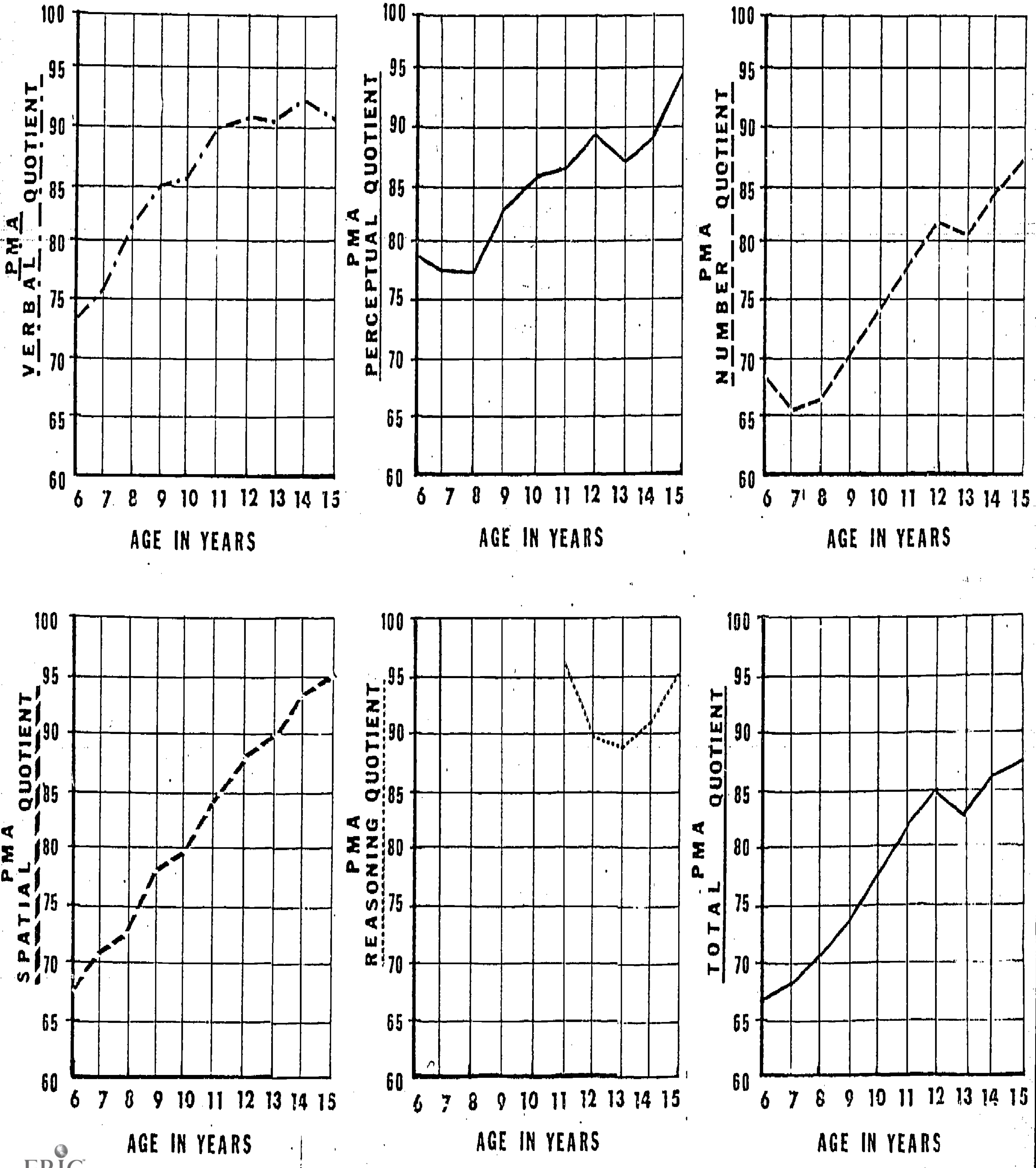
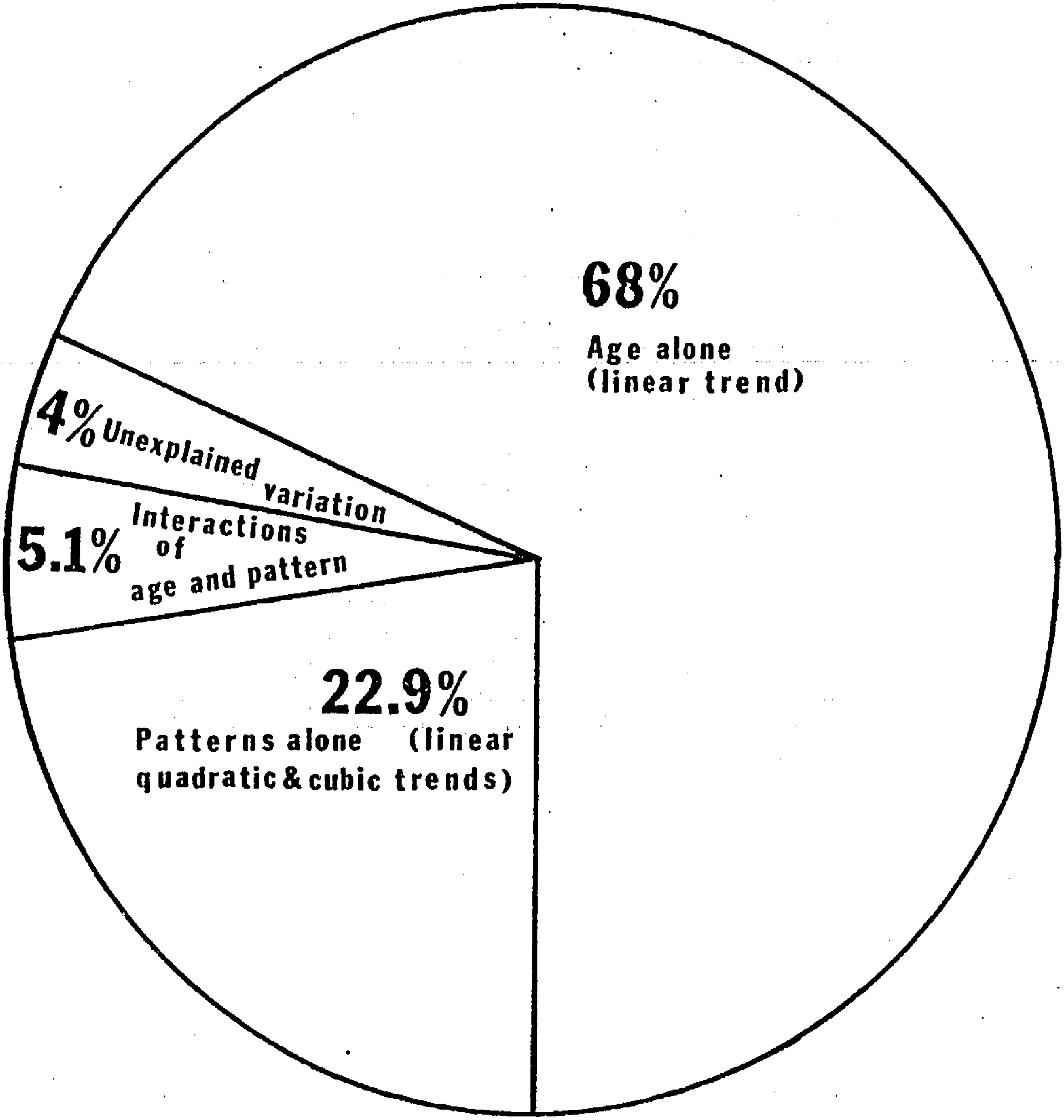


Figure 23

Figure 24

Age trend of PMA scores Semi-longitudinal data





Amount of variation accounted for by age, patterns and interactions in the PMA.

Figure 25

Chapter 12. Patterns of Ability and Behavioral Status on a Classroom-Specific Basis

The formation of self-contained classrooms for brain damaged children was initially based on the assumption that medical data was relevant to the educational concern with grouping students. Recent discussion has tended to discount the role of medical homogeneity, and suggests that such medical criteria are irrelevant to the educational purposes and goals of school classrooms (Birch and Bortner, 1968; Gallagher, 1960; Goldstein, 1956). In the attempt to identify those criteria which would enable educational interests to be more effectively realized, several workers have sought to identify differing patterns of mental abilities and educational performance within retarded and brain damaged populations (Bortner and Birch, 1962, 1970; Feldman, 1953; Baumeister and Bartlett, 1962a, b). Underlying this work was the clear suggestion that the classroom homogeneity achieved primarily on the medical model could be expected to result in heterogeneity on other more educationally significant variables. However, empirical data is needed to determine the extent to which such homogeneity and heterogeneity of mental abilities, academic achievement and behavioral status exist. The purpose of this study, then, was to examine the composition (with respect to the homogeneity-heterogeneity issue) of classrooms for brain damaged children on selected measures of cognitive and behavioral status. Moreover, the study of classroom composition may be viewed as an extension of or next step in the concern with patterns of abilities. The realities of special class placement suggest that it may be advantageous to organize data along classroom-specific lines. Ultimately, such information can serve as a context within which to study instructional variables and teacher behaviors. This study, then, reports on a classroom-specific analysis of several educationally relevant variables including the child's reading achievement, intelligence, and behavioral status as rated by the teacher.

Method

Sample

The classroom data examined in this study were collected during the first two years of the parent four-year longitudinal study of brain damaged children. The sample consisted of 22 classrooms (6 to 8 pupils each; 6 to 11 years of age) from year one, and the same 20 classrooms a year later. Assignment to a particular class was based on the attempt to keep children of similar reading level together. Thus, teachers, administrators and related personnel jointly participated in the decision-making process of classroom assignment. It is important to note that a conscious attempt was also made to make the classrooms viable (homogeneous?) by not bringing those children together who were greatly different from each other either in physical size or in behavioral attributes.

Instruments

The cognitive measures consisted of the grade equivalent scores for Word Knowledge (K), Word Discrimination (D), and Reading (R) from the Metropolitan Achievement Test (MAT): the Verbal (V) and Performance (P) quotients of the Wechsler Intelligence Scale for Children (WISC), and the Verbal Meaning (V), Perceptual Speed (P), Number (N), and Spatial (S) quotients of the SRA Primary Mental Abilities Test (PMA). Analyses of the same set of measures for the 20 classrooms from year two were intended to provide an index of cross-validation. Behavioral descriptions from two teacher-rated behavior checklists were available for year two only. The Rutter (RUT) provides a teacher-rated assessment of the child's classroom behavior and yields scores in the following areas of problem behavior: Neurotic (N), Anti-Social (AS), and Total (T) problem behavior (Rutter, 1967). The Quay (QUA) is a factor analytically derived rating scale similar to the RUT that assesses frequently occurring problem behavior traits in children and adolescents (Quay and Peterson, 1967; Quay, 1963; Quay, Morse and Cutler, 1966). The dimensions of the problem behavior measured by the Quay checklist include: Conduct (C) disorder (psychopathy, unsocialized aggression), Personality (P) disorder (neuroticism, anxious-withdrawn), Inadequacy (I) disorder (immaturity), and a score reflecting Total (T) behavior problems.

Analyses

Two related empirical procedures were employed to examine the composition of the special classrooms. Each procedure was based on the conceptualization of the homogeneity-heterogeneity issue in terms of within- and between-class variation. If each classroom represents a homogeneous group with respect to a particular variable, there should be very large differences between the means of the classrooms, while the range of differences within the classrooms should be very small and uniform. This statement was summarized statistically and initially examined as follows: (a) the standard deviation of a set of classroom means (SD_m) should exceed the mean of the classroom standard deviations (M_{sd}), and (b) the standard deviation of the classroom standard deviations (SD_{sd}) should approximate zero. Any departure from the above would indicate that the classrooms tend toward heterogeneity

(Smith, 1974). Second, in order to describe classroom composition more clearly, an index, $SD_m^2 / (SD_m^2 + M_{sd}^2)$ was defined and employed as an estimate of the proportion of total variance attributable to between-class differences, while its reciprocal, $M_{sd}^2 / (SD_m^2 + M_{sd}^2)$ provided an estimate of the proportion of total variance due to within-class differences. The obtained proportions were then plotted for each variable in the study. Classrooms were interpreted to be generally homogeneous on variables exceeding 70% for between-class differences, and generally heterogeneous on variables exceeding 70% for within-class differences.

Results

The mean (M) and standard deviation (SD) of the classroom means (m) and standard deviations (sd) for each of the variables for year one and two are presented in Table 127. Examination of the pattern of relationships among the values demonstrates that the classrooms do indeed tend toward homogeneity on the cognitive (achievement) behaviors measured by the MAT. Regarding the MAT-K, for example, the standard deviations of the classroom means (SD_m) for years one and two were 1.0 and 1.2. These values, of course, exceed .5 and .6, the mean classroom standard deviations (M_{sd}) for each year. In addition, the

Table 127

Descriptive Statistics For Classroom Measures

Measure	Year One[a]		Year Two[b]		Measure	Year One[a]		Year Two[b]	
	M[c]	SD[d]	M[c]	SD[d]		M[c]	SD[d]	M[c]	SD[d]
WISC(V)m	79.5	8.4	80.7	8.9	MAT(D)sd	.6	.2	.6	.2
WISC(V)sd	8.6	2.4	8.3	2.7	MAT(R)m	2.6	1.0	3.6	1.2
WISC(P)m	78.6	8.6	80.5	10.0	MAT(R)sd	.4	.2	.6	.3
WISC(P)sd	11.9	4.2	13.2	4.3	RUT(AS)m	-	-	2.5	1.7
PMA(V)m	78.1	6.5	93.8	7.8	RUT(AS)sd	-	-	2.3	1.3
PMA(V)sd	13.6	5.1	12.6	5.8	RUT(N)m	-	-	1.6	1.1
PMA(P)m	87.3	7.7	91.7	9.5	RUT(N)sd	-	-	1.5	.6
PMA(P)sd	14.1	4.1	13.2	4.3	RUT(T)m	-	-	9.6	5.6
PMA(N)m	78.1	9.1	81.4	12.0	RUT(T)sd	-	-	4.9	2.4
PMA(N)sd	11.0	3.8	11.1	5.4	QUA(C)m	-	-	5.7	3.1
PMA(S)m	85.5	8.4	88.9	10.7	QUA(C)sd	-	-	4.2	1.4
PMA(S)sd	15.7	3.7	15.3	3.5	QUA(P)m	-	-	5.2	2.8
MAT(K)m	2.8	1.0	3.5	1.2	QUA(P)sd	-	-	2.7	.9
MAT(K)sd	.5	.2	.6	.2	QUA(I)m	-	-	2.1	1.5
MAT(D)m	3.0	1.1	3.5	1.0	QUA(I)sd	-	-	1.4	.6

[a] Data based on an N of 22 classrooms.

[b] Data based on an N of 20 classrooms.

[c] Mean of the classroom means (m) and mean of the classroom standard deviations (sd).

[d] Standard deviation of the classroom means (m) and standard deviation of the classroom standard deviations (sd).

standard deviation of the classroom standard deviations (SD_{sd}) is .2 for each year and does approximate zero. However, on the other measures of cognitive status (intelligence) as well as on the ratings of behavioral status, the classrooms exhibit considerable heterogeneity. For example, on the PMA (V), the SD_m's for year one and two were 6.5 and 7.8 while the M_{sd}'s were 13.6 and 12.6, just the opposite of what would be expected under homogeneity. At the same time, the SD_{sd}'s for each year were 5.1 and 5.8 which certainly do not approximate zero. A picture of classroom composition was then obtained by plotting estimates of the proportions of within- and between-class variance for both years (see Figure 26). The graph visually depicts the classrooms to be generally homogeneous (more than 70% variation between-classes) on the MAT measures and moderately (approximately 50% variation between-classes and 50% within-classes) to markedly (more than 70% variation within-classes) heterogeneous on the PMA, WISC, RUT, and QUA. Furthermore, where the same measures are available for both years, the data indicate very little change in classroom structure.

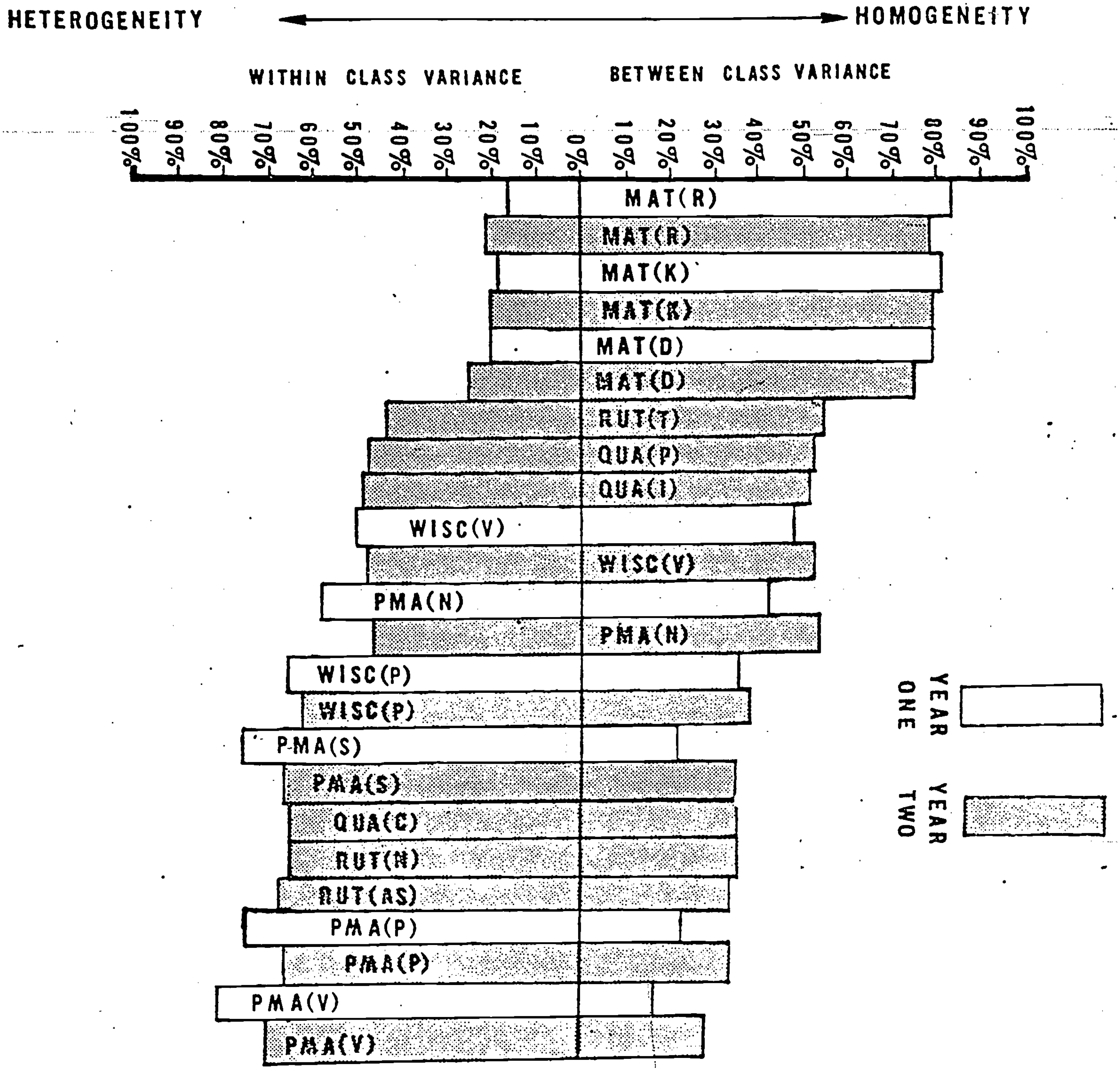


Fig. 26

Classroom composition based on the percentage of within-and between-class variance for year one and year two

Discussion

The results demonstrate that the composition of this sample of classrooms for brain damaged children varies considerably depending on the specific type of cognitive and behavioral variables being considered. This suggests that when classroom homogeneity is based primarily either on the medical model or on certain types of achievement, a similar homogeneity is not necessarily obtained on other equally important educational variables. It would appear, then, that the terms "homogeneity" and "heterogeneity" *per se* have little educational meaning without additional qualification as to the exact basis of their application. The present findings also suggest that studies of the efficacy of grouping procedures based on "homogeneity" may be difficult to interpret since the results are likely to be a function of both homogeneity on the variables specifically employed in the study and unspecified heterogeneity on other unknown and uncontrolled variables whose influence is unknown (cf. Esposito, 1973).

The results obtained here are remarkably identical to data reported on both regular and self-contained educable mentally retarded classrooms employing analogous types of cognitive variables (Lohnes, 1972; Smith, 1974). Moreover, these comparisons suggest that classrooms for brain damaged children evidence the same extent of individual differences found in other types of classrooms, albeit at different levels of cognitive performance. Of course, a more complete statement regarding such comparisons should be based on samples of regular and special classes from the same schools or locations.

For the practitioner, these results suggest that the teacher of brain damaged children probably faces the same range of individual differences (cognitive and behavioral) as teachers of other kinds of classrooms. The foregoing statements recognize the need for empirical documentation of the actual phenomenological conditions of classroom similarity and diversity. Once such descriptive data have been secured, investigation of the teacher behaviors and instructional variables that optimize learning under conditions of varying classroom composition would be feasible.

In this connection, current attempts at mainstreaming exceptional students can be conceptualized in terms of their effect on classroom composition. Such procedures are commonly expected to produce even greater heterogeneity than exists under present conditions. The methodology employed in this study could be used in a before-and-after type design to document the actual effects that various mainstreaming approaches have on the cognitive and behavioral composition of the classrooms into which these students are integrated.

Section IV: Growth and Prediction

Chapter 13. Predictive Value of IQ Scores for Growth in Academic Achievement

The predictive value of intelligence data for academic achievement is characteristically reported as high. However, these relationships are invariably based upon omnibus IQs without reference to the components of intelligence such as may be provided by the Verbal and Performance portions of the WISC or the various subtests of the PMA. Certainly, some components of intelligence are more closely related to achievement than are other aspects.

Frequently, the reports are based upon a simple correlation between level of performance on an intelligence test and level of performance on an achievement test at a given point in time. Of course, such studies cannot deal with the important issue of how much progress is represented in a given achievement score over the previous year's achievement score. Attempts to deal with this issue inevitably bog down in the muddy waters of measuring change. None of the statistical procedures presently available are accepted by all concerned with the issue. In fact, Cronbach seriously questions whether we should even attempt to measure "change."

The following study is concerned with the relationship of aspects of intelligence to aspects of academic achievement. More specifically, it is concerned with the relationship of the verbal and performance aspects of intelligence to reading and arithmetic achievement. In addition, it was possible to relate the results of individual PMA subtests with reading and arithmetic achievement. Finally, since these children had been re-tested in academic achievement over a four year period, it was possible to relate intelligence components with the academic progress made from year one to year two, year two to year three, and year three to year four.

Methodology

A procedure suggested by Cronbach and Furby (1970) was employed to determine whether brighter *S*'s, as measured by the WISC and PMA subtests demonstrate greater yearly change (growth) than less bright *S*'s in MAT reading and arithmetic achievement.

The procedure requires the examination of the correlation (ρ) between the "true" difference (D_{∞}) of two measures ($Y_{\infty} - X_{\infty}$) with an independent variable, say, I. Thus, the issue of change or growth is examined *without* estimating change scores for individuals. The latter approach is unsuitable primarily because such scores are systematically related to any errors of measurement. See Cronbach and Furby (1970) for a more complete discussion of this issue.

In this particular study, D_{cs}, was defined as the difference between MAT reading or arithmetic achievement over adjacent pairs of years during which the study was conducted; that is, differences in achievement between year two and year one, year three and year two, and finally, year four and year three. The I's correlated with each D_{cs} was defined as either the verbal or performance sub-scale of the WISC or the perceptual, numerical, spatial, or reasoning subtests of the PMA. The I's collected during year one of the study were correlated with the D_{cs}'s between year two and year one, year three and two, and finally year four and three. I's collected during year two were correlated with D 's between year three and two, and year four and three. And finally, I's from year three were related to D_{cs}'s between year four and three.

The correlations were obtained directly from the co-variances of the achievement measures with each of the I's of interest. This co-variance takes the form

[1] $$\sigma_{D_{cs}I} = \sigma_{YI} - \sigma_{XI},$$ [1]

---

[1] The co-variances were not provided by program output, but were generated from the available correlational matrix as follows:

$$\sigma_{YI} = \rho_{YI}\,\sigma_{Y}\,\sigma_{I}, \text{ and}$$

$$\sigma_{XI} = \rho_{XI}\,\sigma_{X}\,\sigma_{I}.$$

where Y represents, say, MAT reading collected during year two, X represents, say, MAT reading collected during year one, and I, say, represents WISC (V) collected during year one.

To obtain the correlation coefficient ($\rho_{D_{cs}I}$), $\sigma_{D_{cs}I}$ is divided by $\sigma_{D_{cs}}$ and σ_I, where

[2] $$\sigma_{D_{cs}} = \sigma_X^2 + \sigma_Y^2 - 2\sigma_X\sigma_Y\rho_{XY}$$

A positive correlation (ρ) would suggest that brighter S's gain in achievement at a faster rate than do less bright S's for the adjacent pair of years being examined. A negative correlation would suggest that the brighter S's have already mastered the level of achievement being tapped by the test that the less bright S's have yet to master. This means that the less bright S's may make larger gains over the pair of years being examined--gains that the brighter S's have previously made. At the same time, the absolute value reflects the magnitude of the change or growth.

Positive and negative elements are also likely to be a function of any "ceiling" effect on the achievement tests under consideration. That is, a test that is difficult or one that permits a great range of achievement to be demonstrated will be more likely to generate positive values because it possesses the potential for permitting the brighter *S*'s to show achievement or gain. On the other hand, a relatively easy test or one with a restriction in the level of conceptual achievement it taps will be more likely to permit growth by the less able *S*'s resulting in negative relationships.

Results

Table 128 contains the correlations (ρ) between each of the independent (I) or predictor measures with the difference (D_{cs}) in achievement in reading and arithmetic computation over the pairs of years of the study.

The overall results suggest that reading growth is somewhat more predictable in an absolute sense than is growth in arithmetic achievement as measured by the two MAT subtests. There are 16 significant ρ's involving reading achievement whereas there are only 7 involving arithmetic computational achievement. Since *all* correlations involving reading achievement are positive, it would appear that the brighter *S*'s as defined by specific I measures do show greater growth in this area of achievement than their less bright counterparts. The best predictors, not surprisingly, appear to be either one or a combination of the following three: PMA (R), PMA (V) and WISC (V). There is also some indication that one I measure, in particular, the PMA (R) subtest collected during the first year of the study will predict _subsequent_ growth in MAT reading achievement from year two to three as well as from three to four about as well as the _same_ measure collected during those later years. This suggests considerable _stability_ in the differential growth pattern favoring the brighter _S_'s on this particular measure of achievement.

However, the occurrence of _both_ positive and negative correlations in the case of MAT arithmetic computation achievement suggests that growth favoring brighter _S_'s during one pair of years being examined is followed by greater growth by the less able _S_'s during the following pair of years. That is to say, growth in arithmetic computation achievement does not appear to be as stable as reading achievement for _either_ the brighter or less bright _S_'s.

Table 128

Correlations (ρ) Between Independent Measures (I) and Growth or Differences (D_{cg}) in MAT Reading and Arithmetic Computation Achievement

	Independent Measure (I)	Differences (D_{cg})					
		MAT Reading			MAT Arithmetic Computation		
		Yr 2-Yr 1	Yr 3-Yr 2	Yr 4-Yr 3	Yr 2-Yr 1	Yr 3-Yr 2	Yr 4-Yr 3
Year One	WISC(V)	.30*	.44*	.23	.36*	-.10	-.06
	WISC(P)	.03	.38*	.07	.41*	-.18	.28*
	PMA(V)	.16	.39*	.13	.24	-.33*	.08
	PMA(P)	.20	.21	.13	.16	-.16	.04
	PMA(N)	.24	.30*	.03	.42*	-.04	-.04
	PMA(S)	.13	.31*	.06	.18	-.01	.11
	PMA(R)	.02	.63*	.52*	.13	.19	-.03
Year Two	WISC(V)		.32*	.23		.09	-.23
	WISC(P)		.17	.12		-.08	.10
	PMA(V)		.57*	.12		-.44*	.02
	PMA(P)		.25	.21		.58*	.11
	PMA(N)		.20	.27*		-.07	.06
	PMA(S)		.29*	.07		-.06	.05
	PMA(R)		.42*	.29*		.04	.03
Year Three	WISC(V)			.22			-.08
	WISC(P)			.12			.09
	PMA(V)			.27*			.03
	PMA(P)			.18			.10
	PMA(N)			.08			.07
	PMA(S)			.07			.13
	PMA(R)			.64*			.03

Note. The sample size (N) for the variables involved in the above correlations varied considerably from 210 for the WISC (V) and (P) during year one down to 40 for MAT Arithmetic Computation for year one. In order to insure conservative estimates of the significance of the ρ's, values were tabled based on a sample size of 40, the smallest N for any variable.

Chapter 14. Prediction of Reading Abilities

The prediction of reading achievement was the concern of the following statistical analysis. The specific question raised was which of three sets of independent variables is the best predictor of a set of criterion measures or, to what extent can reading achievement be accounted for by a series of independent measures.

The criterion measure was reading achievement. It was defined as the set of Metropolitan Achievement Test (MAT) grade equivalent scores in reading and word knowledge from the fourth year of data collection. The sets of independent or predictor variables consisted of cognitive, demographic and affective measures obtained in the second year of data collection. The set of cognitive variables was defined as WISC verbal, WISC performance and Draw-A-Man scores. The set of demographic variables was defined as sex, age and socio-economic-status (SES). The set of affective variables was defined as scores obtained on the Rutter Behavioral Checklist (anti-social and neurotic categories) and the Quay Behavioral Checklist (conduct, personality and immaturity categories).

A stepwise multiple regression and canonical correlation analysis was used to look at the relationships among the above sets of measures. These analyses are multivariate techniques which permit the examination of multiple measures of a given number of individuals.

Any number of regression models can be used when attempting to account for achievement in reading. In the present investigation the following regression models were used. (See regression models 1 and 2 on p. 336).

In multiple regression analysis, many independent variables are used to predict a dependent variable. The method and calculations are done in a manner to give the "best" prediction possible, given the correlations among all the variables. The result of the calculations yield a value which tells how "good" the prediction is and approximately how much of the variance of the criterion measure (in this case reading achievement) is accounted for by the "best" linear combination of the independent variables (intelligence, demographic and affective measures).

The regression analysis of data containing more than one dependent measure as well as several independent measures is called canonical correlation analysis. In canonical correlation, a linear composite for the independent variables and a linear composite for the dependent variables are formed. The correlation between these two composites is the

REGRESSION MODEL 1

Achievement Set		Cognitive Set		Affective Set		Demographic Set
				Rutter Anti-Social		Sex
Word Knowledge		WISC-verbal		Rutter-neurotic		
	=	WISC-performance	+	Quay Conduct	+	Age
Reading		Draw-A-Man		Quay Personality		
				Quay Immaturity		SES

REGRESSION MODEL 2

Achievement Set		Cognitive Set		Demographic Set		Affective Set
				Sex		Rutter Anti-Social
Word Knowledge		WISC-V				Rutter-neurotic
	=	WISC-P	+	Age	+	Quay Conduct
Reading		Draw-A-Man				Quay Personality
				SES		Quay Immaturity

canonical correlation. It is the maximum correlation possible given the specific sets of data. Multiple regression analysis is a special case of canonical correlation (Kerlinger, 1973).

A step regression method was used to program the multiple regression analysis. The procedure involves the following steps: The set of independent variables that has the highest correlation with the set of dependent variables is selected first. Then the set of independent variables that, after the first set of variables, contributes most to the variance of the criterion measures is selected. This computation is evaluated. That is, the contribution of the first set of variables had it been entered second is examined. The set of variables is then dropped if its contribution is not statistically significant. The process continues until a statistical test of significance is obtained for a set of variables which does not contribute significantly to the shared variance.

Procedure

Sample Selection

Of the 177 children in the fourth year of the study, 155 children for whom complete data were available were selected for the present analysis. Approximately 74% of the 155 children were boys.

Measuring Instruments

The Goodenough-Harris Draw-A-Man requires the child to "make a picture of a man." It is administered individually in approximately ten minutes. There is a lack of substantial information about test-retest reliability and correlations with other intelligence measures. However, reported correlations between test-retest range from .60 to .70. Interrater reliability ranges from .80 to .96. Correlations between the Goodenough and the Stanford Binet range from .36 to .65 (Dunn, 1972).

The Wechsler Intelligence Scale for Children (WISC) is a stable, general purpose, individually given intelligence test. It is considered a useful and valid measure of immediate or present mental functioning (Osborne, 1972). Fraser (1959) reports reliability coefficients for the verbal subscale as high as .88 at age 7-1/2, .96 at age 10-1/2, and .96 at age 13-1/2. For the performance subscale, reliability coefficients are reported as .86 at age 7-1/2, .89 at age 10-1/2 and .90 at age 13-1/2. Full-scale reliability coefficients are reported as .92, .95, .94. The WISC and the Stanford Binet correlate fairly high, .80, and differ little on their ability to predict academic attainment.

The Rutter Behavior Scale, used in the assessment of children's behavior, consists of 26 statements of behavior to which a teacher responds by checking "certainly applies," "applies somewhat," or "doesn't apply" about a specific child. The responses are scored 2, 1, or 0 respectively, producing a total score which ranges from 0 to 52. A "neurotic" subscore is obtained by summing the scores of items 7, 19, 17 and 23; an "anti-social" subscore is obtained by summing the scores of items 4, 5, 15, 19, 20 and 26. Rutter (1967) reports a retest reliability coefficient of .89 and inter-rater reliability coefficient of .72. The test has been successfully used in differentiating children with neurotic or anti-social disorders.

The Quay Behavior Problem Checklist is a factor analytically derived three-point rating scale for 55 frequently occurring problem behavior traits in children and adolescents. The behavior problem dimension measured by the checklist are conduct disorder, personality disorder, inadequacy-immaturity and subcultural (socialized) delinquincy. Using an early form of the Checklist, Peterson (1961) found inter-teacher reliabilities of .77 for the conduct problem dimension and .75 for the personality problem dimension. Quay and Quay (1965) obtained ratings from two teachers on a subsample of seventh and eighth graders. The inter-teacher correlations for the seventh grade group were .58 for conduct problem and .31 for personality problem; for eighth graders, the correlations were .71 and .22

respectively. Quay, Sprague, Shulman and Miller (1966) obtained ratings from both parents and teachers on a sample of children who were clients of a child guidance clinic. The correlations between parents were .78 for conduct problem and .67 for personality problem.

The Metropolitan Achievement Tests (Reading) is not purported to be a diagnostic instrument. It does offer, however, possibilities for analysis of weaknesses and strengths for given individuals and classes. Reliability for each subtest is reported as .79 to .96 (Robinson, 1965). Measures of validity have been obtained through study of curricula and repeated experimentation. The test yields three scores at the primary level: word knowledge, word discrimination and reading. Two scores, word knowledge and reading, are obtained at the upper levels of the test. Results are reported in grade equivalents, percentiles and stanines.

Statistical Procedure

As previously stated, a stepwise multiple regression and canonical correlation analysis was done on the independent and dependent measures.

The regression models presented the independent variables in their most logical order. The contribution of cognitive variables, assumed to be the most predictive variable in achievement, was examined first. The affective set of variables was examined second. Behavioral disorders might be expected to interfere with academic achievement. The demographic set of variables was examined last. The second regression model reversed the order of demographic and affective variable sets. That is, the cognitive set was still examined first, however, the demographic set was examined second and the affective set examined last.

Results

The means, standard deviations and ranges of predictor and criterion variables are presented in Tables 129 through 132.

The mean age of the sample, 11 years, approximates sixth-grade placement. However, when looking at the mean reading and word knowledge grade equivalent scores, one can say that most of the children were about two years below 6th grade reading achievement. Although the range of reading and word knowledge grade equivalent scores was wide--approximately a 9-year span--the sample is clearly a group which can be labeled "retarded readers."

The scores obtained on the cognitive measures range between a moderate level of retardation to above average intelligence. However, the scores are negatively skewed indicating that most of the children were functioning on an intellectually retarded level, falling within the educable level of retardation.

Table 129

Grade Equivalent Scores for 4th Year Reading Achievement for Total Sample (N=155)

	$\overline{X}$	SD	Range
Word Knowledge	4.2	2.2	1.5 - 10.0+
Reading	4.0	2.1	1.0 - 10.0+

Table 130

Demographic Data Obtained in the 2nd Year for Total Sample (N=155)

	$\overline{X}$	SD	Range
Age	11.16	4.97	7.3 - 13.7
SES*	3.7	1.9	1 - 7

Table 131

Cognitive Scores Obtained in the 2nd Year for Total Sample (N=155)

	$\overline{X}$	SD	Range
WISC-Verbal	78	13.45	46 - 118
WISC-Performance	79	16.80	40 - 120
Draw-A-Man	78	13.32	54 - 111

*Scoring categories based on Warner, Meeker and Eells (1949).

Table 132

Affective Scores Obtained in the 2nd Year
for
Total Sample (N=155)

	$\overline{X}$	SD	Possible Range	Actual Range
Rutter Anti-Social	2.3	2.9	0-13	0-12
Rutter-Neurotic	1.6	1.8	0-8	0-8
Quay-Conduct	5.4	5.5	0-34	0-17
Quay-Personality	4.8	3.7	0-28	0-14
Quay-Immaturity	2.1	2.1	0-16	0- 7

The mean scores obtained on the affective measures indicate that the sample as a group did not exhibit severe behavior disorders as measured by the Rutter and Quay Behavior Checklists.

In summary, the sample appeared to consist of children who were intellectually retarded and below grade expectation in reading achievement. The sample as a group did not seem to have severe behavior disorders. However, some of the children did obtain a maximum score on the affective measures (the Rutter Checklist) indicating that atypical behavior was present to some degree.

The intercorrelations of independent and dependent variables is presented in Table 133 and the results of

Table 133

Intercorrelation Matrix For Principal Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13
d Knowledge	1.0	.82	.01	.05	-.04	.56	.25	.22	-.13	-.04	-.05	.00	-.09
ding		1.0	-.03	.43	-.10	.42	.38	.05	-.16	-.09	-.06	-.10	-.14
			1.0	-.13	.13	.17	.12	.19	.17	-.09	.12	.02	.17
				1.0	-.17	-.33	.19	-.41	-.05	-.10	-.08	-.13	-.12
					1.0	.03	.05	.26	.17	-.04	.07	.05	-.04
C-V						1.0	.49	.53	.09	-.04	.17	-.05	-.03
C-P							1.0	.40	.09	-.20	.04	-.15	-.21
v-A-Man								1.0	.13	-.10	.03	-.07	-.09
er Anti-Social									1.0	.31	.81	.17	.24
er-Neurotic										1.0	.39	.60	.31
-Conduct											1.0	.27	.34
-Personality												1.0	.49
-Immaturity													1.0

Table 134

Univariate and Multivariate Analysis For Model 1

Source	Multivariate F	Univariate F and Percentage of variance accounted for in dependent variables	
		Word Knowledge	Reading
Cognitive Set	$MF_{6,300}=19.94^*$	$F_{3,151}=23.65^*$ 32%	$F_{3,151}=19.36^*$ 28%
WISC-V WISC-P Draw-A-Man			
Affective Set	$MF_{10,290}=1.75$	$F_{5,146}=1.78$ 4%	$F_{5,146}=1.88$ 4%
Rutter Anti-Social Rutter-Neurotic Quay-Conduct Quay-Personality Quay-Immaturity			
Demographic Set	$MF_{6,284}=17.57^*$	$F_{3,143}=7.31^{**}$ 9%	$F_{3,143}=32.24^*$ 27%
Sex Age SES			

* $p < .0001$

** $p < .0002$

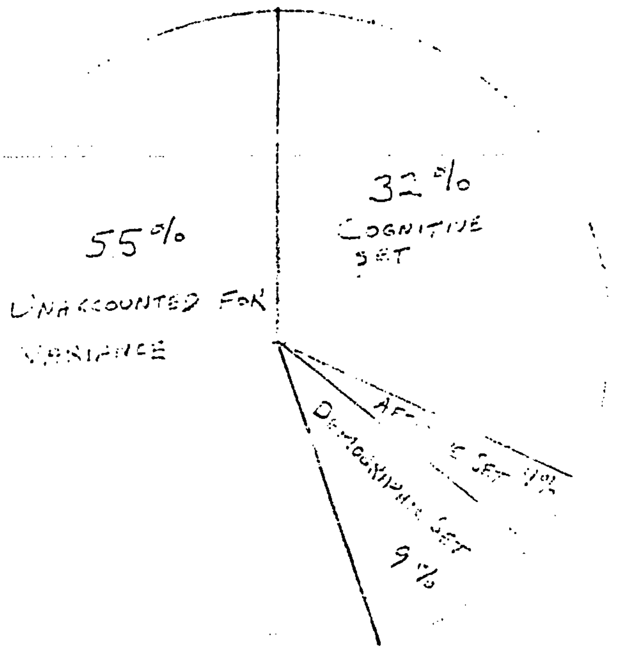
fitting the regression model(s) to the achievement data is presented in Table 134.

The results suggest that 32% of the variance in word knowledge and 28% of the variance in reading can be accounted for by the cognitive measures. The demographic data account for 9% and 27% of the variance in word knowledge and reading achievement respectively. Both percentage values were statistically significant.

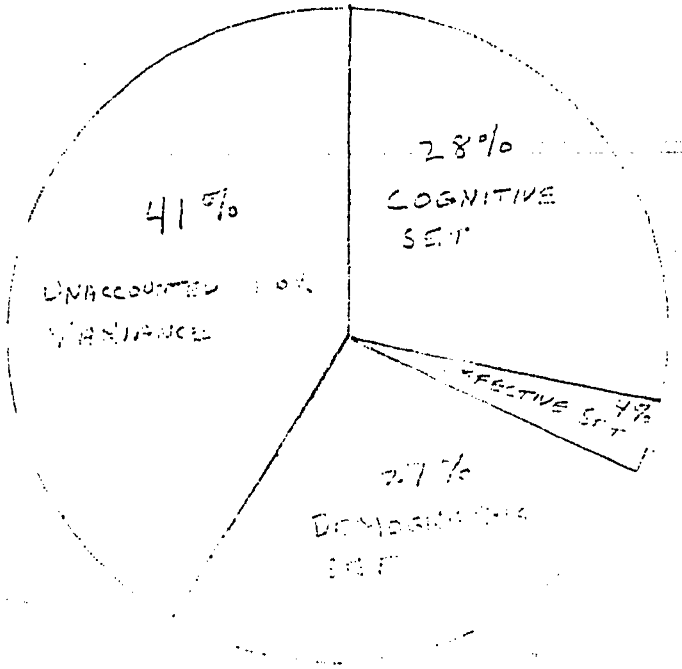
The affective measures accounted for only 4% of the variance in both word knowledge and reading achievement. This percentage value did not reach statistical significance.

Schematically, the percentages of variance in reading and word knowledge achievement accounted for by cognitive, demographic and affective data sets are as follows.

<u>Word Knowledge</u>



<u>Reading</u>



The differential effect of demographic set on reading achievement (27%) and word knowledge (9%) appears to be due to age. The intercorrelation between age and reading was .43. The relationships between the other demographic variable and both achievement measures were minimal.

The obtained results are based on regression model 1. When the variables were entered in the reverse order, the same values were obtained for the data sets. Therefore, all results reported are based on regression model 1.

Discussion

Of the sets of variables used to predict reading achievement in the present investigation, the cognitive and demographic sets accounted for most of the variance in both word knowledge and reading. The affective set accounted for virtually none of the variance in either word knowledge or reading. Therefore, the regression model which best explains reading achievement in the present investigation is the following.

Achievement Set		Cognitive Set		Demographic Set		
Word Knowledge Reading	=	WISC-V WISC-P Draw-A-Man	+	Sex Age SES	+	Unknown

It will be recalled that the cognitive measures used in the present analysis were obtained two years prior to the achievement scores. The cognitive measures thus seem to be good predictors of later achievement. Verbal, performance and perceptual-motor (drawing) deficit accounts for almost one-third of the variance associated with retardation in reading and word recognition two years later.

A complex finding is the difference in the relationship between the demographic variable set and Reading on one hand and Word Knowledge on the other--the former relationship being much higher than the latter. Of the variables that made up the demographic set, age (as compared with SES) clearly had the most significant relationship with MAT Reading. However, a similarly strong relationship does not seem to exist between age and Word Knowledge. MAT Word Knowledge and MAT Reading apparently tap different skills. Word Knowledge probably requires more specific skills. The child is given only one sentence or one picture to which he must respond. In the Reading subtest, the child is presented with many sentences and sometimes a drawing to which he makes a response. Thus, the Reading subtest contains more cues for the child to draw upon when making a response. It is therefore possible that the child with a specific reading disability might have more opportunity to compensate for his deficit on the Reading subtest than on Word Knowledge.

Thus, differences in task demands may underlie the difference in the relationship between the two reading measures and age. In addition, the term "age" is itself an ambiguous global term encompassing something called "experience." However, the nature of that experience is hardly explained by knowing how many years a person has lived. Experience, in turn, may be a better predictor of a comprehensive and non-specific test of reading ability than of such relatively specific skills as word knowledge.

In summary, reading achievement can best be explained by the cognitive set of verbal, performance and perceptual skills and the demographic factor of age. Affective or behavioral variables did not seem to contribute significantly to achievement in reading in this study. In addition to the contribution of these sets of variables there remains a large portion of unexplained variance in both the specific task of word knowledge and the more general task of reading.

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