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ABSTRACT

SEVEN PSYCHOEDUCATIONAL TESTS WERE ADMINISTERED TO 2,767 THIRD AND FOURTH GRADERS TO SCREEN FOR UNDERACHIEVERS WHO WERE THEN INTENSIVELY STUDIED THROUGH PSYCHOEDUCATIONAL TECHNIQUES AND GIVEN OPTHALMOLOGICAL, NEUROLOGICAL, AND ELECTROENCEPHALOGRAPHIC EXAMINATIONS. THE RESULTS WERE THAT 15% WERE DEFINED AS UNDERACHIEVERS (FAIL WAS BELOW LEARNING QUOTIENT OF 90) AND HALF OF THESE HAD A LEARNING DISABILITY. THE LEARNING DISABILITY GROUP WERE INFERIOR TO ALL GROUPS IN VERBAL TESTS AND LANGUAGE SKILLS; THEIR PROCESSES OF ORGANIZING EXPERIENCE APPEARED DIFFERENT; AND THEIR SOCIAL MATURITY WAS BELOW AVERAGE. THESE CHILDREN SHOWED NO GREATER INCIDENCE OF VISUAL DEFECTS INDICATING A NEED TO EMPHASIZE BEHAVIORAL AND MEDICAL ASPECTS IN REMEDIATION. SOME CHILDREN WITH DEFICITS IN LEARNING SHOWED DYSFUNCTIONS OF THE BRAIN AGAIN INDICATING THE NEED FOR MEDICAL DIAGNOSIS AND ATTENTION. THERE WERE INDICATIONS THAT THE UNDERACHIEVERS SHOWED MORE SIGNS OF NEUROLOGICAL DISTURBANCE WHICH SUGGESTED A RELATIONSHIP BETWEEN THESE DISTURBANCES AND LEARNING DEFICIENCIES. TEACHER RATINGS ON THE BASIS OF THE PUPIL RATING SCALE USED WERE FOUND TO BE OF CRITICAL USEFULNESS. EXTENSIVE TABLES OF RESULTS ARE INCLUDED. (AUTHOR/JM)

FINAL REPORT

U.S.P.H.S. Contract 108-65-142

MINIMAL BRAIN DAMAGE IN CHILDREN

June 1969

Neurological and Sensory Disease Control Program
Division of Chronic Disease Programs
Regional Medical Programs Service
Health Services and Mental Health Administration
Public Health Services
Department of Health, Education, and Welfare

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MINIMAL BRAIN DAMAGE IN CHILDREN

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This project was a valuable and enlightening experience for the research team, for many graduate students and visiting scholars. Now that the work has been accomplished we are cognizant that a study of this type cannot be completed without the interest and cooperation of many persons.

We are deeply indebted to the superintendents, principals, and teachers who assisted with the screening phase and made it possible for us to engage a large number of children in the investigation.

We also express appreciation to the parents and children who gave so much of themselves in order that the work could be done. Finally, we are grateful to the Neurological and Sensory Disease Control Program, United States Public Health Service, for its foresight in sponsoring this research project so that the needs of children with learning disabilities might be more fully understood.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES

Table		Page

Table		Page
131	Means, Standard Deviations and t-Scores for the Borderline Group and the Normal Controls on Individual Items of the Pupil Rating Scale	267
132	Means, Standard Deviations and t-Scores on the Pupil Rating Scale for the Borderline Group and the Normal Controls by Grade	270
133	Means, Standard Deviations and t-Scores on the Pupil Rating Scale for Borderline and Normal Control Boys and Girls	271
134	Discriminant Analysis of the Forty-Nine Variables of the Psychoeducational Battery Plus the Pupil Rating Scale for the Borderline Group and Their Normal Controls	272
135	Means, Standard Deviations and t-Scores for the Learning Disability Group and the Normal Controls on the Pupil Rating Scale	274
136	Means, Standard Deviations and t-Scores for the Learning Disability Group and the Normal Controls on Individual Items of the Pupil Rating Scale	276
137	Means, Standard Deviations and t-Scores on the Pupil Rating Scale for the Learning Disability Group and the Normal Controls by Grade	277
138	Means, Standard Deviations and t-Scores on the Pupil Rating Scale for Learning Disability and Normal Control Girls and Boys	278
139	Discriminant Analysis of the Forty-Nine Variables of the Psychoeducational Battery Plus the Pupil Rating Scale for the Learning Disability Group and their Normal Controls	280

SUMMARY

SUMMARY

Through 1965-66 a pilot study involving 561 children was conducted. The results which included all phases of the anticipated investigation indicated that an intensive research project on learning disabilities would be rewarding. Thereby, a plan was formulated to proceed with a study of third and fourth grade children. The objective was to screen for and select those who were failing to learn at their level of expectancy. All underachievers were to be studied intensively using psychoeducational techniques and they were to be given ophthalmological, neurological, and electroencephalographic examinations. This intensive phase of the research project covered the period of 1966-1969. The findings of each portion of the investigation were as follows.

Screening

A battery of seven psychoeducational tests was administered to 2767 third and fourth graders. The criterion for pass-fail was a learning quotient of 90. This quotient represented the ratio of achievement to expectancy for learning. On this basis 15 percent of the population were defined as underachievers—further study revealed that approximately one-half (7.5 percent) of these fell into the learning disability category.

Statistical treatment emphasized comparison of those who passed and those who failed the screening criteria. These groups differed in various respects. A primary difference concerned the intercorrelation and factor analysis results. These findings indicated that those who failed the criteria were unable to normally interrelate verbal and nonverbal experience. The factors of mental ability were less associated. Hence, learning processes might vary and be less successful in comparison with the normal. The results from the intensive studies also disclosed this variation between good and poor learners.

Psychoeducational Study

A total of 627 children were seen for individual evaluation. The psychoeducational study revealed differences between the experimental and control groups. The experimental populations were lower in mental ability but this variation was not considered a primary basis for the extent to which they manifested deficits in learning. Moreover, the borderline and learning disability groups were comparable in intelligence, though they varied in the degree of their learning deficiency. In general, the normal control groups fell at the high-average level intellectually, whereas the experimentals were of average mental ability. The profile for those with learning disabilities varied from the normal. Their pattern was to score higher on performance tests of intelligence while the normals were higher on verbal tests.

Both the borderline and learning disability groups were inferior to the controls on measures of educational achievement. The least difference appeared on tests of auditory language and auditory memory. While these experimental groups were similar to each other on auditory

functions, both were inferior to the normal. The borderline and learning disability subjects differed substantially in facility of learning to use the read and written forms of language, the learning disability children being most deficient. Through discriminant analysis it was determined that ability to syllabicate was a critical factor as far as successful learning was concerned. The implication is that both auditory and visual processing must be intact if educational achievement is to be adequate, if potential is to be actualized. Reading comprehension also proved to be highly useful in differentiating between good and poor learners.

Another outcome of the psychoeducational investigation derived from the intercorrelation analysis. The pattern of relationships varied for the experimentals in comparison with the normals. We concluded that the processes by which the learning deficient child organizes experience are different from those used by the normal child. For example, coding ability correlated with other mental abilities in the normal but not in the experimental subjects. More generally, for the normal learners verbal and nonverbal mental abilities were highly correlated but, in contrast, these abilities often showed only slight or no relationship for the experimental groups. These findings suggest a difference in the psychology of learning which may be critical in planning for special education. This possibility was enhanced by the correlations between mental ability and educational achievement because these also differed significantly for the two groups.

Of unusual interest, also, was the fact that scores on a personality test revealed no difference between the experimental and control groups. Emotional disturbance did not characterize the children with deficiencies in learning. However, those with deficits in learning were inferior in social maturity; when learning was below expectancy the child was below average in development of ability to care for himself. This disturbance of development of independence occurred despite the fact that motor ability was intact.

The psychoeducational study, corroborating the pilot study, revealed that approximately 7 percent of the total population might be designated as having a learning disability. This portion of the study clearly indicated variations from the normal when a learning deficiency was present, moreover, these variations were of the type that must be recognized if we are to meet the needs of this type of handicapped child.

Ophthalmological Study

While there have been persistent claims to the effect that visual defects are common, if not characteristic, in children with deficits in learning, the results of this investigation indicate otherwise. When children with learning disabilities (who have no additional handicaps) are stringently compared with the normal, they do not show a greater incidence of visual defects.

The primary contribution of this facet of the research study is the manner in which it clarifies the nature of a learning disability.

Eye disorders or visual impairments per se are not an integral part of the problem so far as our results are concerned. By inference we conclude that this type of handicap cannot be attributed to a malfunction of vision, hence, the need to focus attention on other facets, behavioral and medical.

Electroencephalographic Study

Summarizing the results of the electroencephalographic study, relationships between electrocortical abnormalities and learning disabilities appeared for the borderline group. In other words, for those with the least severe deficit in learning, classification on the basis of normal or abnormal favored the control group. Further analysis disclosed that focal slow waves appeared more often in these children.

Another result of considerable interest was the fact that children with nonverbal disturbances of learning much more often than the controls had abnormal electroencephalograms. An implication might be that when the brain involvement is on the right hemisphere, the EEG more often reveals dysfunctioning.

A final analysis disclosed that children in the borderline group more frequently scored lower than the controls on psychological tests which discriminated between those with normal and abnormal EEG's.

While the findings for this aspect of the total study were not highly definitive, the results support the initial postulation. Some children with deficits in learning show evidence of having dysfunctions in the brain. Accordingly, electroencephalography not only is useful diagnostically but such studies emphasize the need for medical attention for children with this type of handicap.

Pediatric Neurological Study

There has been speculation as to the role of neurology in relation to learning disabilities. The data from this portion of the research project were revealing in this connection. Although the neurologist was restricted, examining the subjects without knowledge of the history, without information as to whether the child did or did not have a learning disability, it was demonstrated that to some extent neurological disturbances characterized children with deficits in learning.

Though no profile of neurological disorders evolved, two individual signs differentiated between the borderline and control groups. The children in the borderline sample showed a disturbance of graphesthesia on both sides, right and left. In addition, those in the learning disability group were deficient in horizontal movement of the tongue.

Also, a difference appeared for the learning disability sample when type and degree of the involvement were considered. More children with nonverbal learning deficiencies were classified as abnormal neurologically. If nonverbal deficits are viewed as deriving mainly from the right hemisphere, then this type of disturbance seems to be more ascertainable by the pediatric neurologist.

Perhaps the most noteworthy positive findings were those disclosing the incidence of neurological signs. Both experimental groups (borderline and learning disability) showed many more signs of neurological disturbance in comparison with the normal. The borderline exhibited more suspect (soft) signs and the learning disability more clearly abnormal (hard) signs. In terms of the paradigm for this investigation we may conclude that when the deficiency in learning is mild to moderate the neurological involvement also is moderate. Similarly, when the learning deficiency is marked the neurological disturbance also is marked.

Though restrictions were imposed on the examiner, this study suggests that relationships exist between neurological disturbance and deficiencies in learning. There are implications both for neurology and special education. Presumably the needs of this type of handicapped child will be met only when these disciplines combine approaches and provide remediation jointly.

Pupil Rating Scale

The pupil rating scale was developed experimentally and used in conjunction with a number of other techniques in an attempt to evolve economical procedures for identification of children with learning disabilities. The results clearly indicate that teacher ratings obtained on the basis of this scale are of critical usefulness. The rating scale scores successfully discriminated between children with learning disabilities and normals in all of the comparisons. Moreover, it was demonstrated that the ratings were not contaminated by factors of sex or school grade. As a technique, the pupil rating scale was one of the most reliable procedures to come out of this investigation.

INTRODUCTION

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In 1964 contact was made between Northwestern University's Institute for Language Disorders and the Bureau of Neurological and Sensory Diseases of the United States Public Health Service to discuss a possible research project to explore the many facets of learning disabilities. National interest in the perceptually handicapped, the minimally brain damaged, or the child described as having psycho-neurological learning problems had brought many requests for such research. It was determined that an all-inclusive study was needed to provide direction for work in this area of childhood disabilities.

A year of planning by the staff of the Institute for Language Disorders followed. Contacts were made with five public school districts and interest was expressed in co-operating with the University and USPHS. Test batteries and medical procedures were studied to determine their feasibility. A trial run of the psychoeducational screening battery was conducted at the Bell School in Chicago in 1965.

The study began officially in the fall of 1965 in the Northbrook Public School System. Data gathering was completed in November of 1968, with statistical analysis and completion of reports continuing through June 1969. Names of the professional and consulting staff associated with the project are presented in Appendix D , pages

The United States Office of Education defines a learning disability as "one or more significant deficits in essential learning processes requiring special education techniques for remediation. Children with a learning disability generally demonstrate a discrepancy between expected and actual achievement, in one or more areas such as spoken, read or written language, mathematics and spatial orientation. Such disabilities are not primarily the result of sensory, motor, intellectual, or emotional handicap or lack of opportunity to learn." Despite this definition there has been much subjectivity and opinion concerning the nature of deficiencies in learning. Isolated professional approaches have characterized much of the work.

The study of learning entails all aspects of man's behavior, normal and abnormal. Various disciplines are engaged in research that can be expected to expand our knowledge and increase our understanding of this important aspect of man's behavior. Children learn normally only when certain integrities are present and when proper opportunities for learning are provided. A variety of approaches to the study of learning is needed because of the number of aberrations that may be causative. These aberrations have been viewed as being of three principle types: those distinctly psychological, (emotional in origin), those that derive from disturbances of the peripheral system, and those that derive from dysfunction in the brain.

Until recent years the brain dysfunction category included only those with gross neurological involvements resulting in mental retardation or cerebral palsy. We assume that minimal brain damage existed in the past but only since refined techniques for the evaluation of learning have become available has it been possible to differentiate this condition more accurately. Although definition remains difficult, operationally it is necessary to view these children as having a dysfunction of the brain that is not manifested in gross neurological signs but that results in severe disabilities in learning and adjustment and in the actualization of what might be even high intellectual potential. This is the population that is unable to normally comprehend, speak, read, write, tell time, play, calculate, distinguish right from left, and to relate well with others, although they are not mentally retarded, have no sensory impairments, are not primarily emotionally disturbed, and do not present problems mainly in motor functioning. They have integrity and competence in general but they cannot profit normally from experience; they have a deficiency in learning, but not an incapacity to learn. It was through the need to find a new, more appropriate and meaningful designation for these children that the concept of minimal brain damage and learning disabilities arose. It is toward the continuing need for better definition of this problem, toward improved diagnostic, medical, and educational management, that research is directed at this time. The present study is concerned especially with the development of criteria by which differential diagnosis can be achieved more definitively.

Objectives and Study Design

Identification and diagnosis of children with learning disabilities has been arduous by virtue of the complex procedures involved. There is need for simplified yet valid criteria for diagnosis so the problem can be alleviated on a large scale basis.

The objectives of the present study were to derive such criteria for early identification and diagnosis through determining the most sensitive and valid indicators. More inclusively, the basic objectives of this investigation can be summarized as follows:

1. To develop and validate screening procedures for use with school age children so that identification of those with learning disabilities would be facilitated.

2. To establish four types of diagnostic criteria (neurologic, electroencephalographic, ophthalmologic, and behavioral) as indicators of neurogenic learning disabilities. The study comprised two phases. The first concerned screening of public school children to identify those who might have learning disabilities. The second consisted of making an intensive evaluation of the group who failed the screening test criteria and an equal number of control subjects, matched by sex, age, school, and classroom. The intensive evaluation included psychological-educational examination, as well as neurologic, electroencephalographic, and ophthalmologic studies.

INITIAL YEAR

1965 - 1966

THE PILOT STUDY

In preparation for the research study of children with minimal brain damage, a pre-pilot study and a pilot study were undertaken. The research staff was able to equate their abilities in group and individual testing as well as to analyze the tests to be used in the final project. The findings of the pilot year were made available to the project consultants in order to obtain their assistance in additional planning for the project.

Pre-Pilot Study

A screening battery (description follows) was administered to three classes, two third grades and one fourth grade, in a public school in Chicago. The scores were tabulated and learning quotients were calculated for reading, spelling, arithmetic and written language. The results of this program were evaluated by the project staff and discussed with consultants to the project. There was evidence that a large false-positive group was being identified. A refinement of the screening procedures for selection of the experimental group was indicated. It was clear that simply lowering the cut-off point on the learning quotient was not the solution; it might eliminate a number of children who in fact had psychoneurological learning disabilities. In other words, the result would be a large false-negative group, an even more serious problem.

Final clarification of the screening procedures could not be accomplished until intensive study was made of the experimental population, including the potentially false-positive group now identified by the screening battery. The characteristics of the false-positive group should be considered. Hence, with advisement from the project consultants, the project staff concluded that a more extensive pilot study, involving both the screening and intensive study methods, should be undertaken to refine procedures and to eliminate redundancies. It was the feeling of the project staff and the project consultants, following a refinement of the various diagnostic approaches, that a reappraisal of the sample size required for the total project was indicated.

As a result, the plan and design included a pilot study in which 500 children were screened. The expectation was that between 20 and 25 percent would be identified as probably having a learning disability. These, together with an equal number of normal (control) children, were to be studied psychologically, neurologically, electroencephalographically and ophthalmologically. The data collected were to be analyzed statistically to ascertain those techniques having greatest value in determining neurogenicity.

Following this extensive pilot investigation, all the techniques were to be re-evaluated, eliminating those tests that failed to discriminate between the groups. Those showing any predictive value were to be retained and used in the final battery.

The Pilot Study

One school district of 514 third and fourth grade children (275 in third grade and 239 in fourth grade) was selected for the pilot study. The screening battery was administered to this population. On the basis of the learning quotients derived from the test scores, an experimental and a control group were selected. Criteria for selection of these groups was in accordance with the criteria established by the research design. The experimental subjects demonstrated a deficiency in learning (a learning quotient of 89 or below); control subjects demonstrated adequate achievement in all areas of learning and were matched with experimental subjects by sex, grade, and classroom placement. The control and experimental groups selected were studied intensively, behaviorally and medically. A statistical analysis was made of the data obtained in the screening and intensive phases.

The school district selected met the following criteria. There was a sizable pool of third and fourth grade children, excellent parent groups, good liaison with practicing physicians, and available educational and professional resources. In preparation for the study, meetings were held with the superintendent, special services personnel, and the Board of Education. Parent meetings were scheduled to explain the research project to the community and to obtain a signed permission slip for each child who would participate in the intensive psychological-educational and medical examinations.

Selection of Experimental Population

Learning quotients were computed on the verbal, nonverbal, reading, arithmetic, spelling, and written language portions of the screening battery. Third and fourth grade children participating in the study were classified as either (1) those passing the screening battery and (2) those failing the screening battery.

Children Passing Screening Battery: A child obtained learning quotients of 90 or above on all areas examined in the screening battery when classified in this category.

Children Failing Screening Battery: Children were placed in this category if they obtained a learning quotient of 89 or below on one or more of the screening battery tests.

Children were eliminated from further consideration if they obtained an IQ of less than 90 on both the verbal and nonverbal portions of the PMA. Children known to have a serious hearing loss or physical problems were also eliminated.

Pilot Study Procedures

The research staff in the school district screened 275 third graders and 239 fourth graders. Three members of the research staff spent three days per week for three weeks in the schools to accomplish the screening. Randomization of test administrator, time of day for testing, and order of test administration was accomplished by the 3x3 Latin Square technique.

The following tests were used in the screening battery:

1. S.R.A. Primary Mental Abilities Test (Revised 1962), for grades 2 - 4. This test was designed to provide both multifactored and general measures of intelligence and was used to determine separate measures of verbal and nonverbal mental ability.

2. Metropolitan Achievement Tests, Elementary Battery for Grades 3 and 4. This test comprises a coordinated series of measures of achievement in reading, spelling, and arithmetic.

3. Picture Story Language Test devised to measure written language: productivity or length of expression; syntax or correctness of the expression; and abstract-concrete or quality of the ideas expressed.

This screening battery formed the basis for the selection of subjects for Phase II of the investigation.

A Pupil Rating Scale was also developed for use by the classroom teacher. This scale was to evaluate areas which could not be screened in group situations. The pilot study scale was only moderately effective in descriminating the different groups of children, and was redesigned for use in the succeeding years of the research study. The details of the scale and its use in this study are discussed in a separate section.

Results

Table 1 summarizes the scores obtained on the pilot population when the Primary Mental Abilities Test was administered. The group testing revealed an average verbal IQ of 112.6 and an average nonverbal IQ of 108.5.

In addition to mental ages, achievement ages in five learning areas were derived from the screening battery. The learning areas were verbal, nonverbal, reading, spelling, arithmetic, and written language. The Picture Story Language Test proved a cumbersome technique when administered as a group screening test; it required too much time to score to be appropriate as a screening measure. Therefore, the scores from the Picture Story Language Test were not used in the selection of the group who were categorized as failing the screening battery, and the test was eliminated from the final screening test battery.

Table 2 summarizes the achievement scores obtained on the pilot screening population when they were grouped into the five learning areas. The achievement scores were approximately one year above the average chronological age and grade placement.

Using the concepts of expectancy age and achievement age, a learning quotient was computed for each youngster participating in the screening phase of the project. The purpose of the screening battery was to

TABLE 1

SUMMARY OF SCORES ON PRIMARY MENTAL ABILITIES TEST:
SCREENING POPULATION (N = 514*)

Subtest	Mean	SD	Range	
Verbal IQ	112.60	11.56	74.0	142.0
Verbal M.A.	9.96	1.11	7.0	12.5
Perceptual Speed IQ	106.90	10.50	73.0	139.0
Perceptual Speed M.A.	9.58	1.04	6.7	12.5
Spatial Relations IQ	109.50	15.10	67.0	153.0
Spatial Relations M.A.	9.80	1.28	6.3	12.7
Average Non-verbal IQ	108.50	10.90	74.0	139.0
Average Non-verbal M.A.	9.69	0.99	7.0	11.9

*Mean chronological age = 8.92
SD = 0.61

TABLE 2

SUMMARY OF ACHIEVEMENT SCORES:
SCREENING POPULATION (N = 514*)

Test	Mean	SD	Range	
Reading				
Word Knowledge Grade	5.15	1.25	1.9	7.9
Word Knowledge Age	10.30	1.27	7.1	13.2
Word Discrimination Grade	5.07	1.03	1.9	7.9
Word Discrimination Age	10.26	1.04	7.1	13.2
Reading Comprehension Grade	4.87	1.39	1.3	7.9
Reading Comprehension Age	10.04	1.41	6.6	13.2
Spelling				
Spelling Grade	5.45	1.33	2.0	7.9
Spelling Age	10.64	1.37	7.2	13.2
Arithmetic				
Problem Solving Grade	4.49	1.05	2.3	8.2
Problem Solving Age	9.66	1.05	7.5	13.2
Auditory Receptive Language				
PMA Verbal M.A.	9.96	1.11	7.0	12.5
Non-Verbal Learning				
PMA Average Non-Verbal M.A.	9.69	0.99	7.0	11.9

*Mean chronological age = 8.92
SD = 0.61

identify the high-risk population of which neurogenic learning disability children would comprise one segment. The need remained to establish a cut-off score for identification of the high-risk group. In establishing the cut-off score, the research staff turned to data from intelligence testing.

By convention, an IQ of 90 is considered within limits of normal intellectual functioning. Applying the same criteria to the learning quotient distribution, 90 percent efficiency would be defined as adequate functioning; learning quotients of 89 or below were taken as indications of failing the screening battery. All children who obtained one or more learning quotients equal to or below 89 were included in the failed screening sample.

Applying this criterion to the pilot study screening population, 73 children or 14.2 percent were identified as the failed screening group. Table 3 summarizes the grade and sex distribution. Permission for intensive testing was granted by the parents of 50 of these children; 23 children were not available to the study for further testing.

From the remaining children in the screening population for whom permission had been received for participation in the study, 109 control subjects were selected at random. A sufficient number of children were selected so that a control subject was matched with each experimental subject for sex and classroom placement.

In the intensive portion of the pilot study 160 children were seen. All children were required to demonstrate integrity of sensory capacities, intellectual functions, and emotional adjustment in order to qualify for the final study sample. Hearing was screened at 35 db (ISO 1961 standard) in each ear at 500, 1000, 2000, and 4000 Hz. If a hearing loss greater than 30 db was evident in either ear, the child was considered to have failed the hearing criterion; three children fell into this category.

Both near and far point visual acuity were determined by the ophthalmologist. The line of demarcation for a visual impairment originally was set at 20/30. If near or distant vision in either eye (corrected if the child wore glasses) was measured at 20/40 or poorer, the child was considered to have failed the criterion for vision. Twenty-one children fell into this category.

All children were required to attain an IQ of 90 on either the verbal or nonverbal scale of the WISC. Only one child failed this criterion for intellectual functioning.

Emotional adjustment was evaluated using the Children's Personality Questionnaire. Scores were obtained on an anxiety-adjustment scale. Children with scores of 40 and above were considered to have failed the criterion for adequate emotional adjustment. Three children fell into this category.

In addition to determining levels of sensory, intellectual, and

TABLE 3

GRADE AND SEX DISTRIBUTION OF THOSE FAILING THE SCREENING TEST CRITERIA

Sex	Third Grade	Fourth Grade	Total
M	22	29	51
F	11	11	22
Total	33	40	73

emotional functioning, tests covering auditory and visual analytic skills, comprehension and use of the spoken word, reading, spelling, written language, arithmetic, nonverbal behavior, and motor ability were administered by the research staff.

Table 4 presents the tests which were included in the pilot year intensive psychoeducational evaluation. In the area of mental ability, seven different measures were included, providing twenty-eight scores. In the area of educational achievement, six different measures were used, giving thirteen scores. Ten other measures covering motor ability, emotional adjustment, orientation, social maturity, sensory acuity, articulation and auditory discrimination completed the pilot year intensive psychoeducational battery.

The various tests were grouped to represent selective learning areas. Table 5 reveals the learning areas represented by the test battery.

Criteria for Defining Learning Disability Children

The WISC subtest raw scores were converted to test ages using the conversion table provided in the manual; verbal and nonverbal mental ages were computed. The higher MA (verbal or nonverbal) was used, together with the CA and Grade Age at the time of testing to derive an Expectancy Age. Then, using the mean scores in each of the six learning areas outlined in Table 5 , six learning quotients were computed for each child of the 160 children seen for the intensive phase of the pilot study.

Table 6 presents the distribution of scores by learning area for children failing the intensive battery. Forty-four children obtained learning quotients of 89 or below on the intensive psychoeducational test measures. Twenty-seven of these children had failed the screening battery and seventeen had passed. Therefore, if a learning quotient of 89 on the intensive criteria was to be used as the cut-off point for definition of a learning disability child, approximately 23 percent of the total third and fourth grade population would be included.

It was the purpose of the pilot study year to clarify precisely this aspect because for practical reasons an unduly large number of children could not be studied intensively. Considerable discussion of these results transpired, with assistance from the consultant committee.

It appears from the research results that a fortunate resolution was accomplished. It was decided that the experimental population should be comprised of two samples. One would be referred to as the borderline group and the other as the learning disability group. All children with an LQ of 85 to 89 inclusive would be classified in the first group, and those with an LQ of 84 or lower would be classified in the second group. This procedure permitted study of children who fell only slightly below their expectancy level. All of the research results are presented accordingly. This means that the research data include results for an experimental population consisting of two

TABLE 4

INTENSIVE TEST BATTERY: PSYCHOLOGICAL-EDUCATIONAL EXAMINATION

Mental Ability
- Wechsler Intelligence Scale for Children; The Psychological Corp., 1949
- Detroit Test of Learning Aptitude; Bobbs-Merrill, 1959
  - Subtests: Verbal Opposites
    - Auditory Attention Span for Unrelated Words
    - Visual Attention Span for Objects
    - Orientation
    - Free Association
    - Designs
    - Auditory Attention Span for Related Syllables
    - Visual Attention Span for Letters
    - Oral Directions
- Peabody Picture Vocabulary Test; American Guidance Service, 1959
- Arthur Stencil Design Test; The Psychological Corp., 1947
- Healy Picture Completion Test: I and II; C. H. Stoelting Co., 1943
- Kent Emergency Scales; The Psychological Corp., 1946
  - Scales B, C and D
- Goodenough Harris Drawing Test; Harcourt, Brace, and World, Inc., N.Y.,1963

Educational Achievement
- Gates Basic Reading Series; Bureau of Publications, Columbia Uni., rev. 1961
- Wide Range Achievement Test; C.L. Story Co., Wilmington, Delaware, 1963
  - Subtest: Oral Reading
- Gates Russell Spelling Diagnostic, Bureau of Publications, Columbia Uni., 1937
- Gates McKillop Reading Diagnostic, Bureau of Publications, Columbia Uni., 1962
- Picture Story Language Test; Grune and Stratton, 1965
- Metropolitan Achievement Test; Harcourt, Brace and World, Inc., 1959
  - Subtest: Elementary Arithmetic Tests

Motor Ability
- Laterality
- Heath Railwalking Test
- Dynamometer

TABLE 4 - Continued

Emotional Adjustment	
IPAT Children's Personality Questionnaire;	Inst. for Personality and Ability Testing, Champaign, Ill., 1960
Orientation	
A Standardized Road-Map Test of Directional Sense;	The Johns Hopkins Press, 1965
Social Maturity	
Vineland Social Maturity Scale;	Educational Test Bureau, American Guidance Service, Minneapolis, Minn., 1947
Sensory Acuity	
Vision - Snellen Chart	
Hearing - Pure-tone audiometer	
Special Tests	
Templin Articulation Screening Test	
Wepman Auditory Discrimination;	Language Research Associates, 1958

TABLE 5

LEARNING AREAS COVERED BY PSYCHOEDUCATIONAL BATTERY

Learning Area	
Auditory Receptive Language	Detroit Test of Learning Aptitude: Orientation Kent EGY: Scale D
Auditory Expressive Language	Detroit Test of Learning Aptitude: Verbal Opposites Free Association Oral Picture Story Language Test Words Per Sentence Abstract-Concrete
Reading	Gates Basic Reading Test: General Significance Level of Comprehension Noting Details
Written Language	Picture Story Language Test: Total Words Words per Sentence Syntax Abstract-Concrete Written Spelling of Words
Arithmetic	Metropolitan Elementary Battery: Arithmetic Computation
Non-Verbal	Detroit Test of Learning Aptitude: Designs Goodenough-Harris Draw-A-Man Healy Picture Completion Test: Test I

TABLE 6

CHILDREN WITH LEARNING QUOTIENTS OF 89 OR BELOW:
FAILED SCREENING (N=27) PASSED SCREENING (N=17)
TOTAL = 44

Case #	Screening Classification	Learning Areas with Quotients below 89 AR	AE	R	WL	A	NV
92	E					89	
393	E			89			
257	C	89					
409	C					89	
436	E	89			88	89	
83	C				88		
149	E	87					
170	E			87			
248	E						87
163	C						87
362	C	87					
474	C			87	87		
505	C				87		
143	E				86		
453	E			86			
78	C	86					
307	C						86
27	C	86					
428	E			85			
246	E			85			
49	C				85		
151	C			85			
256	C					85	
394	C		85				
56	E			84			
105	E						84
249	E		85	83	83		
319	E						83
367	E				83		88
374	E	83		88	84	87	
481	E				83		
136	E	89	82	84	86		
420	E	82		83			

TABLE 6 - Continued

Case #	Screening Classification	Learning Areas with Quotients below 89 AR	AE	R	WL	A	NV
483	E				82	84	84
308	C				82	89	87
506	E			81	87		
560	E	84			81		
378	C			86	83		81
97	E			80	82	89	
107	E			77	78		
204	E			76	79	83	86
480	C	84	82		75		
145	E			78	74	88	78
473	E		86	72	79	88	88

AR - Auditory Receptive
AE - Auditory Expressive
R - Reading

WL - Written Language
A - Arithmetic
NV - Non-verbal

E - Experimental
C - Control

samples, each of which is compared with an independent normal comparison group. As a research design, this procedure made it possible to explore relationships between medical aspects and degree of deficiency in learning.

To ascertain the number of children who are underachievers, it may be important to use the cut-off point of LQ 89. When this was done 24.3 percent of our third and fourth grade public school children were included. Using the cut-off point of LQ 85, this percentage dropped to 7.4 percent.

Evaluation of the Psychoeducational Battery

Purposes of the pilot program were to determine redundancies in the test battery and to evaluate the proposed examination procedures. Approximately 51 subtest scores were obtained for each child during the full day's psychological-educational evaluation. Each score was converted to a learning quotient for the learning disability children (N=20) and compared with the normal controls (N=20). Table 7 summarizes the means and standard deviations for 48 LQ scores. Sixteen subtest scores failed to achieve significance at the .05 level. Certain of these subtests were eliminated: Peabody Picture Vocabulary Test; Arthur Stencil Design Test; Healy Picture Completion Test II; Kent EGY Scale C; Visual Attention Span for Objects; Initial Letters; Final Letters; Vowels; Auditory Blending; the test of Directional Sense and the Dynamometer Test. Tests of oral and silent reading showed the most significant differences between learning disability and normal children. Three scores derived from the Goodenough-Harris Drawing Test were not converted to learning quotients. Comparison of these raw scores for the two groups (Table 8) yielded significant differences.

Medical Studies

The medical examinations were scheduled to follow the psychological evaluations so that these studies could be explained to the children and their parents. Neurological examinations, EEG, and ophthalmological evaluations were scheduled within two to three weeks of the psychological testing. The neurological examination preceded the EEG.

Following each examination, a short conference was arranged between the parents and the medical examiner in order to discuss the examination findings. A final medical report was forwarded to the family physician or pediatrician. No reports of medical examinations were released to the school.

The evaluation of the medical data was based on twenty learning disability children and a normal control group. Although none of the comparisons reached significance, certain trends were evident. It was expected that these findings would yield significant differences when the number of children studied was increased.

TABLE 7

LQ SCORES IN DESCENDING ORDER OF SIGNIFICANCE FOR COMPARISON BETWEEN LEARNING DISABILITY AND CONTROL GROUPS

Variable	Learning Disability (N=24) Mean	SD	Control (N=24) Mean	SD	t
Reading Vocabulary	89.2	9.9	108.5	8.1	-6.57***
Syllabication	86.4	11.0	106.6	8.8	-6.24***
Gates-Russell Oral Spelling Words	80.8	4.8	92.3	6.8	-6.04***
PSLT Abstract-Concrete	87.4	18.5	136.5	32.6	-5.71***
Reading Comprehension	81.9	7.7	96.9	8.6	-5.68***
Written Spelling Words	86.5	5.5	104.3	13.5	-5.18***
Word Parts	98.7	10.7	113.1	7.0	-4.92***
Gates-Russell Oral Spelling Two-Syllable	87.2	16.2	108.6	11.2	-4.72***
Oral Reading	87.9	9.6	107.8	16.9	-4.46***
Gates-Russell Oral Spelling One-Syllable	91.1	19.6	116.2	15.3	-4.39***
Nonsense Words	91.3	7.6	110.3	5.2	-4.24***
Gates-Russell Written Spelling Two-Syllable	85.6	14.9	103.9	12.4	-4.12***
Detroit Designs	96.7	17.0	116.6	15.1	-3.81***
Gates-Russell Written Spelling Words	82.8	4.8	90.7	7.8	-3.79***
Note Details	90.6	9.5	101.4	8.2	-3.77***
Understand Directions	90.7	8.4	102.0	11.5	-3.49**
Arithmetic Computation	92.1	5.0	97.5	4.6	-3.46**
PSLT Syntax	83.1	12.7	112.5	35.3	-3.41**
PSLT Total Words	79.5	6.6	87.8	9.6	-3.14**
Detroit Auditory Span Words	76.3	15.1	94.6	20.6	-3.13**
Detroit Auditory Span Sentences	85.5	21.1	101.8	11.8	-2.95**
Gates-Russell Written Spelling One-Syllable	91.3	16.9	107.3	17.8	-2.84**
General Significance	88.7	9.2	96.8	8.2	-2.83**
Detroit Visual Span Letters	95.0	14.7	106.1	101.5	-2.69*

TABLE 7 - Continued

Variable	Learning Disability (N=24) Mean	SD	Control (N=24) Mean	SD	t
Kent D	104.9	19.3	119.8	15.0	-2.65*
PSLT Words Per Sentence	84.7	11.8	98.8	21.2	-2.54*
Detroit Orientation	97.1	13.1	105.8	11.8	-2.16*
Detroit Verbal Opposites	103.7	12.7	111.6	10.4	-2.09*
Direction Sense	86.6	28.1	109.1	37.9	-2.07*
Detroit Oral Direction	97.6	21.5	109.9	20.0	-1.82
PSLT Total Sentence	80.9	9.6	91.8	25.1	-1.78
Healy I	112.2	24.7	125.9	24.0	-1.74
Healy II	103.1	27.6	118.5	29.3	-1.67
Oral PSLT Abstract-Concrete	103.7	34.6	123.1	38.5	-1.64
Auditory Blend	95.4	6.6	91.4	8.2	-1.49
Oral PSLT Words Per Sentence	95.3	12.7	103.8	26.3	-1.26
Heath	95.8	19.2	103.7	26.0	-1.06
Stencil Design	93.0	20.2	99.5	23.4	-.92
Detroit Visual Span Objects	108.4	22.2	112.6	13.7	-.69
Kent C	100.4	9.4	102.3	8.8	-.64
Vineland	96.6	9.3	98.4	8.3	-.63
Peabody	113.1	12.2	110.8	10.5	-.62
Initial Letters	91.6	5.0	90.8	6.0	-.45
Final Letters	92.1	5.3	91.4	5.8	-.42
Dynamometer Left	107.9	11.9	106.5	12.0	-.37
Vowels	99.0	10.0	110.0	6.1	-.35
Dynamometer Right	104.5	15.9	106.0	12.6	-.33
Detroit Free Association	94.9	17.1	95.6	16.7	-.12

* p less than .05
** p less than .01
*** p less than .001

TABLE 8

MEANS, STANDARD DEVIATIONS AND t-SCORES ON THE GOODENOUGH-HARRIS DRAWING TEST FOR THE LEARNING DISABILITY GROUP AND NORMAL CONTROLS

	Learning Disability (N=24)		Control (N=24)		
Test	Mean	SD	Mean	SD	t
Draw-A-Man	24.6	8.5	30.6	5.8	-2.53*
Draw-A-Woman	24.1	7.9	27.7	5.2	-1.66
Draw Self	24.3	7.3	28.9	5.7	-2.18*

* p less than .05

Electroencephalography: In the learning disability group 61 percent demonstrated at least one indication of abnormality on the EEG, while 39 percent of the normals showed similar findings. Focal slow wave abnormalities appeared for 17 percent of the learning disability children as compared with a complete absence of this abnormality in the control group. Extreme spindles were reported for 22 percent of the learning disabilities, while only 6 percent of the controls demonstrated extreme spindling.

A greater percentage of learning disability children had a background frequency of 8 - 8.9 than did the normals. Although the difference did not reach significance at the .05 level it is expected that there would be a larger number of cases with a slower (immature) background frequency in the learning disability group than in the normal group.

Neurology: Approximately 75 percent of both learning disability and normal children demonstrated some neurological abnormality when all "hard" and "soft" signs were considered. As in EEG, no single neurological sign seemed to characterize the pilot learning disability sample. More complete analysis, comparing the presence of minor and major signs and evaluating neurological "systems" (i.e., indications of cortical, cerebellar, sensory, etc.), was to be made when a larger number was available. It was postulated that statistical comparisons might differentiate the populations and reveal disturbances that characterized the learning disability group.

Ophthalmology: The ophthalmological evaluation of the children seen in the intensive portion of the pilot study revealed no significant differences in abnormal-normal classifications or in comparison of the experimental and control group on the individual items of the examination form. No single findings appeared to differentiate the learning disability group from their normal comparison group in the pilot study. In both groups, approximately fifty percent of the children had mixed eye-hand dominance.

Summary

In view of the statistical findings for both the screening and intensive batteries, there was reason to assume that this study would be revealing in regard to behavioral, neurological, electroencephalographic, and ophthalmological functions in children with learning problems and children considered normal.

STEP TWO

THE MINIMAL BRAIN DAMAGE PROJECT

1966 - 1969

MINIMAL BRAIN DAMAGE PROJECT

Having completed the pre-pilot and pilot studies, adjusted test measures and procedures, and conferred with the project consultants, the final paradigm for the study was established.

The objectives of the study were:

1. to develop and validate screening procedures for identification of children with learning disabilities.

2. to establish four types of diagnostic criteria (behavioral, electroencephalographic, neurological, and ophthalmological) for children with neurogenic learning disabilities.

The procedures established may be summarized as follows:

1. A large population of third and fourth grade children was to be screened, using group tests of mental ability and achievement in learning. A teacher pupil rating scale also was to be developed.

2. On the basis of an operational definition, using a learning quotient derived from the screening battery, measures were to be calculated to identify two groups of subjects: children failing the screening battery and children passing the screening battery.

3. All children failing the screening battery were to be included if their parents permitted. These children were to be matched with another child who passed the screening battery and who was of the same sex, grade, and classroom placement.

4. The resulting groups of children were to be administered four types of examinations: psychological-educational, neurological, electroencephalographical, and ophthalmological. Also, case history information was to be obtained on all subjects seen in this phase of the study.

5. On the basis of the intensive psychoeducational evaluation, the subjects were to be redefined as learning disability, borderline, control, false control, false experimental, or failed criteria. Explanation of these categories follows in the discussion of the second phase of the study.

6. Statistical analysis was to be accomplished with assistance from the staff and facilities of the Northwestern University Computing Center and the project statistical consultant. The programs of the Control Data Corporation 6400

and special programs written for this project were to be used in the analysis. The programs used in the study are to be listed in the Appendix.

Four school systems participated in the project. Each school was prepared for the research program through meetings with superintendents, supervisory staffs, and Boards of Education. In addition, orientation meetings were held with the third and fourth grade classroom teachers and with the parents of the third and fourth graders included in the study. All third and fourth graders in each school system were included in the screening phase but it was necessary to obtain written parent permission for the children to participate in the intensive phase of the study. (Copies of letters to parents and parent permission forms are included in Appendix A .)

The project was met with enthusiasm and co operation from all of the school systems. In fact, the professional staffs of the schools, the parents, and the children made the project possible through their willingness to give freely of their time. In addition to attendance at the orientation meetings and involvement in the three-hour group testing session in the school, a six-hour psychoeducational testing session was required, as well as a morning session for the ophthalmological study, and a day at the medical school for the neurological and electroencephalographic examination.

The screening phase of the study was to provide data on the following questions:

1. What are the characteristics of the total research population?
2. What are the characteristics of each school sample?
3. What are the test score characteristics of children who fail the screening battery?
4. What are the test score characteristics of children who pass the screening battery?
5. Which tests discriminate between the two groups of children?
6. Is the Learning Quotient a functional measure for selection of the two groups of children, experimental and control?
7. Is a rating scale a reliable indicator when used for identification of children who present learning deficiencies?

The intensive phase of the study was to provide data on the following questions:

1. What are the primary characteristics of the samples, experimental and control?

2. What tests in the psychoeducational battery discriminate the groups most successfully?

3. Which medical findings are the most sensitive discriminators of children with learning disabilities?

4. What are the characteristics of the groups when information from the case history is applied?

5. What are the relationships between case history information, medical information, and behavioral findings?

6. How do the screening battery findings correlate with the intensive psychoeducational test findings?

MINIMAL BRAIN DAMAGE PROJECT

FIRST PHASE

SCREENING

SCREENING

Tests included in the screening battery were the same as those discussed in the pilot phase of the study with the following exceptions. The Picture Story Language Test was eliminated as it was found to be unduly time-consuming. This test was felt to be an excellent measure for intensive study of the subjects included in that battery. The Word Discrimination Test and the Word Knowledge Test from the Metropolitan Achievement Tests also were eliminated; these tests did not discriminate between underachievers and achievers. Moreover, the Metropolitan Achievement Test of Reading Comprehension was highly discriminating and in no instance did either the Word Knowledge or Word Discriminatio~ Tests identify subjects who had not already been identified.

The final screening battery, therefore, included the SRA Primary Mental Abilities Test for grades 2-4 for measurement of verbal and nonverbal mental abilities. The Verbal Meaning Test, the Spatial Relations Test, and the Perceptual Speed Test were given in classrooms of the third and fourth graders. The Reading Comprehension Test, the Spelling Test, and the Arithmetic Problem Solving and Concepts Test of the Metropolitan Achievement Test, Elementary Battery for grades 3 and 4, were administered to obtain estimates of academic achievement. A summary sheet covering the scores obtained on each child from the group testing is included in Appendix B .

The screening battery, in its final form, was reduced from three-hour to two-hour groups. The tests were administered by the research staff and hand-scored at the Center. The results were checked by three different individuals to assure accuracy.

Learning quotient criteria were used for selection of those failing the screening battery and those passing the screening battery. The nonverbal average was used both as a measure of mental ability and a measure of nonverbal functioning and included in the possible areas of underachievement. That is, the child could be considered an underachiever on the basis of nonverbal ability, reading, spelling, or arithmetic. The verbal portion of the PMA had been used likewise but it was soon found to be a poor criterion for underachievement and was not included as a selective factor.

The subjects selected for study were drawn crom four suburban Chicago, Illinois, school districts: School District #28 in Northbrook, Illinois; School District #73½ in Skokie, Illinois; School District #35 in Glencoe, Illinois; and Schoo District #64 in Park Ridge, Illinois. School District #28 was used for the pilot study but these findings were included in the final analyses. These suburban settings were selected because the degree of cooperation demanded from the schools, parents, and children necessitated sophisticated educational communities where interest in learning disabilities had at least begun. Furthermore, the goal of the study was to gather a group of "pure" specific learning disability youngsters and participation of those particular communities afforded control of cultural and economic factors to an extent not possible in larger city school systems.

Third and fourth grade children from the selected communities comprised the sample for this project. It has been determined that validity and reliability of both educational and medical measures improve when evaluation is not attempted until approximatedly third grade level. Moreover, the time required for the examinations was too great for younger children. Thus, to assure the highest level of motivation and interest, the third and fourth grade age levels were selected for study. Two experimental groups were selected for statistical analysis; a borderline and learning disability group with respective control samples. The experimental population was matched on the basis of sex, grade and classroom placement.

The research design, as previously presented, called for two phases. The First Phase was the screening phase of the study, and the Second Phase was the intensive phase of the study. The total plan required that the first year be designated as the Pilot Study Year. The manner in which the research population was studied is as follows.

A summary of the number of children included in the First Phase of the screening portion of the study is shown in Table 9; 2,767 children were screened. A total of 63 children were eliminated immediately because of low IQ scores on the screening mental tests or because of medical reasons which prohibited their continuing in the study. Therefore, a population of 2,704 remained as the sample pool.

The screening test battery was developed as a broad selective procedure. Table 10 reveals that the screening battery identified approximately 15 percent of the school population as underachievers in one or more areas of learning (nonverbal, reading, spelling, arithmetic). However, the available population for the intensive phase of the study was reduced to 10.13 percent when children were eliminated because of lack of parent permission.

TABLE 9

SUMMARY OF THE TOTAL SAMPLE INCLUDED IN THE SCREENING POPULATION

School System	Total Number	Number Eliminated*	Per Cent Eliminated	Number Remaining	Year Studied
A	533	12	2.25	521	65-66
B	410	12	2.93	398	66-67
C	458	7	1.53	451	66-67
D	1366	32	2.34	1334	67-68
TOTAL	2767	63	2.28	2704	

*Due to low I.Q. or for medical reasons

TABLE 10

DISTRIBUTION OF THE UNDERACHIEVING POPULATION AND THE NUMBER ELIMINATED BY SCHOOL

School System	Number	Percent of Total	Number Eliminated	Percent after Elimination	Remaining
A	70	13.44	19	9.79	51
B	55	13.82	11	11.06	44
C	54	11.97	19	7.76	35
D	231	17.32	87	10.79	144
TOTAL	410	15.16	136	10.13	274

Reliability of Sample

Because a number of children who met the criteria were not seen, it was necessary to compare the results from the screening tests obtained on the children meeting the criteria and seen for the intensive phase of the study with the results for those not seen.

Descriptive statistics were completed by computer techniques for the children who failed the screening battery and were seen for intensive study, as well as for the population failing the screening battery but who were not seen for additional study. Table 11 summarizes this information. These samples also were studied by sex and by grade level as shown in Tables 12, 13, 14, and 15.

A review of these data indicate that those seen and not seen essentially were comparable except for differences in the spatial relations raw score on the Primary Mental Abilities Test; those not seen scored lower. The spelling and word discrimination test was dropped in the final screening battery so this difference could not affect the final outcome. Also, spelling was not used as a separate category in the intensive battery so differences in this area could not affect the final classifications.

When the groups were analyzed by sex and grade, again differences appeared for the perceptual tests (PMA) but only for the third grade girls; the third grade girls not seen scored lower. Only one other significant difference appeared; the third grade boys not seen scored lower on the PMA verbal mental age.

Though a few differences were found, this analysis revealed that the subjects seen and those not seen basically were comparable. We may conclude that the population seen for the second phase of the study was representative of the total population of third and fourth graders.

TABLE 11

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR SUBJECTS FAILING SCREENING BUT SEEN FOR INTENSIVE EVALUATION AND SUBJECTS FAILING SCREENING BUT NOT SEEN FOR INTENSIVE EVALUATION

	Seen (N=274)		Not Seen (N=137)		
Item	Mean	SD	Mean	SD	t
Chronological Age	9.12	.66	9.13	.68	-.12
PMA Verbal Raw Score	49.03	5.79	48.52	5.79	.85
PMA Verbal Mental Age	9.66	1.11	9.56	1.15	.84
PMA Verbal IQ	107.29	12.34	105.99	12.65	1.00
PMA Perceptual Raw Score	25.51	7.02	24.50	7.66	1.33
PMA Perceptual Mental Age	8.84	1.04	8.68	1.14	1.42
PMA Perceptual IQ	97.61	11.57	95.46	12.51	1.73
PMA Spatial Raw Score	17.08	4.80	15.88	4.57	2.44*
PMA Spatial Mental Age	9.22	1.39	8.86	1.26	2.60**
PMA Spatial IQ	101.43	16.80	96.93	14.78	2.66**
Mean Nonverbal Mental Age	9.05	1.05	8.79	1.07	2.32*
Mean Nonverbal IQ	99.80	12.23	96.41	11.69	2.69**
PMA Verbal Learning Quotient	103.32	8.49	102.60	8.44	.81
PMA Perceptual Learning Quotient	94.73	10.18	93.40	10.92	1.22
PMA Spatial Learning Quotient	98.90	14.33	95.23	12.68	2.55*
Mean Nonverbal Learning Quotient	97.03	10.28	94.51	10.06	2.36*
Metropolitan Reading Learning Quotient	95.24	13.27	97.47	13.22	-1.61
Metropolitan Spelling Learning Quotient	97.25	13.58	100.97	13.78	-2.61**
Metropolitan Problem Solving Learning Quotient	95.25	8.31	96.25	9.39	-1.10

TABLE 11 - Continued

Item	Seen (N=274) Mean	SD	Not Seen (N=137) Mean	SD	t
Metropolitan Reading					
Raw Score	21.45	9.52	22.46	9.67	-1.01
Scaled Score	45.45	10.65	46.55	10.72	-.99
Grade	3.73	1.44	3.90	1.49	-1.12
Age	8.91	1.45	9.08	1.50	-1.16
Metropolitan Spelling					
Raw Score	16.87	12.32	19.53	12.26	-2.06*
Scaled Score	47.07	10.62	49.28	10.51	-2.00*
Grade	3.92	1.47	4.23	1.50	-1.99*
Age	9.09	1.48	9.41	1.51	-2.01*
Metropolitan Problem Solving					
Raw Score	13.84	7.38	14.24	7.39	-.52
Scaled Score	45.59	9.96	46.09	10.29	-.48
Grade	3.71	.96	3.77	1.03	-.60
Age	8.89	.96	8.95	1.04	-.56
Expectancy Age	9.34	.56	9.31	.61	.54
	(N=130)		(N=49)		
Metropolitan Word Knowledge					
Raw Score	29.18	11.91	30.82	11.67	-.83
Scaled Score	51.85	10.58	53.14	10.77	-.72
Grade	4.48	1.50	4.70	1.58	-.86
Age	9.65	1.51	9.88	1.60	-.90
Learning Quotient	110.32	16.19	104.90	13.01	-1.77
Metropolitan Word Discrimination					
Raw Score	23.24	9.77	25.45	9.56	-1.36
Scaled Score	52.13	11.59	54.92	12.00	-1.42
Grade	4.39	1.28	4.69	1.31	-1.40
Age	9.55	1.27	9.85	1.31	-1.40
Learning Quotient	99.27	14.84	104.67	11.44	-2.30

* p less than .05
** p less than .01

TABLE 12

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR CHILDREN FAILING SCREENING SEEN AND CHILDREN FAILING SCREENING NOT SEEN FOR INTENSIVE EXAMINATION: THIRD GRADE BOYS

Item	Seen (N=99) Mean	SD	Not Seen (N-37) Mean	SD	t
Chronological Age	8.66	.46	8.68	.49	-.19
PMA Verbal Raw Score	47.45	5.29	45.54	5.53	1.85
PMA Verbal Mental Age	9.31	1.01	8.94	.88	2.00*
PMA Verbal IQ	106.68	12.66	102.16	11.11	1.91
PMA Perceptual Raw Score	23.28	6.87	22.22	6.48	.82
PMA Perceptual Mental Age	8.49	1.06	8.36	1.03	.67
PMA Perceptual IQ	96.11	12.36	93.97	12.42	.90
PMA Spatial Raw Score	17.62	5.07	15.70	5.90	1.87
PMA Spatial Mental Age	9.39	1.47	8.88	1.57	1.77
PMA Spatial IQ	105.77	17.82	98.97	19.97	1.91
Mean Nonverbal Mental Age	8.96	1.10	8.65	1.16	1.44
Mean Nonverbal IQ	101.24	13.14	96.65	14.24	1.77
PMA Verbal Learning Quotient	104.05	8.96	101.24	8.07	1.67
PMA Perceptual Learning Quotient	95.00	10.63	95.19	10.96	-.09
PMA Spatial Learning Quotient	104.88	15.00	100.49	16.15	1.49
Mean Nonverbal Learning Quotient	100.18	10.67	97.97	11.57	1.05
Metropolitan Reading Learning Quotient	92.37	8.59	92.95	10.45	-.33
Metropolitan Spelling Learning Quotient	93.43	10.20	96.59	12.35	-1.52
Metropolitan Problem Solving Learning Quotient	94.30	6.22	96.65	7.58	-1.84

TABLE 12 - Continued

Item	Seen (N=99) Mean	SD	Not Seen (N=37) Mean	SD	t
Metropolitan Reading					
Raw Score	16.90	6.82	16.22	7.41	.51
Scaled Score	40.42	7.48	39.68	8.15	.51
Grade	3.07	.82	3.00	.91	.43
Age	8.25	.82	8.19	.91	.39
Metropolitan Spelling					
Raw Score	10.45	8.67	11.78	9.37	-.78
Scaled Score	41.69	7.52	42.76	7.83	-.73
Grade	3.18	.97	3.32	1.04	-.77
Age	8.35	.97	8.51	1.03	-.84
Metropolitan Problem Solving					
Raw Score	9.97	5.16	10.84	5.99	-.84
Scaled Score	40.31	7.19	41.27	8.21	-.66
Grade	3.23	.58	3.34	.67	-.87
Age	8.42	.58	8.52	.66	-.80
Expectancy Age	8.94	.37	8.82	.35	1.74
	(N=38)		(N=15)		
Metropolitan Word Knowledge					
Raw Score	21.63	9.92	20.07	9.85	.52
Scaled Score	45.76	8.65	43.80	8.99	.74
Grade	3.60	1.05	3.43	1.01	.52
Age	8.75	1.03	8.62	1.01	.42
Learning Quotient	93.79	18.45	98.40	10.82	-.91
Metropolitan Word Discrimination					
Raw Score	17.61	8.69	16.33	8.93	.48
Scaled Score	45.50	9.89	44.40	10.32	.36
Grade	3.65	1.05	3.51	1.10	.43
Age	8.84	1.05	8.67	1.07	.53
Learning Quotient	94.79	19.17	98.93	11.77	-.78

* p less than .05

TABLE 13

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR CHILDREN FAILING SCREENING SEEN AND CHILDREN FAILING SCREENING NOT SEEN FOR INTENSIVE EXAMINATIONS: THIRD GRADE GIRLS

	Seen (N=38)		Not Seen (N=28)		
Item	Mean	SD	Mean	SD	t
Chronological Age	8.60	.42	8.50	.36	1.04
PMA Verbal Raw Score	45.13	7.60	45.89	5.67	-.45
PMA Verbal Mental Age	8.99	.95	9.04	.91	-.20
PMA Verbal IQ	103.66	11.13	104.75	12.24	-.38
PMA Perceptual Raw Score	25.08	7.21	20.79	6.37	2.51*
PMA Perceptual Mental Age	8.78	1.06	8.11	1.02	2.54*
PMA Perceptual IQ	99.63	12.00	92.32	12.04	2.44*
PMA Spatial Raw Score	15.37	5.00	13.89	3.76	1.41
PMA Spatial Mental Age	8.73	1.31	8.26	.94	1.64
PMA Spatial IQ	97.37	17.03	92.93	12.10	1.18
Mean Nonverbal Mental Age	8.78	1.05	8.20	.83	2.42*
Mean Nonverbal IQ	98.74	12.88	92.82	10.21	2.01*
PMA Verbal Learning Quotient	101.32	9.16	103.21	8.66	-.85
PMA Perceptual Learning Quotient	99.18	10.91	92.79	11.51	2.30*
PMA Spatial Learning Quotient	98.76	13.95	94.39	10.57	1.39
Mean Nonverbal Learning Quotient	99.18	10.61	93.68	9.24	2.20*
Metropolitan Reading Learning Quotient	97.05	12.66	98.07	10.56	-.35
Metropolitan Spelling Learning Quotient	96.68	12.49	100.18	13.81	-1.07
Metropolitan Problem Solving Learning Quotient	95.74	6.42	97.14	7.96	-.79

TABLE 13 - Continued

Item	Seen (N=38) Mean	Seen (N=38) SD	Not Seen (N=28) Mean	Not Seen (N=28) SD	t
Metropolitan Reading					
Raw Score	19.61	8.82	19.79	8.28	-.08
Scaled Score	43.39	9.50	43.29	9.02	.05
Grade	3.48	1.25	3.40	.96	.29
Age	8.66	1.24	8.58	.95	.28
Metropolitan Spelling					
Raw Score	13.03	11.52	14.86	11.81	-.63
Scaled Score	43.47	9.61	44.86	9.70	-.58
Grade	3.44	1.25	3.59	1.24	-.48
Age	8.61	1.23	8.76	1.20	-.50
Metropolitan Problem Solving					
Raw Score	10.68	5.59	10.86	5.95	-.12
Scaled Score	41.50	7.17	41.32	8.30	.09
Grade	3.32	.62	3.33	.67	-.02
Age	8.50	.63	8.50	.67	.01
Expectancy Age	8.87	.31	8.75	.28	1.65
	(N=16)		(N=8)		
Metropolitan Word Knowledge					
Raw Score	27.25	11.04	32.00	6.46	-1.12
Scaled Score	49.94	8.95	53.25	4.53	-.98
Grade	4.18	1.29	4.58	.72	-.80
Age	9.35	1.28	9.73	.70	-.77
Learning Quotient	103.25	13.74	109.37	9.75	-1.12
Metropolitan Word Discrimination					
Raw Score	21.69	9.77	27.50	6.30	-1.52
Scaled Score	50.31	10.16	55.13	6.22	-1.22
Grade	4.14	1.20	4.79	.75	-1.38
Age	9.35	1.20	9.89	.66	-1.28
Learning Quotient	101.69	12.22	111.25	10.19	-1.90

* p less than .05

TABLE 14

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR CHILDREN FAILING SCREENING SEEN AND CHILDREN FAILING SCREENING NOT SEEN FOR INTENSIVE EXAMINATIONS: FOURTH GRADE BOYS

Item	Seen (N=91) Mean	Seen (N=91) SD	Not Seen (N=41) Mean	Not Seen (N=41) SD	t
Chronological Age	9.61	.50	9.74	.50	1.41
PMA Verbal Raw Score	51.05	4.40	51.44	3.71	-.49
PMA Verbal Mental Age	10.03	.98	10.12	.93	-.48
PMA Verbal IQ	107.84	11.72	108.17	11.32	-.15
PMA Perceptual Raw Score	27.69	6.58	26.56	8.00	.85
PMA Perceptual Mental Age	9.17	.95	8.97	1.15	1.04
PMA Perceptual IQ	98.78	10.92	95.85	13.06	1.34
PMA Spatial Raw Score	18.05	4.57	17.71	3.76	.43
PMA Spatial Mental Age	9.50	1.38	9.35	1.15	.63
PMA Spatial IQ	102.56	16.00	100.17	13.16	.84
Mean Nonverbal Mental Age	9.35	1.03	9.20	1.06	.81
Mean Nonverbal IQ	100.99	11.69	98.27	11.37	1.25
PMA Verbal Learning Quotient	102.66	7.83	103.00	7.59	-.23
PMA Perceptual Learning Quotient	93.93	9.10	91.34	10.81	1.43
PMA Spatial Learning Learning Quotient	97.26	12.64	95.12	10.92	.94
Mean Nonverbal Learning Quotient	95.77	9.13	93.59	9.57	1.25
Metropolitan Reading Learning Quotient	93.16	14.17	97.71	15.38	-1.66
Metropolitan Spelling Learning Quotient	96.38	14.93	99.54	12.27	-1.18
Metropolitan Problem Solving Learning Quotient	94.02	8.46	94.37	10.54	-.20

TABLE 14 - Continued

Item	Seen (N=91) Mean	SD	Not Seen (N=41) Mean	SD	t
Metropolitan Reading					
Raw Score	23.19	9.67	25.93	8.74	-1.55
Scaled Score	47.29	10.81	50.54	9.90	-1.64
Grade	3.91	1.44	4.40	1.58	-1.74
Age	9.09	1.44	9.60	1.61	-1.81
Metropolitan Spelling					
Raw Score	19.45	12.06	22.98	9.81	-1.64
Scaled Score	49.35	10.43	52.17	8.31	-1.53
Grade	4.22	1.46	4.60	1.29	-1.43
Age	9.40	1.48	9.78	1.31	-1.39
Metropolitan Problem Solving					
Raw Score	16.45	6.96	16.88	7.07	-.33
Scaled Score	49.10	9.05	49.80	9.78	-.40
Grade	3.99	.88	4.10	1.12	-.56
Age	9.17	.88	9.27	1.14	-.52
Expectancy Age	9.76	.37	9.82	.35	-.85
	(N=50)		(N=11)		
Metropolitan Word Knowledge					
Raw Score	31.46	10.81	36.55	9.33	-1.44
Scaled Score	53.48	9.50	58.64	9.90	-1.62
Grade	4.70	1.39	5.46	1.68	-1.58
Age	9.87	1.41	10.65	1.74	-1.61
Learning Quotient	100.06	14.12	105.91	15.94	-1.22
Metropolitan Word Discrimination					
Raw Score	24.20	9.16	29.45	6.04	-1.81
Scaled Score	53.06	10.95	59.73	9.96	-1.86
Grade	4.51	1.22	5.21	1.06	-1.76
Age	9.66	1.19	10.40	1.09	-1.90
Learning Quotient	97.98	12.41	103.45	10.19	-1.36

No significant differences found between groups.

TABLE 15

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR CHILDREN FAILING SCREENING SEEN AND CHILDREN FAILING SCREENING NOT SEEN FOR INTENSIVE EXAMINATIONS: FOURTH GRADE GIRLS

Item	Seen (N=46) Mean	SD	Not Seen (N=31) Mean	SD	t
Chronological Age	9.56	.42	9.42	.38	1.53
PMA Verbal Raw Score	51.65	4.74	50.58	5.86	.88
PMA Verbal Mental Age	10.22	1.15	10.04	1.32	.63
PMA Verbal IQ	110.52	13.21	108.77	15.41	.53
PMA Perceptual Raw Score	26.37	6.73	27.87	7.54	-.91
PMA Perceptual Mental Age	8.97	.96	9.17	1.06	-.90
PMA Perceptual IQ	96.83	10.49	99.55	11.72	-1.07
PMA Spatial Raw Score	15.41	3.72	15.55	3.51	-.16
PMA Spatial Mental Age	8.71	1.01	8.72	.97	-.06
PMA Spatial IQ	93.20	11.95	93.81	10.19	-.23
Mean Nonverbal Mental Age	8.86	.84	8.96	.91	-.53
Mean Nonverbal IQ	95.24	9.58	96.90	9.63	-.75
PMA Verbal Learning Quotient	104.70	7.97	103.13	9.87	.77
PMA Perceptual Learning Quotient	92.07	9.68	94.55	10.50	-1.07
PMA Spatial Learning Quotient	89.39	9.96	89.84	9.55	-.20
Mean Nonverbal Learning Quotient	90.93	8.16	92.35	8.79	-.73
Metropolitan Reading Learning Quotient	104.00	16.32	102.03	14.10	.55
Metropolitan Spelling Learning Quotient	107.63	13.22	108.81	14.67	-.37
Metropolitan Problem Solving Learning Quotient	99.30	11.65	97.45	10.87	.70

TABLE 15 - Continued

Item	Seen (N=46) Mean	SD	Not Seen (N=31) Mean	SD	t
Metropolitan Reading					
Raw Score	29.30	8.93	27.74	9.74	.73
Scaled Score	54.30	10.57	52.42	10.56	.77
Grade	4.96	1.75	4.75	1.61	.54
Age	10.15	1.80	9.93	1.61	.56
Metropolitan Spelling					
Raw Score	28.76	9.82	28.42	11.38	.14
Scaled Score	57.09	8.95	57.23	10.15	-.06
Grade	5.32	1.36	5.39	1.55	-.21
Age	10.49	1.42	10.58	1.59	-.26
Metropolitan Problem Solving					
Raw Score	19.59	7.82	17.87	7.62	.95
Scaled Score	53.39	11.02	51.26	10.65	.84
Grade	4.50	1.24	4.27	1.17	.82
Age	9.68	1.27	9.46	1.19	.75
Expectancy Age	9.74	.43	9.71	.43	.32
	(N=26)		(N=15)		
Metropolitan Word Knowledge					
Raw Score	37.00	10.97	36.73	9.95	.08
Scaled Score	58.81	11.27	58.40	9.48	.12
Grade	5.55	1.63	5.49	1.55	.12
Age	10.74	1.66	10.67	1.59	.14
Learning Quotient	108.81	13.97	108.27	12.84	.12
Metropolitan Word Discrimination					
Raw Score	30.58	7.21	30.53	7.48	.02
Scaled Score	61.15	9.80	61.80	10.45	-.20
Grade	5.38	1.06	5.43	1.14	-.16
Age	10.53	1.07	10.61	1.17	-.20
Learning Quotient	107.00	9.73	107.80	10.60	-.25

No significant differences found between groups.

Combining School Districts for Analysis

An analysis of variance was performed to determine the effects of grade, sex, and geography on several of the measures obtained in the study. These measures were Verbal IQ, Non-verbal IQ, Spatial IQ, Perceptual IQ, Reading grade age, Arithmetic grade age, and Spelling grade age as dependent variables in seven separate analyses with one dependent variable for each analysis. A mixed model, with sex as the fixed independent variable and grade and geography as random independent variables, was used. It could be expected that grade would be significant as children of different grades would have unequal competencies in the areas evaluated. Review of Table 16 reveals that grade placement was significant for Verbal IQ, Arithmetic grade age, and Spelling grade age. It was not significant for Non-verbal IQ, Spatial IQ, Perceptual IQ, and Reading grade age.

The effects of sex were not tested as this mixed model does not provide an adequate error term for the fixed variable. This was not considered crucial as other analyses have provided this information. Our primary interest was the effect of geography on our measures. As the tables indicate, geography was not significant for three of our measures, Spatial IQ, Perceptual IQ, and Non-verbal IQ, but was significant when testing for the effects on Verbal IQ, Reading, Arithmetic, and Spelling grade ages. This finding is not surprising for our total population comes from different socioeconomic backgrounds and it is in academic areas that this influence can be expected. The schools used in our study are not unique in manifesting this almost certain prediction of difference. Therefore, by combining our four school systems for analysis we invest our total sample with greater diversity and therefore greater generality when we wish to extrapolate our results to other similar but untested populations.

Selection of Age Score for Statistical Analysis

The tests used yielded either IQ scores, scaled scores, grade scores, raw scores, or age scores. For the purposes of this study age scores were used in the primary statistical analysis. Mental age and other age units were selected as most adequate in measuring the child's level of development in relation to persons of corresponding chronological age. The advantages of using age scores were that they are easily understood and that all tests used yielded an age score directly or they were easily converted to them.

The basic criticism of nonuniformity of age units, i.e., that a unit of mental age at an early age was not the same as a unit of mental age at another and later age, did not affect this study as comparisons were made horizontally, i.e., among persons of approximately the same chronological age and where the age units could be considered equal.

Description of the total population was completed for all possible measures, but for the purposes of this report the descriptive statistics of the age scores for the total screening population are presented in Tables 17 and 18. Table 19 gives the IQ means for the total group.

TABLE 16

ANALYSIS OF VARIANCE FOR MEAN SCORES
ON SCREENING VARIABLES

Source of Variation	Verbal IQ df	SS	MS	F	Nonverbal IQ df	SS	MS	F
Sex	1	.34	.34	--	1	1.69	1.69	--
Grade	1	26.55	26.55	12.46*	1	6.66	6.66	1.44
Geography	3	75.86	25.29	11.87*	3	46.82	15.61	3.37
Sex & Grade	1	.36	.36	.39	1	.21	.21	.21
Sex & Geography	3	2.08	.69	.75	3	2.92	.97	.98
Grade & Geography	3	6.38	2.13	--	3	13.89	4.63	--
Sex, Grade & Geography	3	2.77	.92	--	3	2.97	.99	--
Total	15				15			

Source of Variation	Spatial IQ df	SS	MS	F	Perceptual IQ df	SS	MS	F
Sex	1	65.29	65.29	--	1	28.09	28.09	--
Grade	1	.20	.20	.03	1	24.85	24.85	5.77
Geography	3	78.85	26.28	3.42	3	59.30	19.77	4.59
Sex & Grade	1	1.35	1.35	.65	1	.00	--	--
Sex & Geography	3	7.20	2.40	1.15	3	.76	.25	.52
Grade & Geography	3	23.08	7.69	--	3	12.93	4.31	--
Sex, Grade & Geography	3	6.26	2.09	--	3	1.44	.48	--
Total	15				15			

TABLE 16 - Continued

Source of Variation	Arithmetic Grade Age df	SS	MS	F	Spelling Grade Age df	SS	MS	F
Sex	1	.04	.04	--	1	.98	.98	--
Grade	1	4.14	4.14	414**	1	4.18	4.18	209**
Geography	3	1.64	.55	54.67**	3	3.01	1.00	50**
Sex & Grade	1	.01	.01	.50	1	.00	--	--
Sex & Geography	3	.02	.01	.50	3	.00	--	--
Grade & Geography	3	.04	.01	--	3	.07	.02	--
Sex, Grade & Geography	3	.07	.02	--	3	.09	.03	--
Total	15				15			

Source of Variation	Reading Grade Age df	SS	MS	F
Sex	1	3.88	3.88	--
Grade	1	.20	.20	10.00
Geography	3	2.50	.83	41.50**
Sex & Grade	1	.02	.02	2.00
Sex & Geography	3	.01	.00	--
Grade & Geography	3	.05	.02	--
Sex, Grade & Geography	3	.02	.01	--
Total	15			

* p less than .05
** p less than .01

TABLE 17

MENTAL AGE MEANS AND STANDARD DEVIATIONS
FOR THE TOTAL SCREENING POPULATION BY AGE, GRADE, AND SEX

		Third Grade					Fourth Grade					Combined
		7 yr	8 yr	9 yr	10 yr	Total	8 yr	9 yr	10 yr	11 yr	Total	Total
Verbal MA	N	39	591	84	3	717	48	568	66	1	683	1400
Boys	Mean	9.2	9.4	9.4	9.3	9.4	10.0	10.2	10.4	11.7	10.2	9.8
	SD	1.0	0.9	1.0	.7	1.0	1.1	1.1	1.1	0.0	1.1	1.1
Verbal MA	N	55	559	37	3	654	59	544	40	1	644	1298
Girls	Mean	8.8	9.3	9.8	9.6	9.3	10.0	10.2	10.3	9.3	10.2	9.7
	SD	.8	.9	1.0	1.1	1.0	1.0	1.0	1.0	0.0	1.0	1.1
Perceptual MA	N	39	591	84	3	717	48	568	66	1	683	1400
Boys	Mean	8.7	8.8	8.8	8.7	8.9	9.3	9.6	9.4	10.0	9.6	9.8
	SD	.8	.9	1.0	.9	.9	.9	.9	.9	0.0	.9	1.0
Perceptual MA	N	55	559	37	3	654	59	544	40	1	644	1298
Girls	Mean	8.7	9.1	9.4	10.0	9.0	9.5	9.8	9.8	9.5	9.8	9.4
	SD	.8	.9	.8	0.0	.9	.9	.9	.9	0.0	.9	1.0

TABLE 17 - Continued

		Third Grade					Fourth Grade					Combined
		7 yr	8 yr	9 yr	10 yr	Total	8 yr	9 yr	10 yr	11 yr	Total	Total
Spatial MA	N	39	591	84	3	717	48	568	66	1	583	1400
Boys	Mean	9.6	9.7	9.7	9.9	9.7	10.1	10.2	10.2	11.8	10.2	9.9
	SD	1.4	1.2	1.3	.5	1.2	1.0	1.2	1.1	0.0	1.2	1.2
Spatial MA	N	55	559	37	3	654	59	544	40	1	644	1298
Girls	Mean	9.0	9.4	9.5	8.7	9.4	9.6	9.8	10.1	9.3	9.8	9.6
	SD	1.0	1.2	1.4	.7	1.2	1.1	.8	1.2	0.0	1.2	1.2
Non-Verbal MA	N	39	591	84	3	717	48	568	66	1	583	1400
Boys	Mean	9.2	9.3	9.3	9.3	9.3	9.7	9.9	9.8	10.9	9.9	9.6
	SD	.9	.9	.9	.6	.9	.7	.9	.9	0.0	.9	.9
Non-Verbal MA	N	55	559	37	3	654	59	544	40	1	644	1298
Girls	Mean	8.9	9.3	9.5	9.4	9.2	9.5	9.8	10.0	9.4	9.3	9.5
	SD	.7	.9	1.0	.4	.9	.8	.8	.8	0.0	.8	.9

Table 17 - Continued

		Third Grade					Fourth Grade					Combined
		7 yr	8 yr	9 yr	10 yr	Total	8 yr	9 yr	10 yr	11 yr	Total	Total
<u>Reading</u> <u>MA</u>	N	39	591	84	3	717	48	568	66	1	683	1400
Boys	Mean	9.1	9.5	9.3	8.9	9.4	10.4	10.6	10.3	10.3	10.5	9.9
	SD	1.2	1.2	1.2	.3	1.2	1.6	1.5	1.8	0.0	1.5	1.5
<u>Reading</u> <u>MA</u>	N	55	559	37	3	654	59	544	40	1	644	1298
Girls	Mean	9.5	9.7	10.0	9.9	9.7	10.5	10.7	10.8	9.8	10.7	10.2
	SD	1.0	1.2	1.5	.5	1.2	1.3	1.3	1.7	0.0	1.4	1.4
<u>Spelling</u> <u>MA</u>	N	39	591	84	3	717	48	568	66	1	683	1400
Boys	Mean	9.5	9.7	9.5	9.1	9.7	10.5	10.8	10.2	9.2	10.7	10.2
	SD	1.1	1.3	1.5	.1	1.3	1.3	1.3	1.6	0.0	1.3	1.4
<u>Spelling</u> <u>MA</u>	N	55	559	37	3	654	59	544	40	1	644	1298
Girls	Mean	10.0	10.1	10.4	9.9	10.1	11.2	11.3	11.1	10.7	11.3	10.7
	SD	1.2	1.3	1.4	.1	1.3	1.3	1.2	1.3	0.0	1.2	1.4

Table 17 - Continued

		Third Grade					Fourth Grade					Combined
		7 yr	8 yr	9 yr	10 yr	Total	8 yr	9 yr	10 yr	11 yr	Total	Total
Arithmetic MA	N	39	591	84	3	717	48	568	66	1	683	1400
Boys	Mean	8.9	9.2	9.2	8.8	9.2	10.3	10.3	9.9	11.2	10.3	9.7
	SD	.6	.9	1.0	.3	.9	1.2	1.2	1.3	0.0	1.2	1.2
Arithmetic MA	N	55	559	37	3	654	59	544	40	1	644	1298
Girls	Mean	8.8	9.1	9.4	8.8	9.1	10.0	10.2	10.2	10.1	10.2	9.6
	SD	.5	.7	1.0	.4	.7	1.0	1.0	1.2	0.0	1.0	1.0

TABLE 18

MENTAL AGE MEANS AND STANDARD DEVIATIONS
ON WORD KNOWLEDGE AND WORD DISCRIMINATION TESTS
FOR SCHOOLS A, B, AND C BY AGE, SEX, AND GRADE

		Third Grade					Fourth Grade					Combined
		7 yr	8 yr	9 yr	10 yr	Total	8 yr	9 yr	10 yr	11 yr	Total	Total
Word Knowledge MA												
	N	10	304	52	3	369	13	265	45	1	324	693
Boys	Mean	9.8	9.9	9.8	9.1	9.9	10.4	10.8	10.4	10.8	10.7	10.3
	SD	1.4	1.0	1.2	.2	1.0	1.0	.9	1.2	0.0	.9	1.1
Word Knowledge MA												
	N	13	282	30	3	328	21	291	29	1	342	670
Girls	Mean	10.0	10.2	10.4	10.0	10.2	10.8	10.9	10.9	10.2	10.9	10.6
	SD	.6	.9	1.0	.2	.9	.9	.7	.9	0.0	.8	.9
Word Discrimination MA												
	N	10	304	52	3	369	13	265	45	1	324	693
Boys	Mean	9.6	9.9	9.9	8.9	9.9	10.8	11.1	10.9	10.8	11.1	10.4
	SD	1.6	1.1	1.3	.3	1.2	1.3	1.2	1.7	0.0	1.3	1.4
Word Discrimination MA												
	N	13	282	30	3	328	21	291	29	1	342	670
Girls	Mean	9.7	10.1	10.6	9.8	10.1	11.1	11.2	11.2	10.0	11.2	10.7
	SD	.7	1.0	1.4	.4	1.1	1.1	1.1	1.6	0.0	1.1	1.2

TABLE 19

IQ SCORE MEANS AND STANDARD DEVIATIONS
FOR THE TOTAL SCREENING POPULATION BY AGE, SEX, AND GRADE

		Third Grade					Fourth Grade					Combined
		7 yr	8 yr	9 yr	10 yr	Total	8 yr	9 yr	10 yr	11 yr	Total	Total
Verbal IQ												
	N	39	591	84	3	717	48	568	66	1	683	1400
Boys	Mean	111.0	109.6	103.8	97.0	108.9	111.5	111.2	108.7	115.0	111.0	110.0
	SD	11.3	10.8	12.9	10.4	11.3	13.6	12.4	13.2	0.0	12.6	12.0
Verbal IQ												
	N	55	559	37	3	654	59	544	40	1	644	1298
Girls	Mean	107.1	108.7	108.7	97.7	108.5	112.1	111.2	107.9	89.0	111.0	109.7
	SD	10.5	11.0	11.1	14.2	11.0	11.0	11.6	12.5	0.0	11.7	11.4
Perceptual IQ												
	N	39	591	84	3	717	48	568	66	1	683	1400
Boys	Mean	102.4	101.7	97.7	91.0	101.2	103.7	104.3	98.3	98.0	103.7	102.4
	SD	9.3	10.3	11.9	10.6	10.6	9.6	10.3	10.2	0.0	10.4	10.5
Perceptual IQ												
	N	55	559	37	3	654	59	544	40	1	644	1298
Girls	Mean	102.6	103.8	104.0	104.7	103.7	105.7	106.8	102.8	94.0	106.4	105.1
	SD	9.0	10.2	9.3	1.5	10.0	9.7	9.3	9.8	0.0	9.4	9.8

TABLE 19 - Continued

		Third Grade					Fourth Grade					Combined
		7 yr	8 yr	9 yr	10 yr	Total	8 yr	9 yr	10 yr	11 yr	Total	Total
Spatial IQ	N	39	591	84	3	717	48	568	66	1	683	1400
Boys	Mean	112.4	111.0	106.2	104.7	110.5	112.9	111.5	107.5	120.0	111.3	110.9
	SD	17.4	15.0	15.2	6.1	15.2	12.3	14.6	13.5	0.0	14.4	14.8
Spatial IQ	N	55	559	37	3	654	59	544	40	1	644	1298
Girls	Mean	105.5	107.4	105.5	90.7	107.1	106.1	106.9	107.4	93.0	106.9	107.0
	SD	12.7	14.5	17.0	7.0	14.5	13.6	13.7	14.2	0.0	13.7	14.1
Non-Verbal IQ	N	39	591	84	3	717	48	568	66	1	683	1400
Boys	Mean	107.7	106.6	102.2	98.3	106.1	108.6	108.2	103.2	109.0	107.7	106.9
	SD	10.8	10.4	11.1	7.6	10.6	8.5	10.2	10.1	0.0	10.2	10.4
Non-Verbal IQ	N	55	559	37	3	654	59	544	40	1	644	1298
Girls	Mean	104.1	105.9	105.0	98.0	105.6	106.2	107.1	105.3	94.0	106.9	106.3
	SD	8.7	10.5	11.7	3.6	10.4	9.6	9.3	9.7	0.0	9.4	9.9

Results

The results from the screening test battery were analyzed in two ways, on the basis of pass or fail. Of the total number of subjects, 2294 met the criteria for passing (see Table 20) and 410 failed (see Table 21). To further explore the score differences accordingly, those who failed were compared with a random sample of those who passed. These data are presented in Table 21. The mean scores for the random sample are comparable to the results for the total pass sample shown in Table 20.

That those who failed to meet the criteria were different from those who did not is clearly apparent. The only variable on which the pass group was not superior is on verbal MA. This is of interest because of the suggestion that those who failed did not do so because of a generalized incapacity to learn. It is noteworthy also that the fail group was significantly older than the pass group. Again, the implication is that, though older and of equal intelligence verbally, the fail group was not learning normally in comparison with those who successfully met the established criteria. Failure in attaining normal academic learning was not limited to a given area such as reading, though reading was substantially retarded. Lack of average achievement or development was found also in nonverbal functions, both spatial and perceptual. It is apparent that the screening test battery differentiated between the pass and fail groups and that all of the items in the battery were useful for this purpose.

Validation of Screening Test Battery

The research protocol required that, to the extent possible, the screening test criteria should be validated through the results obtained from a follow-up, intensive evaluation of those who failed to meet the criteria and a comparable group of normal children. A number of such comparisons were made.

As discussed elsewhere, on the basis of the intensive evaluations those who were deficient in learning were classified as borderline (LQ 89-85) or as learning disability (LQ 84 and below). Using this basis for grouping, the screening test results were studied. As can be seen in Table 22, all of the tests used in the screening battery differentiated between those classified as borderline and a normal comparison group.

Equivalent results were obtained for those classified as learning disability, see Table 23. Though they were older, those having deficits in learning scored lower on all of the screening tests. As anticipated on the basis of the classifications employed, the learning disability sample showed greater inferiority in educational achievement in comparison with the borderline group. From this analysis we see that the results from the intensive evaluation studies confirm the findings

TABLE 20

SCREENING TEST MEANS AND STANDARD DEVIATIONS FOR SUBJECTS WHO PASSED CRITERIA (N=2294)

Test	Mean	SD
Chronological Age	8.93	.61
PMA Verbal MA	9.78	1.09
PMA Verbal IQ	110.32	11.51
PMA Perceptual MA	9.38	.93
PMA Perceptual IQ	104.89	9.49
PMA Spatial MA	9.89	1.16
PMA Spatial IQ	110.61	13.67
PMA Mean Nonverbal MA	9.66	.84
PMA Mean Nonverbal IQ	108.00	9.12
Metropolitan Reading - Grade	5.08	1.32
Metropolitan Reading - Age	10.26	1.35
Metropolitan Spelling - Grade	5.47	1.24
Metropolitan Spelling - Age	10.65	1.28
Metropolitan Problem Solving - Grade	4.65	1.07
Metropolitan Problem Solving - Age	9.81	1.08
	(N=1191)	
Metropolitan Word Knowledge - Grade	5.51	1.19
Metropolitan Word Knowledge - Age	10.67	1.21
Metropolitan Word Discrimination - Grade	5.39	.87
Metropolitan Word Discrimination - Age	10.53	.89

TABLE 21

SCREENING TEST MEANS, STANDARD DEVIATIONS AND t-SCORES FOR THOSE WHO FAILED SCREENING (N=410) AND A RANDOM SAMPLE OF THOSE WHO PASSED SCREENING (N=223)

Test	Passed Screening (N=223) Mean	SD	Failed Screening (N=410) Mean	SD	t
Chronological Age	8.93	.57	9.12	.66	-3.60***
PMA Verbal MA	9.75	1.04	9.63	1.12	1.35
PMA Verbal IQ	109.84	11.34	106.86	12.46	2.97**
PMA Perceptual MA	9.46	.98	8.79	1.08	7.77***
PMA Perceptual IQ	105.62	9.88	96.95	11.87	9.30***
PMA Spatial MA	10.03	1.19	9.10	1.36	8.59***
PMA Spatial IQ	112.31	13.93	99.93	16.29	9.60***
PMA Mean Nonverbal MA	9.77	.89	8.97	1.06	9.58***
PMA Mean Nonverbal IQ	109.28	9.63	98.70	12.14	11.23***
Metropolitan Reading - Grade	5.02	1.26	3.78	1.46	10.68***
Metropolitan Reading - Age	10.21	1.30	8.97	1.47	10.59***
Metropolitan Spelling - Grade	5.42	1.26	4.02	1.49	11.92***
Metropolitan Spelling - Age	10.61	1.30	9.20	1.50	11.83***
Metropolitan Problem Solving - Grade	4.71	1.12	3.73	.98	11.43***
Metropolitan Problem Solving - Age	9.88	1.14	8.91	.99	11.15***
	(N=179)		(N=116)		
Metropolitan Word Knowledge - Grade	5.53	1.08	4.55	1.52	6.07***
Metropolitan Word Knowledge - Age	10.68	1.11	9.72	1.54	5.85***
Metropolitan Word Discrimination - Grade	5.42	.80	4.47	1.29	7.07***
Metropolitan Word Discrimination - Age	10.54	.84	9.63	1.28	6.71***

* p less than .05
** p less than .01
*** p less than .001

TABLE 22

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR THE BORDERLINE GROUP AND THE NORMAL CONTROLS ON THE SCREENING BATTERY (N=116)

Test	Borderline (N=116) Mean	SD	Control (N=116) Mean	SD	t
Chronological Age	9.00	.66	8.85	.66	1.77
PMA Verbal Mental Age	9.54	1.18	9.96	1.09	-2.81**
PMA Verbal IQ	106.94	12.11	113.10	10.71	-4.11***
PMA Perceptual Mental Age	8.96	.98	9.27	.97	-2.40*
PMA Perceptual IQ	99.86	11.04	104.12	9.41	-3.16**
PMA Spatial Mental Age	9.64	1.30	10.02	1.22	-2.33*
PMA Spatial IQ	107.23	15.25	112.66	14.00	-2.83**
Mean Nonverbal Mental Age	9.32	.95	9.68	.91	-2.90**
Mean Nonverbal IQ	103.73	10.86	108.60	1.22	-3.64***
Metropolitan Reading - Grade	4.03	1.40	5.09	1.38	-5.82***
Metropolitan Reading - Age	9.20	1.42	10.26	1.40	-5.72***
Metropolitan Spelling - Grade	4.41	1.53	5.48	1.37	-5.59***
Metropolitan Spelling - Age	9.58	1.54	10.66	1.41	-5.56***
Metropolitan Problem Solving - Grade	3.98	.98	4.69	1.21	-4.91***
Metropolitan Problem Solving - Age	9.15	.97	9.88	1.24	-4.99***
	(N=61)		(N=61)		
Metropolitan Word Knowledge - Grade	4.99	1.26	5.69	1.22	-3.15**
Metropolitan Word Knowledge - Age	10.14	1.27	10.85	1.25	-3.13**
Metropolitan Word Discrimination - Grade	4.90	.95	5.52	.84	-3.83***
Metropolitan Word Discrimination - Age	10.04	.95	10.65	.87	-3.70***

* p less than .05
** p less than .01
*** p less than .001

TABLE 23

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR THE LEARNING DISABILITY GROUP AND THE NORMAL CONTROLS ON THE SCREENING BATTERY (N=112)

	Learning Disability (N=112)		Control (N=112)		
Test	Mean	SD	Mean	SD	t
Chronological Age	9.18	.62	8.91	.60	3.34***
PMA Verbal Mental Age	9.49	.94	9.94	1.06	-3.37***
PMA Verbal IQ	104.71	11.43	112.52	10.40	-5.34***
PMA Perceptual Mental Age	9.01	1.06	9.28	.95	-2.02*
PMA Perceptual IQ	99.11	11.87	103.87	9.55	-3.31***
PMA Spatial Mental Age	9.44	1.33	10.11	1.08	-4.11***
PMA Spatial IQ	103.74	16.13	113.32	12.68	-4.94***
Mean Nonverbal Mental Age	9.24	1.06	9.72	.83	-3.71***
Mean Nonverbal IQ	101.74	12.53	108.80	8.90	-4.86***
Metropolitan Reading - Grade	3.28	.96	5.15	1.35	-11.92***
Metropolitan Reading - Age	8.46	.94	10.31	1.40	-11.57***
Metropolitan Spelling - Grade	3.58	1.16	5.32	1.20	-11.11***
Metropolitan Spelling - Age	8.75	1.17	10.51	1.23	-10.93***
Metropolitan Problem Solving - Grade	3.50	.68	4.62	1.02	-9.66***
Metropolitan Problem Solving - Age	8.68	.68	9.79	1.03	-9.48***
	(N=59)		(N=59)		
Metropolitan Word Knowledge - Grade	3.84	.96	5.57	1.24	-8.48***
Metropolitan Word Knowledge - Age	8.99	.95	10.73	1.26	-8.44***
Metropolitan Word Discrimination - Grade	3.94	1.02	5.33	.88	-7.94***
Metropolitan Word Discrimination - Age	9.10	.98	10.47	.91	-7.88***

* p less than .05
** p less than .01
*** p less than .001

from the screening test battery. Stated differently, the screening test results appear reliable in that intensive, individual diagnostic evaluation and subsequent classification confirm the deficits initially revealed by the screening test battery.

Discriminant Analysis

The usefulness of the screening tests for identification of children with learning disabilities was studied further. A discriminant analysis was performed in two ways, as shown by Tables 24 and 25. First, the total pass-fail sample was used with the result that six out of the seven tests employed were found to differentiate between the groups at the .01 level; PMA Spatial Relations failed to reach this level.

The second analysis (Table 25) consisted of comparing those who did not meet the screening criteria with a randomly selected normal comparison group. Though consistent with the findings for the total sample, in this comparison it was the PMA mean nonverbal score that did not reach the .01 level of significance. In general it may be concluded that the nonverbal scores were perhaps less stable but useful nevertheless. In any event, the discriminant analysis revealed that the screening tests were successful in differentiating between the pass-fail groups.

Analysis of Variance

Similar findings derived when the analysis of variance technique was applied; see Table 26. However, in contrast to the discriminant analysis which considered the tests in combination (see above), this technique disclosed that each of the seven screening tests differentiated between the pass-fail groups at the .01 level of significance.

Intercorrelation Analysis

From previous research we were aware that the intercorrelation technique could be revealing in terms of the nature of the learning disabilities that might be present in a given sample of children. Therefore, an intercorrelation analysis was made of the scores on all seven tests, comparing the pass and fail groups.

The results were highly revealing. As we found from other studies, the intercorrelations for each of the groups vary substantially. In general, the abilities measured show greater association and relationship for the pass group than for the fail group (Table 27). This is true irrespective of whether the function measured is comprised of verbal or nonverbal factors. For the fail group, certain nonverbal functions were not associated with the verbal, as seen in the perceptual speed results. Moreover, of considerable importance is the fact that spatial relations for the pass sample is positively correlated with reading but for the fail group it is negatively correlated.

TABLE 24

DISCRIMINANT ANALYSIS OF THE SCREENING VARIABLES FOR ALL SUBJECTS ON THE BASIS OF PASSED (N=2294), FAILED (N=410)

<u>Items significant at .01</u>	F
Metropolitan Spelling	422.61
PMA Mean Nonverbal	264.80
PMA Verbal	214.17
Metropolitan Reading	184.55
PMA Perceptual Speed	147.64
Metropolitan Problem Solving	123.01
<u>Items not significant at .01</u>	
PMA Spatial Relations	

TABLE 25

DISCRIMINANT ANALYSIS OF TEST RESULTS FOR THOSE WHO FAILED (N=410) AND A RANDOM SAMPLE OF THOSE WHO PASSED SCREENING (N=223)

Items significant at .01	F
Metropolitan Spelling	139.96
PMA Spatial Relations	122.21
PMA Verbal	97.60
Metropolitan Reading	83.79
PMA Perceptual Speed	70.54
Metropolitan Problem Solving	59.07
Items not significant at .01	
PMA Mean Nonverbal	

TABLE 26

ONE-WAY ANALYSIS OF VARIANCE OF TEST RESULTS FOR THOSE WHO PASSED AND THOSE WHO FAILED SCREENING

Significant Items	F
PMA Verbal	6.91**
PMA Perceptual Speed	134.85**
PMA Spatial Relations	154.39**
PMA Mean Nonverbal	217.98**
Metropolitan Reading	309.14**
Metropolitan Spelling	422.61**
Metropolitan Problem Solving	246.89**

* p less than .05
** p less than .01

TABLE 27

INTERCORRELATION OF TEST SCORES FOR CHILDREN PASSING AND CHILDREN FAILING SCREENING

	PMA Verbal	PMA Perceptual Speed	PMA Spatial Relations	Metropolitan Reading	Metropolitan Spelling	Metropolitan Problem Solving
PMA Verbal		P=.386 F=.160	P=.370	P=.610 F=.571	P=.393 F=.502	P=.509 F=.525
PMA Perceptual Speed			P=.278 F=.494	P=.319	P=.330	P=.392
PMA Spatial Relations				P= .360 F=-.231	P= .217 F=-.262	P=.408
Metropolitan Reading					P=.598 F=.724	P=.627 F=.711
Metropolitan Spelling						P=.611 F=.705

P = Passed Screening (N=2294)
F = Failed Screening (N=410)

Level of significance at .01: r = .054 (Passed Screening)
r = .127 (Failed Screening)

Factor Analysis

Another technique which proved useful in revealing group differences was factor analysis. These results are shown in Table 28. Of importance from the point of view of the psychology of learning is the fact that for the passed screening group all of the variables fell within a single factor. Irrespective of whether the function was verbal or nonverbal, factorially the abilities were related. In contrast, for the fail group two factors evolved, one verbal (Factor 1) and the other nonverbal (Factor 2). Moreover, the nonverbal results are in the negative direction, similar to the findings for the intercorrelation study; verbal and nonverbal functions were negatively associated.

The factor analysis, as well as the other results discussed in this section, indicate that the screening test battery differentiated between normal learners and those with learning deficiencies. Children who met the criteria for successful learning (pass group) show an integration of functions psychologically, verbal and nonverbal. Whereas those who did not meet the criteria for successful learning (fail group) show an inability in the relatedness of learned experience. For them learning verbally and nonverbally are not necessarily associated. It is on this basis that there might be an objective criterion for definition of a learning disability. Also, it is on this basis that special education becomes critical as a treatment approach because children having these deficiencies, though potentially normal, do not learn in the typical manner.

Results of this type have been found consistently when studying learning disability children. An implication is that the psychology of learning varies from the normal when a learning disability is present. Such implications are highly relevant to educators and to special education. Further discussion of this inference is given below under the results for the intensive study.

Summary

A battery of seven psychoeducational tests was administered to 2767 third and fourth graders. The criterion for pass-fail was a learning quotient of 90. This quotient represented the ratio of achievement to expectancy for learning. On this basis 15 percent of the population were defined as underachievers—further study revealed that approximately one-half (7.5 percent) of these fell into the learning disability category.

Statistical treatment emphasized comparison of those who passed and those who failed the screening criteria. These groups differed in various respects. A primary difference concerned the intercorrelation and factor analysis results. These findings indicated that those who failed the criteria were unable to normally interrelate verbal and nonverbal experience. The factors of mental ability were less associated. Hence, learning processes might vary and be less successful in comparison with the normal. The results from the intensive studies also disclosed this variation between good and poor learners.

TABLE 28

FACTOR ANALYSIS OF THE TEST VARIABLES FOR
THOSE WHO PASSED (N=2294) AND FAILED (N=410) THE SCREENING BATTERY

Passed	Failed
<u>Factor 1</u>	<u>Factor 1</u>
Metropolitan Problem Solving MA (.834)	Metropolitan Problem Solving (.872)
Metropolitan Reading MA (.833)	Metropolitan Reading (.884)
Metropolitan Spelling MA (.742)	Metropolitan Spelling (.863)
PMA Perceptual MA (.589)	PMA Verbal (.763)
PMA Spatial MA (.569)	
PMA Verbal MA (.759)	<u>Factor 2</u>
Percent of Variance 53.154	PMA Perceptual Speed (-.857)
	PMA Spatial Relations (-.852)
	Percent of Variance 26.293

MINIMAL BRAIN DAMAGE PROJECT

SECOND PHASE

THE VALIDATION STUDIES

THE PSYCHOEDUCATIONAL EVALUATION

THE PSYCHOEDUCATIONAL EVALUATION

Psychoeducational Test Battery

This battery of tests was compiled to measure facility in the areas of auditory and visual-perceptual skills, receptive and expressive language, academic achievement, verbal and nonverbal mental abilities, social perception, motor abilities, orientation in time and space, and social and emotional maturity.

A list of the tests included is presented in Table 29. The battery was comprised of 49 scores, or variables. However, of this number 21 were used as selective criteria and served as the basis for establishing the experimental and control populations; see Table 30. This means that of the 49 scores, 21 were used both as selective criteria and as a basis for statistical comparison of the groups. The remaining 28 scores served only as a basis for statistical evaluation of differences among the experimental and control groups. The record form for the intensive psychoeducational battery is presented in Appendix B.

Approximately five hours were required for administration of the test battery; these tests were given individually by members of the research team. As discussed below, the experimental population was composed of subjects who attained a learning quotient of 89 or below on one or more of the psychoeducational areas covered. The comparison population was obtained by matching each experimental child with another child of the same sex, grade and classroom.

Intensive Study Population

The lack of precise definition and terminology has hampered research efforts in the field of learning disabilities. In view of the complexity of the involvements deriving from dysfunctions in the brain and learning, the difficulties with terminology are not surprising. Many types of disturbances in learning and adjustment may ensue, making it difficult to find terms that adequately reflect the total problem.

Children with "specific learning problems" are considered homogeneous in that they have integrity motorically, intellectually, emotionally and sensorially but cannot learn in the normal manner. Differential diagnosis, therefore, requires demonstration of adequte motor, sensory, emotional and mental capacities and a deficit in learning (a discrepancy between potential and actual achievement).

On the basis of these considerations both experimental and control subjects for the intensive phase of the study demonstrated certain basic integrities: adequate sensory capacities, adequate intellectual capacities, adequate motor abilities, and adequate emotional adjustment.

The control subjects demonstrated adequacy in learning as defined by a Learning Quotient, whereas the experimental subjects demonstrated

TABLE 29

PSYCHOLOGICAL-EDUCATIONAL TEST BATTERY (Variables: N=49)

MENTAL ABILITY

(1) Wechsler Intelligence Scale for Children: all 12 subtests
(2) Detroit Test of Learning Aptitude:
- Verbal Opposites
- Auditory Attention Span for Unrelated Words
- Orientation
- Free Association
- Designs
- Auditory Attention Span for Related Syllables
- Visual Attention Span for Letters
- Oral Directions

(3) Healy Picture Completion Test
(4) Kent Oral Emergency, Scale D
(5) Goodenough-Harris Drawing Test
(6) Leiter International Performance Scale

EDUCATIONAL ACHIEVEMENT

(1) Gates-MacGinitie Reading Series: Primary C, Form 1, Form 2
Primary D, Form 1, Form 2

(2) Wide Range Achievement Test: Oral Reading
(3) Gates-Russell Spelling Diagnostic
(4) Gates-McKillop Reading Diagnostic
(5) Picture Story Language Test: Total Words
Total Sentences
Words Per Sentence
Abstract-Concrete
Syntax
(6) Metropolitan Achievement Test: Elementary Arithmetic Tests
Language

MOTOR ABILITY

Laterality: Kicking, Throwing, Catching

Heath Railwalking Test: All three rails

EMOTIONAL ADJUSTMENT

(1) IPAT Children's Personality Questionaire: Anxiety Scale

SOCIAL MATURITY

(2) Vineland Social Maturity Scale: Parents as informants

SENSORY ACUITY

Hearing: Pure-tone Audiometric Screening - 35 db, ISO, for 500, 1000, 4000 hs left and right ear
Vision: 20/40 visual acuity on both eyes as determined by ophthalmological examination

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TABLE 30

AREAS ON WHICH THE SUBJECTS WERE CLASSIFIED AS EXPERIMENTAL OR CONTROL (Variables: N=21)

AUDITORY RECEPTIVE LANGUAGE	
(1) Detroit Test of Learning Aptitude:	Orientation
(2) Kent EGY: Scale D	
AUDITORY EXPRESSIVE LANGUAGE	
(1) Detroit Test of Learning Aptitude:	Verbal Opposites
	Free Association
(2) Oral Picture Story Language Test:	Words Per Sentence
	Abstract-Concrete
READING	
(1) Gates-MacGinitie Reading Series:	Primary C, Form 1, 2
	Primary D, Form 1, 2
	Accuracy
	Comprehension
	Vocabulary
WRITTEN LANGUAGE	
(1) Picture Story Language Test:	Total Words
	Words Per Sentence
	Syntax
	Abstract-Concrete
(2) Metropolitan Language Arts	
(3) Metropolitan Spelling	
ARITHMETIC	
(1) Metropolitan Elementary Battery:	Computation
(2) Primary Mental Abilities:	Number Facility
NONVERBAL	
(1) Detroit Test of Learning Aptitude:	Designs
(2) Goodenough-Harris Draw-A-Man	
(3) Healy Picture Completion Test: I	
(4) Leiter International Performance Scale	

a deficit in at least one of the learning areas covered by the Psycho-educational Test battery. The learning deficit again was defined by the Learning Quotient.

Therefore, integrity limits were established which applied to all subjects in the experimental and control groups. These integrity limits may be summarized as follows:

Sensory capacities: Hearing and vision were evaluated by the research staff. Pure-tone audiometric screening at 35 db ISO at 500, 1000, 2000, and 4000 hz was completed on each subject. If a child failed one or more frequencies in either ear he was not included in the experimental population but categorized separately. It was determined that a hearing loss greater than this level might be an imposition on certain types of learning and therefore such subjects should not be included within the limits of the definition of learning disabilities.

Vision testing was carried out by the research ophthalmologist. It was determined that visual acuity of 20/40 or better was adequate for normal visual learning. Visual impairment beyond this level was felt to be debilitating, hence would result in a different learning process for the individual. The concern of the study was to establish limits of vision and hearing which were adequate for learning and not assumed to cause an imposition on learning; the study did not include the multiply handicapped.

Intelligence: A basic criterion for subject selection, as previously presented, was that the child demonstrate adequate intelligence. The primary consideration was a disability in learning, not an incapacity to learn.

The use of only one measure of intelligence, verbal or nonverbal, oral or read, might provide a measure of the disability rather than of intellectual potential. Use of a composite "total" IQ score also might obscure certain integrities by incorporating aspects of the learning problem into the score. Hence, all children an IQ of 90 on either verbal or nonverbal measures were included in the learning disability group; the total IQ was not used as a final determining score. By so doing, the limits, the criteria for adequate intelligence were more effective for distinguishing between those with mental retardation and those with learning disabilities without retardation. If intellectual abilities, both verbal and nonverbal, were below 90 IQ and if a specific learning disability also was present, the problem was defined as one of multiple involvement.

Motor abilities: Experience and research have purported that one of the characteristics of children with learning disabilities is minimal or subtle problems of incoordination, often affecting acquisition of skills such as hopping, skipping, riding a bicycle, buttoning clothes, and tying shoelaces. Thus, the question of how much integrity must be assumed for adequacy is a difficult one. The lack of well-standardized tests of motor ability further complicates the situation. Scores per se cannot be used as "cut-off" points for indicating where cerebral palsy or other gross motor dysfunctions end and where the minor incoordinations and more subtle motor involvements commonly associated with learning disabilities begin. Therefore, our criterion was whether the child's predominant needs centered around motor problems or around the learning disability. In general, psychomotor problems, including certain ataxic and apraxic involvements, disturbances of laterality, and right-left orientation, commonly associated with deficiencies in learning, were included within the category of adequate motor integrity, whereas the more obvious, gross motor disturbances of a crippling nature were not.

Emotional adjustment: Although progress has been made in the development of techniques for measurement of emotional adjustment, there can be little question that most appraisal of the emotional status of children must be made experimentally, on the basis of clinical judgment. The majority of personality tests require verbal facility and are dependent on either spoken or read language. For the child with verbal learning disabilities these tests are confounded by the learning problem. Despite these limitations, these tests when properly employed can be beneficial in determining the integrity of emotional adjustment. Adequate emotional adjustment means that the principal problem is one of learning, not motivation or emotional maladjustment, although problems of frustration and other difficulties of this type may be presented as secondary symptoms. The measure selected for this research permitted reading the items to the child, hence reading ability per se was not assumed.

Learning Quotient

The most commonly recognized deficits in learning, so far as both schools and parents are concerned are those pertaining to academic success. Therefore, it is the deficiencies in ability to comprehend the spoken word, to speak, to read, to write, and to do arithmetic that have received the most attention in both children and adults. However, experience has demonstrated that these verbal deficiencies of learning are not the only types of learning disabilities that might be sustained through dysfunctions of the brain. There also are those that are nonverbal and these too are highly significant in terms of behavior, adjustment, and actualization of potential.

According to the definition, a learning disability represents a discrepancy between level of attainment and the expected level of learning. Several influences must be considered in defining a realistic level of expectancy for a school-age child. During the years when a child is being taught basic skills for reading, spelling, arithmetic, and writing, his ability to actualize native mental capacity is limited by the extent of his formal instruction, by his background of experience and by his general physical and neurological maturation. The level of expectancy therefore was derived from Mental Age, Grade Age, and Chronological Age.

Mental age as derived from measures of intellectual ability provided a certain indication of learning potential. Unless mental age was included, bright children who do not fall below the level of expectancy for their chronological age, but who are below the level of expectancy according to their mental ability, would not have been identified by the screening procedures. It must be remembered that children with learning disabilities are "underachievers" but they do not necessarily fail in school subjects. However, all of them reveal a gap between mental capacity and actual achievement in learning.

The problem that remained was: which IQ measure was to be used in the computation of mental age? Referring to the discussion on mental capacity, the drawbacks to using the composite IQ are clear; any "fullscale" IQ measure incorporates measures of the disability in the measure of potential, giving an erroneously low estimate of the child's potential for achievement. Similarly only one of the IQ measures, verbal or nonverbal (whichever is lower) also may reflect the learning disability. For this reason mental age in this investigation was computed from the higher of the two IQ scores, verbal or performance. In this way, the computed mental age was as free as possible from contamination of the disability.

Grade age was derived from available norms indicating the average age of children at a given grade placement (e.g., in the fourth month of the school year, children in the third grade average age 8.5 years). Research on the educational deprivation of gifted children, as well as our studies, emphasizes the strong influence of formal teaching in actualization of potential of children in the elementary grades. Thus grade age (GA) is an estimate of the level to which the child should have been formally instructed.

Chronological age was taken as the age of the child (to tenths of a year) at the time of the testing. It was felt that CA represented the level of general physical and neurological maturation of the child--the extent to which he could "support" progress in learning areas (e.g., in written work). It takes into consideration the "time plan of nature." In addition, the CA is a rough estimation of the level of experience of the child, the background of meaningful experience to be called upon in tests of comprehension (e.g., in reading). Hence,

$$\text{Expectancy Age} = \frac{MA+CA+GA}{3}$$

Standard tests of academic achievement including reading, spelling and arithmetic yield grade equivalent scores as indicators of the level of learning attained. Standardized measures of receptive and expressive auditory language, as well as proficiency with the written word yield age equivalent scores. Standardized measures of nonverbal skills traditionally yield quotients. Consequently, comparison of the level of attainment in each area of learning is difficult. For this reason, all learning scores were converted to age equivalents; in this way each child studied had a reading age, writing age, comprehension-of-the-spoken-word age, talking age, social perception age, etc.

Various indices of the extent of deficiency have been used with varying degrees of success. In practice a common index is to measure deficiency by the number of years the child falls below his level of expectancy, using one or two years as the cut-off point. Though this index is useful in some instances, as a quantitative guideline it has serious limitations. One year below expectancy at age eight is not comparable to one year below expectancy at age 16; neither the scope of the learning problem nor the impact of the learning disability on the child are comparable if this index is used. What is needed is a cut-off score that remains constant and comparable irrespective of the child's age, and a ratio or quotient score seems most applicable. Using the concept of expectancy level and level of attainment as just defined, the relationship was computed as follows:

$$\frac{\text{Attainment Age}}{\text{Expectancy Age}} = \text{Learning Quotient.}$$

A learning quotient was calculated for each area measured, verbal and nonverbal, and a profile of learning efficiency generated for each child.

An IQ score of 90 was taken as the lower level of intelligence to be included in the experimental group. Therefore, 90% efficiency was defined as adequate functioning. This being the criterion of adequacy, a learning quotient of 89 or below was taken as indicative of under-achievement. This cut-off point did not exclude children identified as learning disabilities on the basis of more conventional indices (number of years retarded, etc.).

Using the screening battery test scores, learning quotients were calculated for reading comprehension, spelling, arithmetic, and the nonverbal processes of spatial relations and perceptual speed. Children with a learning quotient below 90 on any one of these areas of learning were selected for the experimental group. In addition a control group of normal children (with learning quotients of at least 90) was selected, as per the research design. Control subjects were matched with experimentals for sex, grade, and classroom placement.

Further Definition of Selective Criteria

Control: To be selected as a control subject, learning quotients above 90 were required on all phases of the intensive psychoeducational study. Control subjects were selected for all of the experimental study categories.

Borderline: The classification of borderline was used for learning quotients falling from 85-89 on one or more of the six areas covered by the psychoeducational test battery.

Learning Disability: The classification of learning disability was used when the learning quotient fell at 84 or below on any one of the six areas measured by the psychoeducational test battery.

Failed Vision: A child was placed in this category if the ophthalmological evaluation revealed visual acuity of less than 20/40 in either eye; aided or unaided vision had to be 20/40 or better in both eyes to be included in the experimental or control populations.

Failed Anxiety: Children were categorized as "failed anxiety" if their anxiety score was 40 or above on the Cattell Children's Personality Questionaire. This level had been standardized as a critical cut-off point for anxiety in boys and girls of the age level covered in this study. The items were read to the child.

Failed Hearing: Children were screened on a pure-tone audiometer by the research staff at 35 db at 500, 1000, 2000, and 4000 hz. If a child failed one or more frequencies in either ear he was categorized in the Failed Hearing group.

Failed Intelligence: This group comprised those whose intelligence quotients on both the performance and verbal portions of the Wechsler Intelligence Scale for Children were less than 90 when seen for the intensive psychoeducational evaluation.

False Experimental: On the basis of the screening test results, these children should have manifested deficiencies in learning. However, when seen for the intensive evaluation their learning quotients were 90 or above. These subjects were not selected as controls but were studied separately.

False Controls: This group comprised those who met the screening criteria and were selected as controls but then failed the psychoeducational evaluation with learning quotients of 89 or less. These children were reclassified as borderline or learning disability and used as experimental subjects.

The Sample

The distribution of the children seen for intensive psychoeducational evaluation is shown in Table 31 . The total number seen for this phase of the study was 627. Of this number 98 fell into the learning disability group, 116 were classified as borderline, 238 as true control, 14 as false control, 65 as false experimental, and 96 as "other" (failed vision, hearing, anxiety or IQ).

The screening procedures resulted in two populations, those who met the established levels and those who did not--those who passed and those who failed. Those who met the criteria levels comprised the

TABLE 31

NUMBER OF CHILDREN SEEN FOR INTENSIVE
PSYCHOEDUCATIONAL STUDY BY SCHOOL SYSTEM

School System	Learning Disability	Border-line	True Control	False Control	False Experi-mental	Other*	Total
A	21	26	82	3	11	17	160
B	17	23	46	3	10	24	123
C	12	12	27	3	11	8	73
D	48	55	83	5	33	47	271
Total	98	116	238	14	65	96	627

* Failed vision, hearing, IQ, or anxiety

sampling pool from which the controls were selected. Those selected as controls were compared with those who failed the established criteria, and for whom parental permission was given for participation in this second phase of the study. Tables 32 and 33 show the distribution resulting from the intensive evaluation of those who had met the screening test criteria. A further study of the distribution of the sample is presented in Table 34. This analysis reveals the number of true controls by school system that were matched with the learning disability and borderline groups, those that were matched with subjects in both of those groups, and the number studied intensively but who were not matched with children who had been selected for the experimental population.

A number of children selected as learning disability or borderline subjects, when seen for the intensive evaluation, failed to meet the criteria established; they showed deficiencies in other areas (vision, hearing, anxiety) in addition to their learning disorders. The distribution of those who failed the criteria established, though they had met the screening test criteria, is shown in Tables 35 (borderline), and 36 (learning disability).

Distribution of Sample by Sex

It has been recognized that the number of males with learning disabilities exceeds the number of females. However, in the past no distinction has been made on the basis of the degree of involvement. From the data presented in Tables 37 and 38 it is clear that also in this study the indication is for this type of handicap to appear more frequently in males. But the ratio of males to females varied according to the extent of the learning deficiency. In the borderline group the ratio was approximately two to one. For the learning disability sample this ratio increased to slightly more than four to one. The reasons for this variation of incidence by sex is not apparent from the research.

TABLE 32

NUMBER CLASSIFIED AS LEARNING DISABILITY, BORDERLINE, FALSE EXPERIMENTAL AND OTHER FOR SUBJECTS WHO FAILED THE SCREENING CRITERIA

School System	Learning Disability	Borderline	False Experimental	Other*	Total
A	21	12	11	7	51
B	17	10	10	7	44
C	12	7	11	5	35
D	48	38	33	25	144
Total	98	67	65	44	274

* Failed hearing, vision, IQ, or anxiety

TABLE 33

NUMBER CLASSIFIED AS TRUE CONTROL, FALSE CONTROL, BORDERLINE, AND OTHER FOR SUBJECTS WHO PASSED THE SCREENING CRITERIA

School System	Borderline	True Control	False Control	Other*	Total
A	14	82	3	10	109
B	13	46	3	17	79
C	5	27	3	3	38
D	17	83	5	22	127
Total	49	238	14	52	353

* Failed hearing, vision, IQ, or anxiety

TABLE 34

NUMBER OF TRUE CONTROLS (TC) BY SCHOOL SYSTEM WHO WERE MATCHED WITH LEARNING DISABILITY AND BORDERLINE SUBJECTS

School System	Matched With Learning Disability	Matched With Borderline	Matched With Both	Matched With None	Total
A	17	19	7	39	82
B	9	12	11	14	46
C	9	6	6	6	27
D	17	19	36	11	83
Total	52	56	60	70	238

TABLE 35

NUMBER CLASSIFIED AS BORDERLINE*
WHO FAILED HEARING, VISION, OR ANXIETY

School System	Failed Hearing	Failed Vision	Failed Anxiety	Number Remaining	Total
A	0	1	0	26	27
B	0	2	3	23	28
C	0	2	2	12	16
D	2	6	10	55	73
Total	2	11	15	116	144

* Identified by Intensive Battery as children scoring from 85-89% of expectancy level.

TABLE 36

NUMBER CLASSIFIED AS LEARNING DISABILITY*
WHO FAILED HEARING, VISION, OR ANXIETY

School System	Failed Hearing		Failed Vision		Failed Anxiety		Number Remaining	Total
	TE**	FC**	TE**	FC**	TE**	FC**		
A	1	0	0	1	1	1	24	28
B	0	0	1	1	2	1	20	25
C	0	0	0	0	3	0	15	18
D	0	0	4	0	2	1	53	60
Total	1	0	5	1	8	3	112	131

* Identified by Intensive Battery as children scoring at or below 84% of expectancy level.

**Indicates status on Screening Battery: True Experimental (TE) and False Control (FC).

TABLE 37

THE BORDERLINE SAMPLE BY SEX

School System	Males Number	Males % of Total	Females Number	Females % of Total	Total
A	15	57.69%	11	42.31%	26
B	14	60.87	9	39.13	23
C	7	58.33	5	41.67	12
D	40	72.73	15	27.27	55
Totals	76	65.52%	40	34.48%	116

TABLE 38

THE LEARNING DISABILITY SAMPLE BY SEX

School System	Males		Females		Total
	Number	% of Total	Number	% of Total	
A	20	83.33%	4	16.67%	24
B	14	70.00	6	30.00	20
C	12	80.00	3	20.00	15
D	44	83.02	9	16.98	53
Totals	90	80.36%	22	19.64%	112

Results

The findings for the intensive psychoeducational study are considered broadly under the categories of intellectual abilities, language and educational achievement, and motor and other functions.

Intellectual Ability

Intelligence and learning (especially academic learning) are highly correlated. A predominant question, therefore, was whether those who failed the screening test criteria differed in intellectual ability from those who met these criteria. The research question involved concerns the role of mental capacity in the identification and diagnosis of children with learning disabilities. Though this study did not presume to answer this complex question, the findings are relevant and presented accordingly.

Borderline Group:

The WISC test was used as the primary measure of mental ability. The scores obtained were analyzed in two ways--by mental age and by the scaled score. The mental age findings for the borderline group are shown in Table 39 . Significant differences appeared in favor of the normal controls on all of the sub-tests except Comprehension, Picture Completion, Picture Arrangement, Object Assembly and Mazes. In other words, of the 12 tests administered five showed no difference and seven showed the control group to be superior.

When the scaled scores were analyzed (Table 40) only two of the tests (Object Assembly and Mazes) did not reveal significantly higher scores for the control group. From the WISC findings, therefore, there is reason to conclude that the children identified as being deficient in learning, though to a slight degree, were of lower mental ability than those not so identified. This conclusion does not preclude the existence of learning disabilities, and should not be construed as an explanation of learning deficits in toto. It is precisely for this reason that the learning quotient technique was utilized, making it possible to compute a ratio of ability to achievement. Moreover, the control group fell above normal with an IQ level of 112 to 114. The borderline sample fell more closely to the average with an IQ range of 105 to 106.

Several other tests of intelligence were administered and the findings are of interest; see Table 41 . For example, of eight tests from the Detroit Tests of Learning Aptitude, all showed the borderline group to be inferior to the controls. Likewise, the Leiter, Kent D, and Healy I differentiated in favor of the normal controls. The Draw-A-Man test revealed no difference between the groups.

Another analysis was performed to investigate possible differences in intellectual ability; see Table 42 . The mean higher MA (verbal or performance), expectancy age and grade age for the borderline group and their controls were compared. Differences in higher WISC MA reached

TABLE 39

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR THE BORDERLINE GROUP AND THE NORMAL CONTROLS ON WISC MENTAL AGE SCORES (N=116)

	Borderline		Control		
Test	Mean	SD	Mean	SD	t
Information	10.31	1.78	11.26	1.92	-3.90***
Comprehension	9.52	2.27	10.07	2.15	-1.91
Arithmetic	10.13	1.55	11.17	1.69	-4.90***
Similarities	11.10	2.52	11.86	2.74	-2.18*
Vocabulary	10.33	2.06	11.55	2.03	-4.52***
Digit Span	9.72	2.98	11.34	3.33	-3.90***
Mean Verbal	10.20	1.45	11.23	1.60	-5.14***
Picture Completion	9.86	2.87	10.37	2.73	-1.39
Picture Arrangement	10.80	2.66	11.32	2.54	-1.51
Block Design	10.57	2.58	11.53	2.51	-2.86**
Object Assembly	10.57	2.89	11.01	2.57	-1.22
Coding	10.11	1.48	10.82	1.79	-3.27**
Mazes	10.05	2.73	10.48	2.73	-1.19
Mean Performance	10.34	1.59	10.92	1.51	-2.85**

* p less than .05
** p less than .01
*** p less than .001

TABLE 40

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR THE BORDERLINE GROUP AND THE NORMAL CONTROLS ON THE WISC SCALED SCORES (N=116)

	Borderline		Control		
Test	Mean	SD	Mean	SD	t
Information	11.38	2.66	13.12	2.52	-5.12***
Comprehension	10.01	2.97	10.87	2.77	-2.29*
Arithmetic	10.92	2.30	12.67	2.18	-5.95***
Similarities	11.78	2.72	12.66	2.82	-2.42*
Vocabulary	11.42	2.68	13.43	2.59	-5.81***
Digit Span	9.72	2.61	11.29	3.04	-4.24***
Picture Completion	10.18	3.06	10.99	2.99	-2.04*
Picture Arrangement	10.85	2.71	11.56	2.72	-1.98*
Block Design	11.24	3.10	12.48	2.89	-3.15**
Object Assembly	11.09	3.19	11.79	2.83	-1.79
Coding	11.39	2.62	12.79	2.74	-3.99***
Mazes	10.12	2.27	10.68	2.22	-1.90
Verbal IQ	105.48	10.68	114.83	10.54	-6.71***
Performance IQ	105.66	12.19	112.10	11.73	-4.11***
Full Scale IQ	106.06	10.09	114.94	10.46	-6.58***

* p less than .05
** p less than .01
*** p less than .001

TABLE 41

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR THE BORDERLINE GROUP AND THE NORMAL CONTROLS ON OTHER MEASURES OF INTELLIGENCE (N=116)

Test	Borderline		Control		
	Mean	SD	Mean	SD	t
Detroit Test of Learning Aptitude					
Free Association	9.80	1.78	10.68	1.91	-3.64***
Verbal Opposites	10.84	1.53	11.69	1.43	-4.41***
Words	7.92	2.26	9.22	2.45	-4.19***
Sentences	8.79	2.41	10.17	2.20	-4.57***
Oral Directions	9.91	2.11	11.05	2.06	-4.15***
Letters	10.02	1.48	11.02	1.91	-4.45***
Orientation	9.96	1.33	10.75	1.26	-4.64***
Designs	9.76	1.82	10.71	1.93	-3.87***
Other Measures					
Leiter	9.02	1.16	9.89	1.47	-4.41***
Kent D	10.72	2.20	11.76	1.89	-3.87***
Healy I	11.16	2.39	12.22	2.67	-3.19**
Draw-A-Man	9.60	2.27	10.00	2.25	-1.35

* p less than .05
** p less than .01
*** p less than .001

TABLE 42

HIGHER MA, EXPECTANCY AGE AND GRADE AGE FOR THE BORDERLINE AND NORMAL CONTROL GROUPS (N=116)

	Borderline		Control		
	Mean	SD	Mean	SD	t
WISC Higher MA	10.94	1.45	11.66	1.48	-3.78***
Expectancy Age	9.88	.70	10.09	.76	-2.28*
Grade Age	9.32	.54	9.36	.55	-.54

* p less than .05
** p less than .01
*** p less than .001

TABLE 43

DIFFERENCES BETWEEN WISC VERBAL AND PERFORMANCE IQ SCORES FOR THE BORDERLINE GROUP AND THEIR CONTROLS

Number of Points Different	Borderline			Control		
	N	Higher Verbal	Higher Performance	N	Higher Verbal	Higher Performance
0	7			4		
1 - 10	63	29	34	75	38	37
11 - 20	31	13	18	27	16	11
21 - 30	11	6	5	9	8	1
More than 30	4	3	1	1	1	0
TOTAL	116	51	58	116	63	49

the .001 level; expectancy age differed at the .05 level. No significant difference appeared for grade age.

A more intensive investigation of differences between WISC Verbal and Performance IQ scores was made; see Table 43. Borderline and control subjects were categorized in terms of the number of points difference between these two scores, using increments of ten points. Within each category the number of subjects having higher verbal and higher performance scores was determined. It appears that a slightly greater number of borderline children obtained higher performance IQ scores, particularly when the difference was 20 points or less. The opposite trend occurs for the control group, with more children obtaining higher verbal scores.

Learning Disability Group:

Of considerable interest is the fact that though they had greater deficiencies in learning, those classified as learning disability were not intellectually inferior to those classified as borderline. The WISC IQ scores for these experimental groups were equivalent; the full scale score for the learning disability was 104.31 and for the borderline it was 106.06, with verbal and performance scores equally comparable.

The WISC mental age scores for the learning disability sample are shown in Table 44. These results, essentially, are identical to those for the borderline group. Again, the control children are superior on most of the tests, with the same tests showing no difference (an exception is Object Assembly which reached the .05 level in this comparison). Likewise, when the scaled scores were used, more of the sub-tests differentiated between the groups; see Table 45. The only ones that showed no differences were Comprehension, Picture Completion, and Picture Arrangement. So far as this study is concerned, there is considerable agreement among the WISC scores for both experimental groups. Also, the control group for the learning disability comparison, like the one for the borderline comparison, fell above average. Both experimental groups were of average mental ability but inferior to the control groups as these groups were of high average mental capacity.

The results obtained from the other measures of intelligence also are comparable to those found for the borderline groups; see Table 46. In contrast to the results for the borderline sample, on the Draw-A-Man test the learning disability groups fell significantly below the normal comparison group. This was true also of their performance on the Healy I, the Leiter, and on Kent D.

A comparison of the learning disability and control mean higher WISC MA showed that the learning disability group, like the borderline, was inferior to their controls at the .001 level of significance; see Table 47. Expectancy age and grade age revealed no difference between the groups. Of importance is the fact that these measures are almost identical for the borderline and learning disability groups. The higher MA, expectancy age, and grade age for those with the greatest deficiency in learning (learning disability) are equivalent to those with minimal

TABLE 44

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR THE LEARNING DISABILITY GROUP AND THE NORMAL CONTROLS ON WISC MENTAL AGE SCORES (N=112)

	Learning Disability		Control		
Test	Mean	SD	Mean	SD	t
Information	9.93	1.51	10.98	1.73	-4.83***
Comprehension	9.62	1.70	9.85	2.11	-.90
Arithmetic	9.82	1.56	11.17	1.84	-5.94***
Similarities	10.71	2.23	11.90	2.67	-3.64***
Vocabulary	10.11	1.81	11.52	1.97	-5.58***
Digit Span	10.07	2.96	11.30	3.33	-2.92**
Mean Verbal	10.06	1.28	11.15	1.47	-5.93***
Picture Completion	10.08	2.84	10.35	2.75	-.73
Picture Arrangement	11.32	2.77	11.49	2.54	-.47
Block Design	10.26	2.60	11.63	2.48	-4.02***
Object Assembly	10.19	2.89	11.10	2.58	-2.48*
Coding	10.16	1.29	10.78	1.67	-3.11**
Mazes	10.00	2.79	10.64	2.60	-1.77
Mean Performance	10.34	1.61	10.99	1.32	-3.32***

* p less than .05
** p less than .01
*** p less than .001

TABLE 45

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR THE LEARNING DISABILITY GROUP AND THE NORMAL CONTROLS ON THE WISC SCALED SCORES (N=112)

	Learning Disability		Control		
Test	Mean	SD	Mean	SD	t
Information	10.71	2.66	12.61	2.50	-5.49***
Comprehension	10.02	2.44	10.47	2.85	-1.28
Arithmetic	10.22	2.55	12.49	2.37	-6.90***
Similarities	11.21	2.68	12.72	2.75	-4.16***
Vocabulary	10.95	2.71	13.26	2.57	-6.57***
Digit Span	9.93	2.69	11.23	3.06	-3.39***
Picture Completion	10.38	3.03	10.89	3.01	-1.28
Picture Arrangement	11.25	2.71	11.62	2.46	-1.06
Block Design	10.63	3.09	12.48	2.70	-4.77***
Object Assembly	10.44	3.22	11.82	2.85	-3.55***
Coding	11.22	2.26	12.58	2.81	-3.99***
Mazes	9.97	2.37	10.77	1.96	-2.73**
Verbal IQ	103.26	11.61	113.49	10.20	-7.01***
Performance IQ	104.60	12.07	111.90	10.17	-4.90***
Full Scale IQ	104.31	9.96	114.04	9.58	-7.45***

* p less than .05
** p less than .01
*** p less than .001

TABLE 46

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR THE LEARNING DISABILITY GROUP AND THE NORMAL CONTROLS ON OTHER MEASURES OF INTELLIGENCE (N-112)

	Learning Disability		Control		
Test	Mean	SD	Mean	SD	t
Detroit Tests of Learning Aptitude					
Free Association	9.69	2.03	10.52	1.84	-3.21**
Verbal Opposites	10.47	1.32	11.65	1.34	-6.66***
Words	8.04	2.15	9.21	2.64	-3.64***
Sentences	8.34	2.29	10.04	2.14	-5.77***
Oral Directions	9.50	2.09	10.95	2.14	-5.13***
Letters	9.59	1.36	10.93	1.82	-6.24***
Orientation	9.75	1.26	10.76	1.27	-5.98***
Designs	8.95	1.84	10.63	1.80	-6.90***
Other Measures					
Leiter	8.62	1.15	9.89	1.38	-6.67***
Kent D	10.08	1.97	11.70	1.84	-6.34***
Healy I	10.88	3.09	12.65	2.78	-4.52***
Draw-A-Man	9.03	2.44	10.29	2.26	-4.02***

* p less than .05
** p less than .01
*** p less than .001

TABLE 47

HIGHER MA, EXPECTANCY AGE AND GRADE AGE FOR THE LEARNING DISABILITY AND NORMAL CONTROL GROUPS (N-112)

	Learning Disability		Control		
	Mean	SD	Mean	SD	t
WISC Higher MA	11.01	1.26	11.61	1.36	-3.38***
Expectance Age	9.94	.62	10.10	.73	-1.80
Grade Age	9.30	.54	9.40	.53	-1.37

* p less than .05
** p less than .01
*** p less than .001

TABLE 48

DIFFERENCE BETWEEN WISC VERBAL AND PERFORMANCE IQ SCORES FOR THE LEARNING DISABILITY GROUP AND THEIR CONTROLS

Number of Points Different	Learning Disability			Control		
	N	Higher Verbal	Higher Performance	N	Higher Verbal	Higher Performance
0	1			5		
1 - 10	50	23	27	75	39	36
11 - 20	39	15	24	26	17	9
21 - 30	18	11	7	5	4	1
More than 30	4	1	3	1	1	0
TOTAL	112	50	61	112	61	46

involvement (borderline). On the basis of this information we cannot attribute the differences in effective learning to variations in intelligence, expectancy age, or grade age.

Learning disabilities and controls were also compared for differences between WISC verbal and performance IQ; see Table 48. As appeared in the borderline comparison, the experimental sample showed a slight trend toward higher performance scores while the opposite was true for controls. It is interesting to note also that a smaller proportion of learning disability children fell within the category of 1 - 10 points difference between verbal and nonverbal scores, while many more of the controls were represented in this category. It follows from this that the learning disability group is represented much more strongly in the categories of 11 - 20 and 21 - 30 points of difference between verbal and performance scores.

The findings for intelligence indicated that the experimental groups were equivalent, that these groups were of average mental ability, and that the normal comparison groups fell at the high average level. Moreover, the difference in the extent of the deficiency in learning in the borderline and learning disability samples cannot be attributed to differences in intelligence.

Language and Educational Achievement

The paradigm for the study indicated that a comparison should be made for the experimental and control groups on both verbal and nonverbal learning. The area of verbal learning was subdivided into auditory, read, and written language. Each of these was further separated: auditory--receptive and expressive; read--oral, accuracy, vocabulary, comprehension, and syllabication; written--total words, words per sentence, syntax, use of abstract ideas (meaning), spelling, grammar, and punctuation. Other facets of verbal behavior, such as auditory memory and word attack skills, also were studied. Nonverbal learning was measured in four ways: the Detroit Designs Test; the Draw-A-Man; the Healy I; and the complete battery of the Leiter International Test. These measures were selected to cover the facets of nonverbal behavior often referred to as visual-motor ability, visual perception, person perception, and social perception.

The mean score results for each of the general areas of learning for the experimental and control groups are shown in Table 49. The mean scores for all six of the general areas of learning favored the control groups. Though these scores represent the 21 variables used in classification of these subjects, they are of consequence in several respects. To be classified in an experimental group the subject had to be deficient in only one of the areas. Yet, the mean scores for all areas of learning repeatedly show both experimental samples to be inferior to the controls. It is also of interest to note that the two control groups scored similarly, but as expected, the learning disability group consistently fell below the borderline group.

Additional insight on the nature of the learning deficiency is

TABLE 49

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR THE BORDERLINE (N=116), LEARNING DISABILITY (N=112), AND RESPECTIVE CONTROL GROUPS ON AREAS OF LANGUAGE AND EDUCATIONAL ACHIEVEMENT

	Borderline		Control		
Area	Mean	SD	Mean	SD	t
Auditory Receptive	10.36	1.64	11.28	1.37	-4.64***
Auditory Expressive	11.11	1.63	11.86	1.56	-3.61***
Reading	9.53	1.50	11.08	1.84	-7.04***
Written Language	10.20	1.46	11.26	1.49	-5.46***
Arithmetic	9.32	.71	9.93	.87	-5.89***
Nonverbal	9.98	1.36	10.79	1.46	-4.36***

	Learning Disability		Control		
Area	Mean	SD	Mean	SD	t
Auditory Receptive	9.93	1.43	11.25	1.36	-7.09***
Auditory Expressive	10.93	1.46	11.78	1.55	-4.27***
Reading	8.53	1.14	10.90	1.83	-11.63***
Written Language	9.44	1.36	11.26	1.41	-9.85***
Arithmetic	8.97	.75	9.94	.78	-9.49***
Nonverbal	9.44	1.59	10.95	1.37	-7.59***

* p less than .05
** p less than .01
*** p less than .001

gained from the data in Tables 50 and 51. These results derive from a comparison of each experimental group with the respective controls on individual test items representing the 21 variables. Of these scores, one (Oral PSLT Abstract-Concrete) did not differentiate between the experimental and control groups; it appears that in the oral language form, meaning per se was not impaired. One other measure, the Draw-A-Man test, showed no difference between the borderline and controls; this test did discriminate between the learning disability and control sample. Nineteen of the 21 scores showed the controls to be superior to the borderlines and 20 of the 21 favored the controls over the learning disability sample.

It is of considerable interest to note differences in the scores for the two experimental samples. In auditory language the two groups are highly comparable; if only the parameter of auditory language behavior had been used, no difference in degree of learning deficit would have appeared. However, variation in extent of deficiency in learning was apparent in all of the other areas of learning: reading, written language, arithmetic, and nonverbal. From these findings it is clear that though both experimental groups were inferior to the normal on auditory language behavior, both were equally inferior. Hence, on this parameter they were equivalent, whereas on all of the other measures they differed from each other, the learning disability being more deficient.

In addition to the 21 language and educational achievement measures discussed above, other achievement tests were administered; these were not used in the classification of the subjects as experimental or normal control. The borderline and learning disability samples were compared with the respective control groups on these measures; see Tables 52 and 53. The areas of learning covered by these tests are categorized as auditory memory and reading-syllabication.

Four of the subtests from the Detroit Tests of Learning Aptitude (also discussed in relation to intelligence) were used as a measure of auditory memory. It is noteworthy that also on these auditory functions the borderline and learning disability samples did not differ from each other, though both groups were inferior to the controls. These findings are in agreement with those from the auditory language battery, indicating that the experimental groups were equivalent in their deficiency in auditory learning and processing. These groups differed in the extent of the deficit in learning only in the read and written word and in nonverbal facets of learning.

This is revealed further by the additional reading and syllabication test results. In all instances on these scores the learning disability subjects fell below those classified as borderline. The findings from the discriminant analysis, discussed below, underline the importance of techniques such as those found in this supplemental battery. For example, for differentiating children with deficits in learning from those without such deficits, none of the procedures used was more effective than the measure of syllabication.

TABLE 50

MEANS, STANDARD DEVIATIONS AND t-SCORES
ON LANGUAGE AND EDUCATIONAL ACHIEVEMENT TESTS
FOR THE BORDERLINE AND CONTROL GROUPS (N-116)

Test	Borderline Mean	Borderline SD	Control Mean	Control SD	t
Auditory Receptive					
Detroit Orientation	9.96	1.33	10.75	1.26	-4.64***
Kent D	10.72	2.20	11.76	1.89	-3.87***
Auditory Expressive					
Detorit Free Association	9.80	1.78	10.68	1.91	-3.64***
Detroit Verbal Opposites	10.84	1.53	11.69	1.43	-4.41***
Oral PSLT Words per Sentence	11.62	3.03	12.54	3.23	-2.25*
Oral PSLT Abstract-Concrete	12.13	3.58	12.55	3.70	-.89
Reading					
Gates-MacGinitie Accuracy	9.57	2.10	11.14	2.59	-4.47***
Gates-MacGinitie Comprehension	9.31	1.56	11.20	2.10	-6.86***
Gates MacGinitie Vocabulary	9.48	1.62	11.15	1.74	-6.62***

TABLE 50 - Continued

Test	Borderline Mean	Borderline SD	Control Mean	Control SD	t
Written Language					
PSLT Total Words	9.25	2.34	10.14	2.86	-2.57*
PSLT Words per Sentence	9.79	2.22	10.53	2.70	-2.30*
PSLT Syntax	10.41	3.15	11.70	3.69	-2.85**
PSLT Abstract-Concrete	12.56	3.90	13.88	3.63	-2.67**
Metropolitan Spelling	9.59	1.39	10.74	1.26	-5.81***
Metropolitan Language Arts	9.38	1.19	10.69	1.40	-6.81***
Arithmetic					
Metropolitan Arithmetic	9.21	.62	9.68	.85	-4.79***
PMA Arithmetic	9.40	.93	10.25	1.06	-5.69***
Nonverbal					
Detroit Designs	9.76	1.82	10.71	1.93	-3.87***
Draw-A-Man	9.60	2.27	10.00	2.25	-1.35
Healy I	11.16	2.39	12.22	2.67	-3.19**
Leiter	9.02	1.16	9.89	1.47	-4.41***

* p less than .05
** p less than .01
*** p less than .001

TABLE 51

MEANS, STANDARD DEVIATIONS AND t-SCORES
ON LANGUAGE AND EDUCATIONAL ACHIEVEMENT TESTS
FOR THE LEARNING DISABILITY AND CONTROL GROUPS

Test	Learning Disability Mean	Learning Disability SD	Control Mean	Control SD	t
Auditory Receptive					
Detroit Orientation	9.75	1.26	10.76	1.27	-5.98***
Kent D	10.08	1.97	11.70	1.84	-6.34***
Auditory Expressive					
Detroit Free Association	9.69	2.03	10.52	1.84	-3.21**
Detroit Verbal Opposites	10.47	1.32	11.65	1.34	-6.66***
Oral PSLT Words per Sentence	11.53	2.91	12.41	3.17	-2.19*
Oral PSLT Abstract-Concrete	11.97	3.76	12.58	3.69	-1.22
Reading					
Gates-MacGinitie Accuracy	8.57	1.36	11.07	2.86	-7.36***
Gates-MacGinitie Comprehension	8.30	1.18	11.00	2.09	-10.48***
Gates-MacGinitie Vocabulary	8.52	1.49	10.99	1.76	-10.06***

TABLE 51 - Continued

Test	Learning Disability Mean	Learning Disability SD	Control Mean	Control SD	t
Written Language					
PSLT Total Words	8.93	2.08	10.07	2.69	-3.54***
PSLT Words per Sentence	9.31	1.87	10.69	2.67	-4.50***
PSLT Syntax	9.01	2.17	11.68	3.63	-6.67***
PSLT Abstract-Concrete	11.89	4.15	13.96	3.64	-3.97***
Metropolitan Spelling	8.79	1.30	10.57	1.19	-9.48***
Metropolitan Language Arts	8.60	1.32	10.51	1.32	-9.62***
Arithmetic					
PMA Arithmetic	8.99	.94	10.21	.98	-8.49***
Metropolitan Arithmetic	8.90	.69	9.67	.78	-7.87***
Nonverbal					
Detroit Designs	8.95	1.84	10.63	1.80	-6.90***
Draw-A-Man	9.03	2.44	10.29	2.26	-4.02***
Healy I	10.88	3.09	12.65	2.78	-4.52***
Leiter	8.62	1.15	9.89	1.38	-6.67***

* p less than .05
** p less than .01
*** p less than .001

TABLE 52

MEANS, STANDARD DEVIATIONS AND t-SCORES ON SUPPLEMENTAL ACHIEVEMENT TESTS FOR THE BORDERLINE AND CONTROL GROUPS (N=116)

Test	Borderline Mean	Borderline SD	Control Mean	Control SD	t
Auditory Memory					
Detroit Words	7.92	2.26	9.22	2.45	-4.19***
Detroit Sentences	8.79	2.41	10.17	2.20	-4.57***
Detroit Oral Directions	9.91	2.11	11.05	2.06	-4.15***
Detroit Letters	10.02	1.48	11.02	1.91	-4.45***
Reading - Syllabication					
Wide Range Oral Reading	10.19	1.84	11.88	2.38	-6.07***
Gates-McKillop Word Parts	10.20	1.34	11.20	.93	-6.64***
Gates-McKillop Nonsense Words	9.60	.90	10.15	.61	-5.41***
Gates-McKillop Syllabication	9.71	1.41	10.88	.91	-7.51***
Gates-Russell Oral-Words	8.66	.88	9.43	1.11	-5.85***
Gates-Russell One Syllable	9.41	2.00	10.75	1.95	-5.14***
Gates-Russell Two Syllables	9.40	1.82	10.67	1.59	-5.69***

* p less than .05
** p less than .01
*** p less than .001

TABLE 53

MEANS, STANDARD DEVIATIONS AND t-SCORES
ON SUPPLEMENTAL ACHIEVEMENT TESTS
FOR THE LEARNING DISABILITY AND CONTROL GROUPS (N=112)

	Borderline		Control		
	Mean	SD	Mean	SD	t
Auditory Memory					
Detroit Words	8.04	2.15	9.21	2.64	- 3.64***
Detroit Sentences	8.34	2.29	10.04	2.14	- 5.77***
Detroit Oral Directions	9.50	2.09	10.95	2.14	- 5.13***
Detroit Letters	9.59	1.36	10.93	1.82	- 6.24***
Reading - Syllabication					
Wide Range Oral Reading	8.95	1.26	11.60	2.25	-10.89***
Gates-McKillop Word Parts	9.27	1.47	11.22	.98	-11.68***
Gates-McKillop Nonsense Words	8.92	1.00	10.09	.63	-10.43***
Gates-McKillop Syllabication	8.72	1.33	10.79	.98	-13.23***
Gates-Russell Oral Words	8.10	.70	9.28	.94	-10.64***
Gates-Russell One Syllable	8.57	1.74	10.56	1.97	- 7.98***
Gates-Russell Two Syllables	8.50	1.62	10.57	1.56	- 9.54***

* p less than .05
** p less than .01
*** p less than .001

Motor and Other Functions

In the study of deficiencies in learning it is advantageous to view the problem broadly, especially in an investigation of this type. Therefore, not only was learning potential (expectancy) considered in detail, including verbal and nonverbal, but various other types of behavior were studied. Tables 54 and 55 cover the findings from the personality test (anxiety), the Vineland Social Maturity Scale, and the motor and laterality tests.

Personality: The Children's Personality Questionnaire was administered and from this an anxiety score was determined. According to the standardized procedure the items were read to each subject, experimental and control, so that ability to read was not involved. As can be seen in Table 54, the mean scores for both experimental groups and for the normal comparison groups are essentially identical; the standard deviations also are highly comparable. These results indicate that both experimental and control samples fell within the normal range on the anxiety scale, the mean scores are within the expected range in comparison with the standardization sample. It must be noted that all subjects were screened initially for anxiety and those who did not meet the established criterion of an anxiety score of less than 40 were eliminated from the experimental group and studied separately.

In using the anxiety scale mainly as a control of the emotional variable, it was indicated that children who have deficiencies in learning do not necessarily show evidence of greater emotional maladjustment than a sample of normally achieving children. So far as our findings are concerned, emotional factors do not appear to have been an influencing factor in the group differences that have been demonstrated. It appears that there are many children who have learning disabilities without concommitant emotional disturbances. Moreover, despite their deficits in learning, they are making an adequate emotional adjustment.

Social Maturity: The Vineland Social Maturity Scale measures the degree to which the child has developed independence, in terms of the extent to which he has learned to care for himself. The results, shown in Table 54 , reveal that both experimental groups were inferior to the normal comparison groups. These results are of interest because they reflect the generalized impact of the deficiency in learning. Though the social maturity scale includes items on ability to communicate, these scores are obtained through an interview with the parents. It is unlikely that the social ages derived are significantly influenced by problems of school learning. The importance of these results, therefore, is that they reveal the pervasive effect of a learning disability; it is not only a school problem. Program planning, in terms of meeting the needs of a learning disability child must include consideration of the generalized nature of this type of handicap.

Motor Ability: The rationale for including a study of motor abilities developed from clinical experience with children who have deficits in learning. Various disciplines (pediatrics, neurology, child psychology, and psychiatry) have emphasized that these children

TABLE 54

MEANS, STANDARD DEVIATIONS AND t-SCORES ON MOTOR AND OTHER TESTS FOR THE BORDERLINE (N=116), LEARNING DISABILITY (N=112) AND THEIR RESPECTIVE CONTROL GROUPS

	Borderline		Control		
Test	Mean	SD	Mean	SD	t
Children's Personality Questionnaire	29.55	5.86	28.33	5.37	1.65
Vineland	9.52	.98	9.89	.95	-2.87**
Heath Rails	9.35	2.30	9.97	2.58	-1.95

	Learning Disability		Control		
Test	Mean	SD	Mean	SD	t
Children's Personality Questionnaire	28.51	5.25	28.57	5.58	-.07
Vineland	9.34	.95	9.90	.87	-4.66***
Heath Rails	9.46	2.35	9.86	2.27	-1.29

* p less than .05
** p less than .01
*** p less than .001

TABLE 55

LATERALITY TESTS FOR BORDERLINE, LEARNING DISABILITY AND THEIR RESPECTIVE CONTROL GROUPS

Test	Number of Pairs	Borderline			Control		
		Right	Left	Both	Right	Left	Both
Kick	114	106	8	0	102	12	0
Catch	115	101	13	1	105	10	0
Throw	115	104	9	2	107	8	0
Write	116	104	12	0	103	13	0

Test	Number of Pairs	Borderline		Control	
		Same	Different	Same	Different
Hand and Foot	114	93	21	99	15
Hand and Eye	111	65	46	70	41
Foot and Eye	109	61	48	65	44
Hand-Foot-Eye	110	55	55	61	49
Write-Throw-Catch	115	94	20	103	11

Test	Number of Pairs	Learning Disability			Control		
		Right	Left	Both	Right	Left	Both
Kick	110	91	18	1	103	7	0
Catch	111	98	12	1	105	6	0
Throw	111	100	9	2	105	6	0
Write	112	97	15	0	103	9	0

Test	Number of Pairs	Learning Disability		Control	
		Same	Different	Same	Different
Hand and Foot	108	93	15	98	10
Hand and Eye	108	66	42	73	35
Foot and Eye	106	70	36	70	36
Hand-Foot-Eye	106	61	45	67	39
Write-Throw-Catch	110	99	11	99	11

typically are poorly coordinated or delayed in motor development. It is apparent these observations are based on young children (often of preschool age) seen in clinical settings. However, to investigate the possibility that motor function and learning disabilities are related, selected tests of coordination and laterality were administered.

The results of this part of the investigation are found in Tables 54 and 55. The Heath Railwalking test was used to measure locomotor coordination. The mean scores for the experimental and control groups are essentially identical. On the basis of this type of motor study, it appears that deficit in learning and motor function are not necessarily related. As in certain other aspects of this total research project, it must be emphasized that our experimental population was identified through learning tests alone, not by clinically determined criteria. In the type of sample studied, locomotor coordination seems not to be a critical factor.

Similarly, laterality showed no relationship to deficits in learning, irrespective of the degree of the deficit. The dominant hand for throwing, catching, and writing, the dominant leg for kicking, and the preferred eye for sighting, were all unrelated to deficiencies in learning. Despite the contention of many years duration, that handedness and eyedness are related to academic learning and especially to learning to read, no such association was found in this study. Though such a relationship might exist for a given type of learning disability child, caution should be exercised in implying that motor involvement or sidedness are significant factors in all types of children with deficiencies in learning. It is apparent that a learning disability may occur with or without the additional factor of a motor disturbance being present.

Intercorrelation Analysis

As suggested in the discussion of the screening test data, the intercorrelation technique is useful in exploring basic group differences in relation to clusters or patterns of psychological functions. The screening test data revealed differing patterns of psychological organization for those who met the criteria in comparison with those who did not. The intensive study data presented support and confirm the screening test results.

Intercorrelation of Mental Abilities

The intercorrelation matrix for the borderline group and their controls is shown in Table 56, and the matrix for the learning disability group and their controls is shown in Table 57. The correlations presented include only those falling at the .01 level of significance or above.

The results indicate that the greatest differences between the borderline and control samples appeared for the performance test scores. Correlations for the verbal tests were highly similar, with the exception of Digit Span. In the borderline-normal comparison Digit Span was

TABLE 56

INTERCORRELATION OF MENTAL ABILITIES FOR THE BORDERLINE AND NORMAL COMPARISON GROUPS (WISC WITH WISC) (N=116)

	WISC Information	WISC Comprehension	WISC Arithmetic	WISC Similarities	WISC Vocabulary	WISC Digit Span	WISC Picture Completion	WISC Picture Arrangement	WISC Block Design	WISC Object Assembly	WISC Coding	WISC Mazes
WISC Information		B=.49 C=.40	B=.42 C=.60	B=.52 C=.55	B=.68 C=.59	C=.29	B=.35	B=.36	C=.39		C=.41	C=.27
WISC Comprehension			B=.42 C=.38	B=.48	B=.51 C=.42	C=.27	C=.30	B=.31	C=.27	C=.34	C=.32	C=.30
WISC Arithmetic				B=.32 C=.29	B=.32 C=.56	C=.34			C=.43		C=.31	C=.25
WISC Similarities					B=.47 C=.54		B=.38		B=.33 C=.48		C=.29	C=.26
WISC Vocabulary						C=.31	B=.28 C=.30	B=.35	B=.30 C=.55	C=.36	C=.41	C=.45
WISC Digit Span									C=.28		C=.33	
WISC Picture Comp.								B=.31	B=.37 C=.26			
WISC Picture Arrang.									B=.41	B=.31		
WISC Block Design										B=.62 C=.52	C=.37	B=.26 C=.39
WISC Object Assembly											C=.31	B=.32 C=.40
WISC Coding												C=.30
WISC Mazes												

B = Borderline Group
C = Normal Comparison Group

Level of significance at .01: r = .24

TABLE 57

INTERCORRELATION OF MENTAL ABILITIES FOR THE LEARNING DISABILITY AND NORMAL COMPARISON GROUPS (WISC WITH WISC) (N=112)

	WISC Information	WISC Comprehension	WISC Arithmetic	WISC Similarities	WISC Vocabulary	WISC Digit Span	WISC Picture Completion	WISC Picture Arrangement	WISC Block Design	WISC Object Assembly	WISC Coding	WISC Mazes
WISC Information		L=.42 C=.38	L=.38 C=.46	L=.46 C=.43	L=.55 C=.61	C=.25			C=.32	C=.25	C=.29	C=.27
WISC Comprehension			L=.26 C=.29		L=.53 C=.37		L=.28		C=.32	L=.25 C=.28		
WISC Arithmetic				L=.36	L=.36 C=.42	C=.27			C=.46			
WISC Similarities					L=.38 C=.52	L=.25			C=.45	C=.27		
WISC Vocabulary						L=.26	C=.30		C=.38	C=.31	C=.38	C=.30
WISC Digit Span												L=-.27
WISC Picture Comp.									L=.41	L=.46		L=.30
WISC Picture Arrang.												
WISC Block Design										L=.62 C=.40	C=.25	L=.36
WISC Object Assembly											C=.28	L=.37 C=.35
WISC Coding												
WISC Mazes												

L = Learning Disability Group
C = Normal Comparison Group

Level of significance at .01: r = .25

significantly correlated with six other tests for the controls but shows no relationships with other abilities in the borderline group. The reverse appeared for Picture Arrangement. It was associated with six other functions in the borderline sample but with none in the controls. Coding was related to most other abilities for the controls (nine out of eleven) but showed no association with any test score in the borderline sample. Maze scores also were correlated with eight other functions in the controls but with only two in the borderline sample.

The pattern of results for the learning disability-normal comparison varied in several aspects from that found for the borderline and control analysis. Block Design correlated with seven functions for the controls and only three for the learning disability. Coding was less generally associated with other test scores but again it was related to other abilities only in the control group. Coding as a process differentiated completely between the experimental and control populations; we have long suspected that this test was a reliable indicator of disturbances in learning. The Maze score correlations again are interesting but different from those found for the borderline comparison.

The primary suggestion to be derived from this analysis of the intercorrelation of mental abilities (WISC) is that the pattern of intellectual functions found in children with deficits in learning varies from the normal. Implied is the possibility that because the psychological functions are organized differently, the processes whereby the learning disability child organizes his experiences and learns also are different. This possibility presents a basic challenge to the special educator.

Intercorrelation of Mental Ability and Educational Achievement

Because the constellation of mental abilities varied for the experimental and control groups, it was hypothesized that the interrelationships among the intelligence and achievement test scores would be different for each of these groups. These correlation data for the borderline and comparison samples are shown in Table 58, and for the learning disability group and their controls in Table 59. This analysis also made it possible to compare the experimental samples with each other.

As anticipated, the intercorrelation patterns showed similarities but also differences. Clearly, the borderline population came closer to the pattern seen for the normal controls; the learning disability sample showed the greater variation. However, both experimental groups manifested less than normal association between verbal and nonverbal functions. For example, for the controls, coding and mazes intercorrelated with educational achievement to a high degree. For the experimentals this association was minimal. A similar difference appeared for Picture Arrangement, Picture Completion, and Block Design. Verbal versus nonverbal relationships showed differences, especially for the learning disability sample, also on the Leiter and Draw-A-Man scores. Results from these measures correlated with educational achievement more

TABLE 58

INTERCORRELATION OF INTELLIGENCE AND EDUCATIONAL ACHIEVEMENT VARIABLES FOR THE BORDERLINE AND NORMAL COMPARISON GROUP (WISC WITH ALL OTHER VARIABLES)

	Wide Range Oral Reading	Gates - MacGinitie Accuracy	Gates - MacGinitie Comprehension	Gates - MacGinitie Vocabulary	Gates-McKillop Word Parts	Gates - McKillop Nonsense words	Gates - McKillop Syllabication	Metropolitan Arithmetic	PMA Arithmetic	Metropolitan Spelling	Gates - Russell Oral words
WISC Information	B=.51 C=.66	B=.60 C=.60	B=.66 C=.70	B=.70 C=.68	B=.36 C=.42	B=.34 C=.27	B=.36 C=.46	B=.44 C=.66	B=.41 C=.52	B=.47 C=.63	B=.42 C=.61
WISC Comprehension	B=.48 C=.39	B=.56 C=.35	B=.52 C=.49	B=.57 C=.44	B=.37 C=.25	B=.24	B=.37 C=.36	B=.30 C=.38	B=.39 C=.43	B=.43 C=.35	B=.41 C=.28
WISC Arithmetic	B=.39 C=.48	B=.40 C=.53	B=.40 C=.53	B=.38 C=.55	B=.32 C=.39	B=.30	B=.27 C=.40	B=.48 C=.65	B=.53 C=.64	B=.39 C=.54	B=.37 C=.54
WISC Similarities	B=.26 C=.53	C=.37	B=.41 C=.56	B=.37 C=.62	B=.25 C=.46	C=.31	C=.41	C=.42	C=.37	C=.57	C=.49
WISC Vocabulary	B=.58 C=.59	B=.60 C=.69	B=.64 C=.72	B=.70 C=.73	B=.38 C=.35	B=.33	B=.38 C=.41	B=.40 C=.56	B=.39 C=.60	B=.46 C=.54	B=.40 C=.50
WISC Digit Span	B=.38 C=.39		B=.30	B=.34 C=.31	B=.31 C=.34	C=.27	B=.40 C=.33	C=.40	C=.33	B=.37 C=.29	B=.41 C=.36
WISC Picture Comp.		C=.28		B=.28							
WISC Picture Arrang.	B=.25	B=.35	B=.29	B=.27							
WISC Block Design	C=.39	C=.43	C=.52	C=.54	C=.40		C=.27	C=.41	C=.40	C=.41	C=.28
WISC Object Assembly		C=.27	C=.28						C=.29		
WISC Coding	C=.34	B=.39 C=.53	C=.58	C=.51	C=.25		B=.25 C=.26	B=.38 C=.53	B=.42 C=.44	B=.29 C=.52	B=.25 C=.34
WISC Mazes	C=.27	C=.40	C=.37	C=.36	C=.26	C=.26		C=.29	C=.36	C=.33	

B = Borderline Group
C = Normal Comparison Group

	Gates-Russell One-syllable	Gates-Russell Two-syllables	Metropolitan Language	PSLT Total Words	PSLT Total Sentences	PSLT Words Per Sentence	PSLT Syntax	PSLT Abstract - Concrete	Detroit Free Association	Detroit Verbal Opposites	Detroit Words	Detroit Sentences
WISC Information	B=.41 C=.41	B=.36 C=.39	B=.59 C=.65	 C=.29				 C=.26	 C=.33	B=.68 C=.62	B=.29	B=.50 C=.34
WISC Comprehension	B=.32 C=.31	B=.35 C=.32	B=.48 C=.37						B=.28 C=.25	B=.49 C=.38	B=.29	B=.29
WISC Arithmetic	B=.34 C=.36	B=.33 C=.33	B=.32 C=.49				 C=.29	B=.30	 C=.26	B=.49 C=.42		B=.46 C=.31
WISC Similarities	B=.29 C=.41	 C=.35	B=.43 C=.59						 C=.26	B=.49 C=.55		B=.36 C=.32
WISC Vocabulary	B=.42 C=.42	B=.38 C=.35	B=.58 C=.61				 C=.26	B=.27 C=.28	 C=.36	B=.66 C=.60	B=.27	B=.41 C=.36
WISC Digit Span	B=.34	B=.36 C=.30	B=.27 C=.41						 C=.29	B=.28 C=.30	B=.44 C=.52	B=.44 C=.54
WISC Picture Comp.										B=.26 C=.28		
WISC Picture Arrang.			B=.41							B=.36		
WISC Block Design	 C=.40	 C=.37	 C=.51				 C=.24			 C=.49		 C=.29
WISC Object Assembly			B=.28							 C=.27		
WISC Coding	 C=.34	 C=.37	B=.27 C=.56						B=.34 C=.48	 C=.33	 C=.30	 C=.40
WISC Mazes			B=.28 C=.27					 C=.31	 C=.26			

B = Borderline Group
C = Normal Comparison Group

TABLE 58 - Continued

	Detroit Oral Directions	Detroit Letters	Detroit Orientation	Detroit Designs	Oral PSLT Words Per Sentence	Oral PSLT Abstract - Concrete	Leiter	Healy I	Vineland	Kent D	Health Rails	Draw-A-Man
WISC	B=.46	B=.40	B=.53			B=.32	B=.45		B=.29	B=.63		
Information	C=.38	C=.43	C=.47	C=.41		C=.35	C=.45		C=.40	C=.51		C=.46
WISC	B=.33	B=.34	B=.39			B=.25	B=.45		B=.32	B=.44		
Comprehension	C=.26	C=.29	C=.24			C=.26	C=.34		C=.29	C=.30		C=.36
WISC	B=.29	B=.36	B=.30			B=.34	B=.40		B=.28	B=.29		
Arithmetic	C=.33	C=.39	C=.53	C=.33		C=.34	C=.45		C=.30	C=.48		
WISC	B=.34	B=.37	B=.31	B=.36	B=.26		B=.37			B=.59		
Similarities	C=.33	C=.41	C=.45	C=.30			C=.34		C=.48	C=.47		C=.34
WISC	B=.28	B=.35	B=.41	B=.29		B=.33	B=.39		B=.43	B=.58		
Vocabulary	C=.38	C=.41	C=.40	C=.44		C=.25	C=.50		C=.48	C=.58		C=.35
WISC												
Digit Span	C=.38	C=.41	C=.41	C=.31								
WISC		B=.29	B=.37	B=.41				B=.26		B=.53		
Picture Comp.									C=.27			C=.29
WISC	B=.28		B=.29	B=.26			B=.38			B=.46		
Picture Arrang.	C=.30											
WISC			B=.33	B=.52			B=.55		B=.31	B=.50		B=.34
Block Design	C=.26	C=.26	C=.44	C=.45	C=.25		C=.50	C=.37	C=.35	C=.58		C=.39
WISC			B=.32	B=.38			B=.53			B=.36		B=.38
Object Assembly	C=.28			C=.39			C=.37			C=.36		C=.38
WISC	B=.29											
Coding	C=.52	C=.41	C=.32	C=.31			C=.45		C=.32	C=.26	C=.31	C=.30
WISC			B=.25	B=.31			B=.31					B=.30
Mazes	C=.30		C=.28	C=.38			C=.34		C=.31	C=.28		C=.27

B = Borderline Group
C = Normal Comparison Group

Level of significance at .01: r = .27 (90 subjects)
r = .24 (116 subjects)

TABLE 59

INTERCORRELATION OF INTELLIGENCE AND EDUCATIONAL ACHIEVEMENT VARIABLES FOR THE LEARNING DISABILITY AND NORMAL COMPARISON GROUPS
(WISC WITH ALL OTHER VARIABLES)

	Wide Range Oral Reading	Gates-MacGinitie Accuracy	Gates-MacGinitie Comprehension	Gates-MacGinitie Vocabulary	Gates-McKillop Word Parts	Gates-McKillop Nonsense Words	Gates-McKillop Syllabication	Metropolitan Arithmetic	PMA Arithmetic	Metropolitan Spelling	Gates-Russell Oral Words
WISC Information	L=.36 C=.54	L=.29 C=.62	L=.30 C=.66	L=.39 C=.70	C=.33	C=.26	C=.39	L=.29 C=.58	L=.37 C=.49	C=.59	L=.28 C=.55
WISC Comprehension			C=.39	C=.36					L=.28 C=.38		
WISC Arithmetic	L=.34 C=.47	L=.41 C=.42	L=.45 C=.50	L=.53 C=.54	L=.29 C=.37	C=.33	L=.26 C=.41	C=.70	L=.63 C=.60	L=.41 C=.48	L=.43 C=.57
WISC Similarities	L=.29 C=.38	C=.39	C=.49	L=.28 C=.57	L=.28 C=.25	L=.27	C=.29	C=.36	C=.29	L=.29 C=.51	L=.26 C=.37
WISC Vocabulary	L=.35 C=.54	C=.69	L=.31 C=.71	L=.33 C=.75	L=.26 C=.27	C=.29	L=.26 C=.27	L=.37 C=.50	C=.53	L=.30 C=.58	L=.25 C=.52
WISC Digit Span	L=.33			L=.29	L=.26	C=.28	L=.36	C=.34			L=.35 C=.34
WISC Picture Comp.		C=.32	L=-.30 C=.31				C=.25			L=-.35	
WISC Picture Arrang.											
WISC Block Design		C=.31	C=.48	C=.46	C=.32			C=.49	C=.38	C=.30	
WISC Object Assembly		C=.38	C=.30	C=.31					C=.31		
WISC Coding		C=.43	C=.37	C=.42				L=.34 C=.39	L=.42 C=.52	C=.44	L=.27 C=.29
WISC Mazes		C=.29		C=.31					C=.39	C=.25	

L = Learning Disability Group
C = Normal Comparison Group

TABLE 59 - Continued

	Gates-Russell One-Syllable	Gates-Russell Two-Syllables	Metropolitan Language	PSLT Total Words	PSLT Total Sentences	PSLT Words per Sentence	PSLT Syntax	PSLT Abstract-Concrete	Detroit Free Association	Detroit Verbal Opposites	Detroit Words	Detroit Sentences
WISC Information	L=.26 C=.31	L=.32 C=.29	C=.58			C=.30		L=.26	C=.28	L=.51 C=.61	L=.30	L=.41 C=.40
WISC Comprehension										L=.39 C=.26	L=.27	
WISC Arithmetic	L=.48 C=.36	L=.45 C=.32	L=.45 C=.38					L=.28	L=.33	L=.41 C=.42	L=.39	L=.29 C=.33
WISC Similarities	L=.32 C=.30	L=.30	L=.32 C=.58					L=.27		L=.49 C=.63	L=.30	L=.37 C=.35
WISC Vocabulary	L=.27 C=.34	L=.31 C=.32	L=.32 C=.67					C=.25	L=.32 C=.32	L=.58 C=.60	L=.42	L=.48 C=.36
WISC Digit Span	L=.35	L=.30 C=.25	C=.28								L=.29 C=.54	L=.39 C=.62
WISC Picture Comp.	C=.29		C=.32							C=.27		
WISC Picture Arrang.												
WISC Block Design	C=.36	C=.33	C=.44							C=.46		C=.39
WISC Object Assembly			C=.33							C=.32		
WISC Coding			L=.31 C=.44	C=.30					C=.46	C=.26	C=.26	C=.39
WISC Mazes												

L = Learning Disability Group
C = Normal Comparison Group

TABLE 59 - Continued

	Detroit Oral Directions	Detroit Letters	Detroit Orientation	Detroit Designs	Oral PSLIT Words per Sentence	Oral PSLIT Abstract-Concrete	Leiter	Healy I	Vineland	Kent D	Heath Rails	Draw-A-Man
WISC Information	L=.30 C=.3[illegible]	C=.37	L=.45 C=.49			L=.35	C=.40		L=.27 C=.36	L=.41 C=.48		C=.46
WISC Comprehension			L=.36				C=.43			L=.30 C=.26		C=.34
WISC Arithmetic	L=.31 C=.28	L=.31	L=.45 C=.42	C=.34			C=.43		C=.27	L=.32 C=.46		
WISC Similarities	C=.34	L=.37 C=.30	L=.27 C=.37			L=.28	C=.32	L=.27 C=.31	C=.31	L=.37 C=.50		C=.33
WISC Vocabulary	L=.28 C=.40	L=.36 C=.44	L=.46 C=.41	C=.27			C=.43		C=.38	L=.46 C=.59		C=.30
WISC Digit Span	C=.26	L=.38 C=.41	C=.31									
WISC Picture Comp.				L=.34			L=.50	L=.30	C=.29	L=.27	L=.25	L=.30 C=.27
WISC Picture Arrang.	C=.25							L=.39				
WISC Block Design	C=.31		C=.41	L=.31 C=.27			L=.57 C=.47	L=.32	C=.40	C=.49		L=.46 C=.27
WISC Object Assembly	L=.27 C=.25		C=.34	L=.39 C=.35			L=.60 C=.36	L=.31	C=.28			L=.49 C=.39
WISC Coding	C=.40	C=.30		L=.32			C=.29					
WISC Mazes			C=.31	L=.31 C=.30			L=.34	L=.31				L=.25

L = Learning Disability Group
C = Normal Comparison Group

Level of Significance at .01: r = .28 (90 subjects)
r = .25 (116 subjects)

frequently in the normal control groups.

The intercorrelation data support the position that children with deficits in learning show less generalized integration of abilities, hence, show different patterns of learning. Though they may show normal achievement in a given area of learning, e.g. nonverbal, this does not assure that they can muster the use of this ability for learning of another type, e.g. verbal. This may be one of the most consequential outcomes of this research. If it is further verified, these results could serve as the basis for development of a construct of the psychology of learning as it relates to learning disability children.

Intercorrelation of Educational Achievement Tests

To further explore the clustering of relationships by group, the intercorrelation of scores on the measures of educational achievement were analyzed. The matrix for the borderline versus the control group is shown in Table 60, and the matrix for the learning disability versus the normal comparison group is presented in Table 61.

A number of differences are apparent. Again, the learning disability sample varied most widely from the normals; the borderlines showed a pattern more comparable to that of the controls. Written language (PSLT Total Words) frequently was associated with other aspects of educational achievement in the learning disability group, but not in the control group. Moreover, Oral Directions was highly correlated with other educational test results for the normal sample but not for those classified as learning disabilities.

One of the most interesting differences, corresponding to the findings for intelligence, was the consistent correlation between nonverbal and verbal measures for the normals, and the lack of such correlation for both the borderline and the learning disability groups. This is exemplified particularly by the results for the Leiter, Draw-A-Man, and Detroit Designs: these tests show relationship to educational achievement essentially only for the normals; almost no correlation with educational tests appeared for the learning disability group.

The intercorrelation analysis clearly indicated that the constellation of mental abilities varies for children with deficits in learning. In addition, the greater the deficiency in learning, the greater the variation from the normal. In other words, the clusters of mental faculties are not the same for normal and learning deficient children. Perhaps the most obvious difference occurs in the ways in which verbal and nonverbal abilities do not interrelate in those with deficits in learning, and the ways in which they do interrelate for the normal. Therefore, for children with learning disabilities it is very difficult to predict success in verbal learning from nonverbal measures. Whereas, for normal children such predictions can be made with reliability.

TABLE 60

INTERCORRELATIONS OF EDUCATIONAL ACHIEVEMENT VARIABLES FOR THE BORDERLINE AND NORMAL COMPARISON GROUPS (EDUCATIONAL ACHIEVEMENT WITH EDUCATIONAL ACHIEVEMENT)

	Wide Range Oral Reading	Gates-MacGinitie Accuracy	Gates-MacGinitie Comprehension	Gates-MacGinitie Vocabulary	Gates-McKillop Word Parts	Gates-McKillop Nonsense words	Gates-McKillop Syllabication	Metropolitan Arithmetic	PMA Arithmetic	Metropolitan Spelling	Gates-Russell Oral Words
Wide Range Oral Reading		B=.72 C=.68	B=.79 C=.71	B=.85 C=.82	B=.69 C=.65	B=.58 C=.54	B=.70 C=.64	B=.48 C=.56	B=.48 C=.53	B=.81 C=.71	B=.82 C=.79
Gates-MacGinitie Accuracy			B=.68 C=.74	B=.75 C=.67	B=.52 C=.51	B=.44 C=.44	B=.55 C=.48	B=.55 C=.56	B=.45 C=.55	B=.64 C=.60	B=.65 C=.57
Gates-MacGinitie Comprehension				B=.85 C=.78	B=.48 C=.52	B=.45 C=.39	B=.49 C=.53	B=.46 C=.54	B=.40 C=.53	B=.63 C=.65	B=.62 C=.61
Gates-MacGinitie Vocabulary					B=.58 C=.61	B=.53 C=.52	B=.63 C=.59	B=.52 C=.61	B=.46 C=.62	B=.74 C=.75	B=.70 C=.72
Gates-McKillop Word Parts						B=.56 C=.63	B=.78 C=.70	B=.46 C=.43	B=.40 C=.48	B=.77 C=.69	B=.70 C=.64
Gates-McKillop Nonsense Words							B=.59 C=.52	B=.48 C=.30	B=.41 C=.39	B=.63 C=.60	B=.62 C=.57
Gates-McKillop Syllabication								B=.41 C=.42	B=.42 C=.47	B=.73 C=.64	B=.72 C=.58
Metropolitan Arithmetic									B=.74 C=.78	B=.61 C=.67	B=.55 C=.60
PMA Arithmetic										B=.51 C=.60	B=.55 C=.60
Metropolitan Spelling											B=.88 C=.80
Gates-Russell Oral Words											

B = Borderline Group
C = Normal Comparison Group

TABLE 60 - Continued

	Gates-Russell One-Syllable	Gates-Russell Two Syllables	Metropolitan Language	PSILT Total Words	PSILT Total Sentences	PSILT Words Per Sentence	PSILT Syntax	PSILT Abstract-Concrete	Detroit Free Association	Detroit Verbal Opposites	Detroit Words	Detroit Sentences
Wide Range	B=.66	B=.64	B=.69	B=.35			B=.33	B=.24		B=.58	B=.25	B=.33
Oral Reading	C=.55	C=.51	C=.67	C=.31				C=.36	C=.32	C=.53		C=.40
Gates-MacGinitie	B=.49	B=.48	B=.60	B=.32		B=.29	B=.32		B=.41	B=.64		B=.31
Accuracy	C=.46	C=.42	C=.64	C=.37	C=.27			C=.36	C=.45	C=.53		C=.46
Gates-MacGinitie	B=.52	B=.49	B=.71				B=.37			B=.69		B=.45
Comprehension	C=.47	C=.49	C=.71	C=.44	C=.30			C=.41	C=.37	C=.61		C=.43
Gates-MacGinitie	B=.53	B=.56	B=.71				B=.37		B=.29	B=.70	B=.38	B=.46
Vocabulary	C=.54	C=.52	C=.73	C=.31				C=.34	C=.36	C=.64		C=.37
Gates-McKillop	B=.71	B=.69					B=.29			B=.46	B=.24	B=.26
Word Parts	C=.70	C=.59	C=.63				C=.33		C=.30	C=.35	C=.25	C=.34
Gates-McKillop	B=.61	B=.60		B=.33	B=.30			B=.27		B=.25		
Nonsense words	C=.54	C=.50	C=.45								C=.28	C=.30
Gates-McKillop	B=.65	B=.60		B=.31			B=,27		B=.28	B=.42	B=.28	B=.29
Syllabication	C=.50	C=.50	C=.52	C=.29			C=.26		C=.33	C=.41	C=.26	C=.30
Metropolitan	B=.46	B=.36					B=.31	B=.29	B=.26	B=.41		
Arithmetic	C=.44	C=.37	C=.64	C=.25					C=.45	C=.43	C=.25	C=.42
PMA	B=.38	B=.36	B=.43	B=.28				B=.30	B=.32	B=.49	B=.35	
Arithmetic	C=.51	C=.42	C=.57	C=.27			C=.28	C=.30	C=.50	C=.43	C=.25	C=.38
Metropolitan	B=.70	B=.68	B=.63	B=.30			B=.43		B=.32	B=.53		B=.33
Spelling	C=.60	C=.56	C=.73	C=.39		C=.32			C=.40	C=.49		C=.34
Gates-Russell	B=.66	B=.65	B=.60	B=.29			B=.34		B=.31	B=.44	B=.32	B=.32
Oral Words	C=.54	C=.50	C=.66	C=.46	C=.26	C=.32	C=.29	C=.30	C=.38	C=.38	C=.29	C=.35

B = Borderline Group
C = Normal Comparison Group

TABLE 60 - Continued

	Gates-Russell One-Syllable	Gates-Russell Two-Syllables	Metropolitan Language	PSLT Total Words	PSLT Total Sentences	PSLT Words per Sentence	PSLT Syntax	PSLT Abstract-Concrete	Detroit Free Association	Detroit Verbal Opposites	Detroit Words	Detroit Sentences
Gates-Russell One-Syllable		B=.78 C=.59	B=.57 C=.61				C=.26		B=.25 C=.36	B=.49 C=.38	B=.26	B=.38 C=.27
Gates-Russell Two-Syllables			B=.58 C=.58				C=.31			B=.48 C=.33	B=.25 C=.24	B=.34 C=.38
Metropolitan Language				C=.35			B=.42 C=.29	C=.32	B=.36 C=.35	B=.56 C=.62	B=.31	B=.50 C=.41
PSLT Total Words					B=.83 C=.77			B=.34 C=.43	C=.30		C=.25	C=.26
PSLT Total Sentences								B=.49 C=.43	C=.25			C=.29
PSLT Words per Sent.								B=.30				
PSLT Syntax										C=.25		
PSLT Abstract-Concrete									C=.29			
Detroit Free Association										B=.28 C=.24	B=.27 C=.39	C=.42
Detroit Verbal Opposites											B=.27	B=.48 C=.38
Detroit Words												B=.57 C=.64

B = Borderline Group
C = Normal Comparison Group

TABLE 60 - Continued

	Detroit Oral Directions	Detroit Letters	Detroit Orientation	Detroit Designs	Oral PSLT Words per Sentence	Oral PSLT Abstract-Concrete	Leiter	Healy I	Vineland	Kent D	Heath Rails	Draw-A-Man
Wide Range Oral Reading	B=.30 C=.34	B=.50 C=.63	C=.44	C=.32	C=.28	B=.36 C=.33	B=.30 C=.43		B=.31 C=.38	B=.27 C=.47		C=.46
Gates-MacGinitie Accuracy	B=.31 C=.45	B=.45 C=.55	B=.38 C=.35	C=.27	C=.28	B=.39	B=.34 C=.51	C=.39	B=.36 C=.40	B=.40 C=.42		C=.49
Gates-MacGinitie Comprehension	B=.43 C=.47	B=.58 C=.54	B=.50 C=.41	C=.44		C=.29	B=.38 C=.56		B=.31 C=.53	B=.47 C=.54		C=.53
Gates-MacGinitie Vocabulary	B=.39 C=.39	B=.59 C=.53	B=.39 C=.53	C=.49	C=.28	B=.36	B=.35 C=.51		B=.40 C=.47	B=.48 C=.54		C=.48
Gates-McKillop Word Parts	B=.33 C=.26	B=.33 C=.46	C=.42	B=.34 C=.30		B=.26 C=.27	C=.37	C=.27	C=.25	C=.29		C=.32
Gates-McKillop Nonsense Words		B=.39 C=.37		B=.38		B=.33	B=.33 C=.28		C=.26			C=.35
Gates-McKillop Syllabication	B=.35 C=.31	B=.41 C=.44	C=.38	B=.26		B=.29	B=.30 C=.38	C=.32	B=.30	C=.33		C=.38
Metropolitan Arithmetic	B=.31 C=.52	B=.30 C=.46	B=.32 C=.53	B=.26 C=.51		B=.26 C=.26	B=.50 C=.46		B=.34 C=.41	B=.35 C=.50		C=.30
PMA Arithmetic	B=.40 C=.52	B=.34 C=.39	B=.33 C=.60	C=.55		C=.24	B=.41 C=.38	C=.29	C=.38	B=.30 C=.49		C=.40
Metropolitan Spelling	B=.34 C=.38	B=.49 C=.52	C=.53	B=.29 C=.47		B=.34	C=.49		B=.32 C=.48	C=.38		C=.40
Gates-Russell Oral Words	B=.30 C=.37	B=.50 C=.62	C=.48	C=.42		B=.29 C=.32	C=.42		C=.36	C=.37		C=.35

B = Borderline Group
C = Normal Comparison Group

TABLE 60 - Continued

	Detroit Oral Directions	Detroit Letters	Detroit Orientation	Detroit Designs	Oral PSLT Words per Sentence	Oral PSLT Abstract-Concrete	Leiter	Healy I	Vineland	Kent D	Heath Rails	Draw-A-Man
Gates-Russell One-Syllable	B=.37 C=.26	B=.42 C=.35	C=.33	C=.36		B=.30	B=.39 C=.40	C=.27	B=.27 C=.33	B=.26 C=.33		C=.28
Gates-Russell Two-Syllables	B=.27	B=.42 C=.39	C=.35	B=.25 C=.26		C=.34	B=.32 C=.34		C=.32	C=.30		C=.34
Metropolitan Language	B=.44 C=.45	B=.54 C=.52	B=.41 C=.54	B=.44 C=.42			B=.42 C=.55		B=.28 C=.49	B=.52 C=.45		B=.30 C=.50
PSLT Total Words		C=.41				B=.46 C=.29	C=.36					C=.28
PSLT Total Sentences		C=.34				B=.42 C=.28	C=.33					
PSLT Words Per Sent.												
PSLT Syntax												
PSLT Abstract-Concrete		C=.31		B=.26		B=.65 C=.52	B=.35 C=.29	C=.25				C=.32
Detroit Free Association	B=.26 C=.33	B=.27 C=.37				B=.25			C=.35		C=.25	
Detroit Verbal Oppo.	B=.38 C=.33	B=.36 C=.34	B=.58 C=.46	C=.27		B=.30	B=.46 C=.42		B=.28 C=.31	B=.57 C=.58		C=.42
Detroit Words	B=.26 C=.35	B=.42 C=.53		C=.24							B=.31	

B = Borderline Group
C = Normal Comparison Group

TABLE 60 - Continued

	Detroit Sentences	Detroit Oral Directions	Detroit Letters	Detroit Orientation	Detroit Designs	Oral PSLT Words per Sentence	Oral PSLT Abstract-Concrete	Leiter	Healy I	Vineland	Kent D	Heath Rails	Draw-A-Man
Detroit Sentences		B=.40 C=.45	B=.45 C=.56	B=.28 C=.30						B=.26 C=.36	B=.36		
Detroit Oral Directions			B=.37 C=.44	B=.38 C=.42	C=.35	B=.27		B=.41		B=.31	B=.31 C=.26		C=.24
Detroit Letters				C=.32			C=.31	B=.28 C=.23		B=.24 C=.34	B=.27 C=.32		C=.26
Detroit Orientation					C=.35			B=.49 C=.33		B=.25 C=.24	B=.62 C=.48		C=.26
Detroit Designs								B=.50 C=.38		C=.32	B=.32 C=.38		B=.37 C=.27
Oral PSLT Words per Sen.									C=.25				C=.29
Oral PSLT Abs.-Concrete								B=.30					
Leiter									B=.34 C=.34	B=.28 C=.43	B=.55 C=.52		B=.36 C=.47
Healy I											C=.30		C=.33
Vineland											B=.25 C=.29		
Kent D													C=.45
Heath Rails													
Draw-A-Man													

B = Borderline Group
C = Normal Comparison Group

Level of Significance at .01: r = .27 (90 subjects)
r = .24 (116 subjects)

TABLE 61

INTERCORRELATION OF EDUCATIONAL ACHIEVEMENT VARIABLES FOR THE LEARNING DISABILITY AND NORMAL COMPARISON GROUPS

(EDUCATIONAL ACHIEVEMENT WITH EDUCATIONAL ACHIEVEMENT)

	Wide Range Oral Reading	Gates-MacGinitie Accuracy	Gates-MacGinitie Comprehension	Gates-MacGinitie Vocabulary	Gates-McKillop Word Parts	Gates-McKillop Nonsense Words	Gates-McKillop Syllabication	Metropolitan Arithmetic	PMA Arithmetic	Metropolitan Spelling	Gates-Russell Oral Words
Wide Range Oral Reading		L=.65 C=.66	L=.69 C=.65	L=.76 C=.71	L=.73 C=.58	L=.64 C=.43	L=.80 C=.57	L=.52 C=.42	L=.41 C=.45	L=.86 C=.70	L=.84 C=.81
Gates-MacGinitie Accuracy			L=.79 C=.69	L=.75 C=.68	L=.43 C=.37	L=.38 C=.30	L=.51 C=.41	L=.49 C=.48	L=.47 C=.50	L=.61 C=.62	L=.61 C=.52
Gates-MacGinitie Comprehension				L=.80 C=.78	L=.51 C=.48	L=.46 C=.40	L=.55 C=.48	L=.55 C=.52	L=.48 C=.47	L=.64 C=.61	L=.65 C=.59
Gates-MacGinitie Vocabulary					L=.60 C=.54	L=.58 C=.46	L=.66 C=.54	L=.61 C=.52	L=.52 C=.55	L=.72 C=.72	L=.75 C=.65
Gates-McKillop Word Parts						L=.65 C=.60	L=.77 C=.69	L=.42 C=.35	L=.28 C=.35	L=.77 C=.59	L=.71 C=.62
Gates-McKillop Nonsense Words							L=.62 C=.44	L=.39 C=.37	L=.31 C=.33	L=.62 C=.52	L=.60 C=.55
Gates-McKillop Syllabication								L=.43 C=.38	L=.32 C=.41	L=.78 C=.62	L=.73 C=.56
Metropolitan Arithmetic									L=.79 C=.71	L=.59 C=.58	L=.58 C=.54
PMA Arithmetic										L=.41 C=.57	L=.47 C=.53
Metropolitan Spelling											L=.89 C=.79
Gates-Russell Oral Words											

L = Learning Disability
C = Normal Comparison Group

TABLE 61 - Continued

	Gates-Russell One-Syllable	Gates-Russell Two-Syllables	Metropolitan Language	PSLT Total Words	PSLT Total Sentences	PSLT Words Per Sentence	PSLT Syntax	PSLT Abstract-Concrete	Detroit Free Association	Detroit Verbal Opposites	Detroit Words	Detroit Sentences
Wide Range Oral Reading	L=.67 C=.42	L=.71 C=.43	L=.57 C=.57	L=.43	L=.40		L=.28	L=.30		L=.42 C=.47		C=.43
Gates-MacGinitie Accuracy	L=.53 C=.29	C=.35	C=.62	C=.28				C=.28	C=.37	L=.34 C=.56	C=.28	C=.36
Gates-MacGinitie Comprehension	L=.59 C=.46	L=.55 C=.48	L=.62 C=.69	L=.51 C=.33	L=.37			L=.31 C=.29		L=.44 C=.68		C=.46
Gates-MacGinitie Vocabulary	L=.76 C=.50	L=.81 C=.48	L=.73 C=.65	L=.39	L=.36			L=.34		L=.42 C=.70	L=.30 C=.29	C=.43
Gates-McKillop Word Parts	L=.67 C=.67	L=.63 C=.50	L=.47 C=.55	L=.25						L=.36 C=.31		C=.29
Gates-McKillop Nonsense Words	L=.54 C=.50	L=.58 C=.39	L=.49 C=.47	L=.29	L=.33			L=.26				C=.30
Gates-McKillop Syllabication	L=.67 C=.52	L=.70 C=.45	L=.49 C=.52	L=.45	L=.34		L=.26	L=.28		L=.26 C=.39		C=.26
Metropolitan Arithmetic	L=.44 C=.35	L=.48 C=.33	L=.56 C=.57	L=.33	L=.31	C=.29		L=.31 C=.28	L=.28 C=.33	L=.46 C=.45		L=.37 C=.41
PMA Arithmetic	L=.37 C=.37	L=.45 C=.37	L=.42 C=.54	L=.34			C=.33	L=.38 C=.30	L=.32 C=.40	L=.39 C=.47		L=.31 C=.38
Metropolitan Spelling	L=.72 C=.54	L=.72 C=.47	L=.57 C=.66	L=.54 C=.32	L=.49	C=.27	C=.30	L=.34	C=.40	L=.40 C=.51		C=.39
Gates-Russell Oral Words	L=.66 C=.52	L=.68 C=.48	L=.58 C=.63	L=.42 C=.29	L=.38	C=.31	L=.26 C=.37			L=.29 C=.39	C=.26	C=.40

L = Learning Disability
C = Normal Comparison Group

TABLE 61 - Continued

	Detroit Oral Directions	Detroit Letters	Detroit Orientation	Detroit Designs	Oral PSLT Words per Sentence	Oral PSLT Abstract-Concrete	Leiter	Healy I	Vineland	Kent D	Heath Rails	Draw-A-Man
Wide Range		L=.41				L=.28						
Oral Reading		C=.62	C=.38		C=.26		C=.28			C=.44		C=.30
Gates-MacGinitie		L=.29	L=.35			L=.29						
Accuracy	C=.47	C=.43	C=.37		C=.28			C=.35	C=.33	C=.47		C=.39
Gates-MacGinitie			L=.35			L=.36						
Comprehension	C=.45	C=.48	C=.41				C=.47		C=.45	C=.55		C=.44
Gates-MacGinitie		L=.38				L=.32			L=.28			
Vocabulary	C=.44	C=.47	C=.49	C=.28			C=.44		C=.42	C=.62		C=.40
Gates-McKillop		L=.32										
Word Parts	C=.33	C=.46	C=.28	C=.27			C=.32			C=.35		
Gates-McKillop		L=.35										
Nonsense Words	C=.27	C=.45		C=.31			C=.30					
Gates McKillop		L=.38						L=-.29				
Syllabication		C=.35	C=.31	C=.33			C=.29			C=.32		C=.28
Metropolitan		L=.35	L=.35						L=.41	L=.34		
Arithmetic	C=.41	C=.34	C=.41	C=.36			C=.47		C=.48	C=.46		C=.30
PMA			L=.43	L=.31					L=.40	L=.30		
Arithmetic	C=.48		C=.50	C=.40			C=.41		C=.31	C=.45		C=.42
Metropolitan		L=.38	L=.28			L=.28		L=-.36	L=.35			
Spelling	C=.39	C=.47	C=.45	C=.34			C=.36		C=.35	C=.47		C=.34
Gates-Russell		L=.40	L=.26					L=-.27	L=.32			L=.26
Oral Words	C=.37	C=.55	C=.36	C=.33			C=.31		C=.25	C=.42		

L = Learning Disability
C = Normal Comparison Group

TABLE 61 - Continued

	Gates-Russell One-Syllable	Gates-Russell Two-Syllables	Metropolitan Language	PSILT Total Words	PSILT Total Sentences	PSILT Words per Sentence	PSILT Syntax	PSILT Abstract-Concrete	Detroit Free Association	Detroit Verbal Opposites	Detroit Words	Detroit Sentences
Gates-Russell One-Syllable		L=.80 C=.56	L=.70 C=.53	L=.31	L=.26					L=.32 C=.32	L=.38	L=.34
Gates-Russell Two-Syllables			L=.72 C=.49	L=.32	L=.27					L=.32 C=.35	L=.25	L=.28 C=.34
Metropolitan Language				C=.31			L=.31 C=.31	L=.28 C=.28	C=.42	L=.39 C=.62		C=.43
PSILT Total Words					L=.77 C=.75	L=.41		L=.43 C=.35	C=.29			
PSILT Total Sentences								L=.46 C=.37				
PSILT Words Per Sentence							L=.26					
PSILT Syntax											L=.26	
PSILT Abstract-Concrete										C=.26		
Detroit Free Association										L=.27	L=.42	L=.27 C=.26
Detroit Verbal Opposites											L=.35	L=.47 C=.38
Detroit Words												L=.60 C=.64

L = Learning Disability Group
C = Normal Comparison Group

TABLE 61 - Continued

	Detroit Oral Directions	Detroit Letters	Detroit Orientation	Detroit Designs	Oral PSLT Words per Sentence	Oral PSLT Abstract-Concrete	Leiter	Healy I	Vineland	Kent D	Heath Rails	Draw-A-Man
Gates-Russell One-Syllable		L=.36 C=.30		C=.35			C=.40			C=.34		C=.2
Gates-Russell Two-Syllables		L=.40 C=.31				L=.25 C=.28	C=.33		L=.25	C=.28	C=.26	C=.2
Metropolitan Language	C=.50	L=.34 C=.47	L=.34 C=.43	C=.32			C=.43	C=.31	L=.37 C=.40	L=.28 C=.57		C=.4
PSLT Total Words						L=.36						
PSLT Total Sentences						L=.35	L=.26					
PSLT Words Per Sentence				C=.25								C=.3
PSLT Syntax												
PSLT Abstract-Concrete	L=.25					L=.51 C=.46						C=.2
Detroit Free Association	C=.27											C=.2
Detroit Verbal Opposites	C=.45	L=.35 C=.32	L=.49 C=.53				C=.45		C=.26	L=.44 C=.63		C=.4
Detroit Words	L=.27 C=.39	L=.26 C=.46										

L = Learning Disability Group
C = Normal Comparison Group

TABLE 61 - Continued

	Detroit Sentences	Detroit Oral Directions	Detroit Letters	Detroit Orientation	Detroit Designs	Oral PSLT Words per Sentence	Oral PSLT Abstract-Concrete	Leiter	Healy I	Vineland	Kent D	Heath Rails	Draw-A-Man
Detroit Sentences		C=.48	L=.38 C=.63	L=.26 C=.32	C=.30		L=.30						
Detroit Oral Directions			C=.39	L=.30 C=.41	C=.28			C=.31			L=.31 C=.35		
Detroit Letters								C=.35			C=.28		
Detroit Orientation								C=.34			L=.53 C=.50		
Detroit Designs								L=.50 C=.32				L=.31	L=.42
Oral PSLT Wds. Per Sentence													C=.26
Oral PSLT Abstract Concrete													
Leiter									L=.37		C=.48		L=.45 C=.40
Healy I											C=.27		L=.28 C=.28
Vineland													
Kent D													C=.35
Heath Rails													L=.25
Draw-A-Man													

L = Learning Disability
C = Normal Comparison Group

Level of significance at .01: r = .28 (88 subjects)
r = .25 (112 subjects)

Discriminant Analysis

An important objective of this research was to evolve a test battery for differentiating between normal children and children with deficits in learning. The discriminant analysis technique has been demonstrated to be useful in determining the extent to which a given measure can be relied upon when making such a differentiation.

This technique was used in two ways. First, all of the test score variables were analyzed in terms of their strength in distinquishing between the experimental and control populations. These results are found in Tables 62 and 63. One must be impressed with the agreement found as to the most potent discriminators, whether the child was classified as borderline or as learning disability. In both cases the most significantly discriminating test was syllabication. This is of keen interest both clinically and scientifically. On this test the child is required to pronounce nonsense words which he sees. In order to perform well he must be able to recognize the letters and to organize them into their auditorized equivalents. For normal performance, therefore, he must be able to both visualize and auditorize; to some extent this is true also of ability to spell in the written form. The ability to integrate auditory and visual stimuli appears to be critical in school learning.

Though the Leiter Test ranked high as a discriminator (next to syllabication) for those in the learning disability sample, it did not rank in the top four for the borderline group. However, in addition to syllabication, reading comprehension and WISC comprehension proved to be highly significant discriminators fc: >th experimental populations. It should be noted that when all 49 variables were included, 45 of them discriminated between the experimental and control groups at the .01 level.

The second analysis concerned only the 21 variables used to classify the intensive study sample as normal, borderline, or learning disability. With the reduced number of variables differences appeared in the order of the tests by F value, in terms of the level at which they differentiated between the experimental and control groups (see Tables 64 and 65). However, again reading comprehension was a highly significant factor. Moreover, though the order varied, all 21 of the variables discriminated between each experimental group and its controls at the .01 level.

From these discriminant analysis results, we again infer implications for the basis of the psychology of learning. The interrelated functions which appear to be of utmost importance are verbal and non-verbal abilities and the capacity to visualize from the auditory and to auditorize from the visual. Another way in which to view the implications is in terms of integrative capacities. The normal learner seems capable of integrating new experience whether it be verbal, non-verbal, auditory, or visual in nature. Those with deficits seem to acquire learning in an isolated manner so that, though acquired, it does not generalize to other experience in the usual manner.

TABLE 62

DISCRIMINANT ANALYSIS OF THE FORTY-NINE VARIABLES OF THE PSYCHOEDUCATIONAL BATTERY FOR THE BORDERLINE GROUP AND THE NORMAL CONTROLS (N=90)

Items significant at .01	F
Gates-McKillop Syllabication	51.45
Gates-MacGinitie Comprehension	33.50
WISC Comprehension	24.43
PMA Arithmetic	19.44
Gates-MacGinitie Accuracy	16.27
WISC Similarities	14.00
Metropolitan Language	12.64
Healy I	11.47
Draw-A-Man	10.59
Detroit Letters	9.71
Detroit Sentences	9.00
Gates-McKillop Nonsense Words	8.46
Metropolitan Spelling	7.95
WISC Block Design	7.45
Kent D	7.08
Oral PSLT Words Per Sentence	6.71
Oral PSLT Abstract-Concrete	6.38
PSLT Abstract-Concrete	6.10
Gates-McKillop Word Parts	5.83
Gates-Russell 1 Syllable	5.57
Leiter	5.34
Metropolitan Arithmetic	5.15
Detroit Free Association	4.96
WISC Arithmetic	4.82
WISC Object Assembly	4.65
Detroit Orientation	4.48

TABLE 62 - Continued

Items significant at .01	F
PSLT Syntax	4.32
Gates-Russell Oral Words	4.16
Detroit Verbal Opposites	4.03
Gates-MacGinitie Vocabulary	3.90
Heath Rails	3.76
Detroit Oral Directions	3.63
WISC Vocabulary	3.51
PSLT Words Per Sentence	3.39
Mean Performance M.A.	3.28
Vineland	3.17
Digit Span	3.07
WISC Picture Completion	2.97
WISC Picture Arrangement	2.87
(Mean Performance M.A. is removed)	2.97
WISC Coding	2.87
PSLT Total Sentences	2.78
PSLT Total Words	2.70
Mean Performance M.A.	2.62
WISC Mazes	2.60
Gates-Russell 2 Syllables	2.53
Wide Range Oral Reading	2.46

Not significant at .01: WISC Information
Mean Verbal M.A.
Detroit Words
Detroit Designs

TABLE 63

DISCRIMINANT ANALYSIS OF THE FORTY-NINE VARIABLES OF THE PSYCHOEDUCATIONAL BATTERY FOR THE LEARNING DISABILITY GROUP AND THE NORMAL CONTROLS (N=88)

Items significant at .01	F
Gates-McKillop Syllabication	111.53
Leiter	74.07
Gates-MacGinitie Comprehension	53.91
WISC Comprehension	43.62
Healy I	37.05
Gates-McKillop Nonsense Words	32.76
Gates-Russell 1 Syllable	29.49
Gates-McKillop Word Parts	27.31
PSLT Syntax	25.35
Mean Verbal M.A.	23.36
Detroit Sentences	22.16
PMA Arithmetic	20.91
WISC Coding	20.19
Mean Performance M.A.	19.12
PSLT Total Words	18.27
Gates-Russell Oral Words	17.36
Heath Rails	16.40
PSLT Total Sentences	15.49
Metropolitan Arithmetic	14.71
Detroit Designs	13.99
Detroit Verbal Opposites	13.35
Gates-MacGinitie Accuracy	12.72
Detroit Free Association	12.15
Oral PSLT Abstract-Concrete	11.63
WISC Vocabulary	11.15
Oral PSLT Words Per Sentence	10.70

TABLE 63 - Continued

Items significant at .01	F
Detroit Oral Directions	10.30
WISC Similarities	9.93
Metropolitan Spelling	9.58
Gates-Russell 2 Syllables	9.24
Detroit Words	8.91
Wide Range Oral Reading	8.59
Detroit Orientation	8.28
Metropolitan Language	7.99
WISC Picture Completion	6.98
WISC Information	6.76
PSLT Abstract-Concrete	6.54
WISC Digit Span	6.34
WISC Arithmetic	6.15
Kent D	5.97
PSLT Words Per Sentence	5.79
WISC Block Design	5.62

Not significant at .01: WISC Object Assembly
WISC Mazes
Vineland
Draw-A-Man

TABLE 64

DISCRIMINANT ANALYSIS OF TWENTY-ONE CLASSIFICATION VARIABLES FOR THE BORDERLINE GROUP AND THE NORMAL CONTROLS (N=90)

Items significant at .01	F
Gates-MacGinitie Comprehension	47.06
Metropolitan Language	27.23
Draw-A-Man	19.87
Healy I	15.92
PMA Arithmetic	13.38
Gates-MacGinitie Accuracy	11.78
Metropolitan Arithmetic	10.35
Detroit Free Association	9.19
PSLT Words Per Sentence	8.22
Oral PSLT Abstract-Concrete	7.43
PSLT Abstract-Concrete	6.87
Metropolitan Spelling	6.32
Oral PSLT Words Per Sentence	5.84
Leiter	5.44
Detroit Verbal Opposites	5.07
Gates-MacGinitie Vocabulary	4.74
Detroit Orientation	4.46
Kent D	4.21
PSLT Total Words	3.97
PSLT Syntax	3.75
Detroit Designs	3.56

TABLE 65

DISCRIMINANT ANALYSIS OF TWENTY-ONE CLASSIFICATION VARIABLES FOR THE LEARNING DISABILITY GROUP AND THE NORMAL CONTROLS (N=88)

Items significant at .01	F
Gates-MacGinitie Comprehension	104.78
Detroit Designs	62.83
Metropolitan Spelling	46.45
Healy I	37.90
PSLT Syntax	33.34
Oral PSLT Abstract-Concrete	27.60
Leiter	24.13
Metropolitan Arithmetic	21.55
PMA Arithmetic	19.77
Gates-MacGinitie Accuracy	18.04
Oral PSLT Words Per Sentence	16.40
Detroit Verbal Opposites	15.03
PSLT Total Words	13.89
Metropolitan Language	12.89
Draw-A-Man	11.99
Detroit Orientation	11.19
Detroit Free Association	10.50
PSLT Words Per Sentence	9.86
Kent D	9.29
PSLT Abstract-Concrete	8.77
Gates-MacGinitie Vocabulary	8.30

Summary

The psychoeducational study revealed differences between the experimental and control groups. The experimental populations were lower in mental ability but this variation was not considered a primary basis for the extent to which they manifested deficits in learning. Moreover, the borderline and learning disability groups were comparable in intelligence, though they varied in the degree of their learning deficiency. In general, the normal control groups fell at the high-average level intellectually, whereas the experimentals were of average mental ability. The profile for those with learning disabilities varied from the normal. Their pattern was to score higher on performance tests of intelligence while the normals were higher on verbal tests.

Both experimental groups were inferior to the controls on measures of educational achievement. The least difference appeared on tests of auditory language and auditory memory. While the experimental groups were similar to each other on these functions, both were inferior to the normal. The borderline and learning disability subjects differed substantially in facility of learning to use the read and written forms of language; the learning disability children were most deficient. Through discriminant analysis it was determined that ability to syllabicate was a critical factor as far as successful learning was concerned. The implication is that both auditory and visual processing must be intact if educational achievement is to be adequate, if potential is to be actualized. Reading comprehension also proved to be highly useful in differentiating between good and poor learners.

A noteworthy outcome of the psychoeducational investigation concerned the findings from the intercorrelation analysis. The pattern of relationships varied for the experimentals in comparison with the normals. Thereby, we concluded that the processes by which the learning deficient child organizes experience are different from those used by the normal child. For example, coding ability correlated with other mental abilities in the normal but not in the experimental subjects. More generally, for the normal learners verbal and nonverbal mental abilities were highly correlated but, in contrast, these abilities often showed only slight or no relationship for the experimental groups. These findings suggest a difference in the psychology of learning which appears critical in planning for special education. This possibility was enhanced by the correlations between mental ability and educational achievement because these also differed significantly for the two groups.

Of unusual interest, also, was the fact that scores on a personality test revealed no difference between the experimental and control groups. Emotional disturbances did not characterize the children with deficiencies in learning. However, those with deficits in learning were inferior in social maturity; when learning was below expectancy the child was below average in development of ability to care for himself. This disturbance of development of independence occurred despite the fact that motor ability was intact.

The psychoeducational study clearly indicated variations in those with learning deficiencies, and these variations were of the type that are of utmost consequence in meeting the needs of this type of handicapped child.

OPHTHALMOLOGICAL STUDY

OPHTHALMOLOGICAL STUDY

Vision and visual processes are known to be directly related to success in reading. In the field of learning disabilities, various individuals and professional groups have emphasized the role of vision, frequently to the exclusion of other facets or dimensions. In planning the present investigation, it was decided that visual functions should be evaluated. Hence, ophthalmological studies were made of all children selected for the intensive diagnostic phase of the project.

Except for the examiner reliability study, all subjects were evaluated by the same ophthalmologist. This specialist was certified by the American Board of Ophthalmology and has been a faculty member of Northwestern University Medical School, Department of Ophthalmology, since 1954. His experience with learning disability children is excessive, covering a period of more than a decade. During this period he has served as a consultant to the Institute for Language Disorders. He is a member of the Interdisciplinary Committee on Reading Problems of the Center for Applied Linguistics and of the Dyslexia Study Association of Ophthalmologists. He has a long-standing research interest in the relationships between ophthalmological factors and deficits in learning.

Consistent with the research design developed for this investigation, the ophthalmologist examined all subjects without knowing whether the child represented an experimental or control group. He knew only that the subject was included in the research project in either of these groups. He was permitted to do his own history and these findings are summarized below. The form used is presented in Appendix C.

Reliability Studies

With assistance from the consultant committee at the initiation of the project, it was agreed that examiner reliability in ophthalmology was unknown. Therefore, we conducted a study to ascertain the extent to which our ophthalmologist was consistent with himself (intra-examiner reliability) and the degree to which his findings were in agreement with those of another ophthalmologist (inter-examiner reliability).

As shown in Table 66, of the 19 subjects examined twice, 17 were classified consistently by the research ophthalmologist. Two subjects first classified as abnormal were classified as normal on the second examination. In other words, using the broad categorizing of normal-abnormal, the examiner was highly consistent in his findings from the first to the second evaluation; his proportion of agreement was .89.

The specific findings per subject varied for seven children. Two subjects were found to have deficits in ocular coordination when seen the first time but on the second examination were found to be normal. One subject when first seen was considered normal but when seen the second time was judged astigmatic. The findings for four subjects varied mainly in the degree of involvement rather than in the clinical manifestations or signs. In general, despite the fact that the specific

TABLE 66

RESULTS FOR THE INTRA-EXAMINER RELIABILITY STUDY IN OPHTHALMOLOGY

Classification Category	Number	First Examination	Second Examination
True Control	5	Normal	Normal
True Control	1	Abnormal	Normal*
False Experimental	2	Abnormal	Abnormal
False Experimental	1	Normal	Normal
False Experimental	1	Abnormal	Normal*
Borderline	5	Normal	Normal
Borderline	1	Abnormal	Abnormal
False Control	1	Abnormal	Abnormal
Failed Intelligence	1	Normal	Normal
Failed Sensory	1	Normal	Normal
Total Number	19		

* Change between first and second examination.

Proportion of agreement = .89

findings varied for seven out of 19 subjects it is apparent that this examiner exhibited a high degree of consistency with himself.

A second ophthalmologist was engaged for the study of inter-examiner reliability. This examiner, like the first, was unaware of the child's classification (experimental or control). She conducted her examination approximately four to six weeks after the subjects had been seen by the regular research ophthalmologist.

The inter-examiner results for the general classification (normal-abnormal) are presented in Table 67. Of the 18 subjects seen by both examiners, disagreement occurred for only one; the first examiner categorized this subject as normal and the second examiner found him to be abnormal. On the basis of these results, the inter-examiner proportion of agreement was .94, a level of uniformity which is excellent. We can sssume that the findings of the ophthalmologist engaged in this research project represent the judgments of other physicians.

The findings from the intra-examiner and inter-examiner reliability studies indicate that highly experienced ophthalmologists are consistent with themselves and with each other. A direct implication for the results presented below is that the outcome was not unduly affected by examiner variability. Inasmuch as considerable interest has been manifested in the visual facets of minimally brain damaged children, this is fortunate.

The Sample

As indicated in the discussion of the sample (see introductory section), the subjects were selected from four public school systems in the metropolitan Chicago area. The total sample for the intensive phase of the investigation consisted of 627 subjects, distributed among the four school systems as shown in Table 68. Of this number, 611 were seen by the ophthalmologist. Only 16 children were not seen by the eye physician; the parents could not arrange to have their children participate. Review of the psychoeducational test scores for the 16 subjects not examined revealed no significant pattern; hence, it may be assumed that the 611 subjects comprising the sample for statistical analysis are representative of the total number of children selected for the second phase of the investigation.

Classification Criteria

The history was obtained from either parent. Birth defects of the ocular structures were noted and recorded as present or absent; if present, the specific defect was recorded but not classified as the incidence was insufficient to be statistically significant. If glasses had been professionally advised, this was recorded with the prescription of the lenses. In some instances the children had glasses but did not use them. Not infrequently, the child had been advised to use reading glasses for near range only; he suffered blurred vision upon viewing distant objects with his glasses on. If glasses had been worn in the past but were subsequently discontinued upon professional advice, the notation of glasses worn was negative. If bifocals were used, this

TABLE 67

RESULTS FOR THE INTER-EXAMINER RELIABILITY STUDY IN OPHTHALMOLOGY

Classification Category	Number	First Examiner	Second Examiner
True Control	2	Normal	Normal
True Control	2	Abnormal	Abnormal
False Experimental	2	Normal	Normal
False Experimental	1	Abnormal	Abnormal
Borderline	4	Normal	Normal
True Experimental	2	Normal	Normal
Failed Sensory	3	Abnormal	Abnormal
Failed Anxiety	1	Normal	Normal
Failed Anxiety	1	Normal	Abnormal*
Total Number	18		

* Disagreement between first and second examiner.

Proportion of agreement = .94

TABLE 68

SUMMARY BY SCHOOL SYSTEM OF THE SAMPLE
SEEN BY THE OPHTHALMOLOGIST

School System	Number Selected	Number Seen by Ophthalmologist	Number Not Seen by Ophthalmologist
A	160	157	3
B	123	120	3
C	73	72	1
D	271	262	9
Total	627	611	16

was noted. The item "orthoptics" was recorded as positive if the child had received any form of eye training. This included patching for amblyopia and binocular training by any means. Surgery was noted if the history included correction of strabismus, ptosis, or congenital cataract. A notation of trauma was positive only if a permanent defect resulted therefrom. If nystagmus of any type were present, it was recorded. Not recorded were the usual childhood accidental injuries of corneal abrasions, "black eyes," etc.

The neuro-ophthalmological evaluation included the following test procedures:

1. Pupillary reaction, both direct and consensual to light and accommodation was studied; equality was noted also.

2. Corneal sensation was tested by use of a cotton "whisp" gently applied to the center of each cornea.

3. The intactness of the third, fourth, and sixth cranial nerves was studied by asking the child to turn his eyes to the right, left, up and down, followed by fixation of a light in the six cardinal directions of gaze.

4. Convergence was measured by fixation of a small symbol moved progressively closer toward the bridge of the nose until either eye deviated from fixation, at which time the distance was noted and recorded in millimeters.

5. Visual field studies were performed on every child using the Harrington-Flocks visual screener. Color vision was tested using the Ishihara pseudochromatic plates.

Dominance of the hand was determined in other aspects of the research project. In the ophthalmological evaluation history of the hand used for writing was recorded. Moreover, ocular dominance was determined by sighting through a five millimeter hole in the center of a cardboard held at arm's length by both hands. The "controlling eye" was not determined. Because all of the children in the study were in the third or fourth grade (eight or nine years of age), the following classification criteria were used to record the findings as normal or abnormal.

Accommodation was measured for each eye individually using the Prince Rule and noting the blur point for each eye. A reading between eleven and sixteen diopters was established as normal, ten or less as abnormal.

Vision was tested with and without glasses for the right and left eyes individually; this included testing for distance (twenty feet) and near (fourteen inches) vision. In testing distance vision, a projector was used for the visual acuity chart to avoid memorization of the letters prior to testing and to standardize the illumination. A Lebensohn chart was used for near vision. For both distance and near vision, the normal standards were established as 20/20 to 20/40, and abnormal as 20/50 or less.

Ocular coordination was appraised by placing the Maddox Rod over the right eye while viewing a muscle light mounted on a wall twenty feet away with the left eye. The Maddox Wing test was used for determination of ocular alignment in the reading range. Notation was made as to the presence of eso-, exo-, or hypertropia. In the horizontal direction, measurements between zero and five prism diopeters were considered normal and six prism diopeters or more as abnormal. In the vertical direction, one diopeter or less was classified as normal, and more than one prism diopeter was recorded as abnormal.

Fusion and stereopsis were measured by the Wirt Stereotest using the nine graded designs, consisting of four circles. The responses were recorded in seconds and considered normal in the range of 100 seconds or greater. They were designated abnormal when they fell below 100 seconds, when fusion was present only for the Worth Four-Dot Test, and when absent completely.

Evaluation of refractive error was made by retinoscopy approximately thirty minutes after the instillation of two drops of 1% Mydriacel given five minutes apart. Measurement of one diopeter or less of hyperopia, myopia or astigmatism was listed as normal. Values for hyperopia and myopia in excess of one diopeter were categorized as abnormal. Astigmatism of more than one diopeter was listed as abnormal. The axis of the astigmatism also was recorded.

Results

As discussed in the first section of this report, the population was comprised of third and fourth grade public school children. Psychoeducational tests were administered to 2767 children and those who fell below ninety percent of effectiveness in achievement were judged to have deficiencies in learning. These experimental subjects (borderline and learning disability) were seen for an intensive evaluation and control subjects were studied in an identical manner; grade, sex, and classroom were controlled. This research design was the basis for the statistical results presented below: the primary groups were borderline and learning disability, with their respective control groups, and failed criteria (vision, hearing, anxiety, or IQ). To study these various populations, the ophthalmologist examined a total of 611 children, of which 108 had been classified as learning disability and 112 as borderline.

Case History Findings

Because a detailed medical history was done by other members of the research team, the ophthalmologist's history was brief, covering only six points: birth defects, use of glasses, orthoptics, surgery, trauma, and nystagmus. The results from the case history, comparing the borderline and learning disability groups with respective normal comparison groups, are given in Table 69 .

TABLE 69

RESULTS FOR THE OPHTHALMOLOGICAL HISTORY:
BORDERLINE (N=112), LEARNING DISABILITY (N=108), AND CONTROL GROUPS

History	Proportion of Normalcy			Proportion of Normalcy		
Item	Borderline	Control	Difference	Learn.Dis.	Control	Difference
Birth Defect	.991	.991	.000	1.000	.889	.009
Glasses	.911	.938	-.027	.889	.926	-.037
Orthoptics	.964	.991	-.027	.954	1.000	-.046
Surgery	.991	.991	.000	.972	.991	-.019
Trauma	.991	1.000	-.009	.991	1.000	-.009
Nystagmus	1.000	1.000	.000	.991	1.000	-.009

* p less than .05

These findings disclose that the incidence of the involvements covered by the ophthalmological history is low, both for the experimental and the control groups. As far as the six factors covered by the history are concerned, all groups were unusually free of disturbances. Irrespective of the presence or degree of deficiency in learning, birth defects, use of glasses, orthoptic training, eye surgery, eye accidents, and nystagmic disorders virtually were non-existent. However, it must be remembered that those with visual impairment were excluded initially, reducing the number that would have been found had such previous screening not been done.

Results for General Classification

The results for the primary populations are shown in Table 70 . The incidence of eye defects is highly comparable for all groups, those with or without deficits in learning; the differences between the experimental and control groups are not statistically significant. On the basis of these findings it appears that visual disorders as determined by the ophthalmologist do not contribute to deficits of learning as defined in this investigation.

To further explore the types of eye disorders found per group, the samples were classified on the basis of the principal involvement (Table 71). The most common problem was coordination but again the differences by group were not statistically significant.

Cross Dominance

Because of the clinical impression that discrepancies between hand and eye dominance are associated with learning, particularly with learning to read, the ophthalmologist evaluated this aspect of visual behavior. This classification was recorded as crossed or normal; no gradations of cross dominance were attempted. The results from the cross dominance study for the two groups (learning disability and borderline) and their controls are shown in Table 72. These findings indicate that cross dominance, discrepancy between eye and hand dominance, is unrelated to deficits in learning as identified and defined in this investigation. Irrespective of the degree of involvement, as reflected by the classifications of learning disability and borderline, there was no greater incidence of cross dominance when these groups were compared with the respective control groups. These results are revealing inasmuch as various questions have been raised with respect to the importance of eye-hand dominance in learning disabilities.

Specific ~ :amination Findings

To ascertain whether any single facet of the ophthalmological examination findings might be related to deficits in learning, an analysis was made of the thirty-three categories included in the study of vision (Table 73). The experimental and control groups were compared, using the test of proportion to ascertain which items represented significant differences. The results are highly revealing because in no instance did any one ophthalmological item differentiate

TABLE 70

OPHTHALMOLOGICAL EXAMINATION RESULTS BY GROUP WHEN CATEGORIZED AS NORMAL OR ABNORMAL

Group	N	Classification: Normal	Classification: Abnormal	Proportion	X^2
Borderline	112	91	21	.804	.507
Control	112	95	17	.839	
			Difference	-.035	
Learning Disability	108	91	17	.843	.619
Control	108	95	13	.861	
			Difference	-.018	

* p less than .05

TABLE 71

OPHTHALMOLOGICAL CLASSIFICATION
ON THE BASIS OF THE PRINCIPAL INVOLVEMENT

Principal Involvement	Borderline	Control	Learning Disability	Control
Normal	91	95	91	95
Hyperopia	3	4	2	4
Astigmatism	0	2	1	1
Co-ordination	16	9	12	6
Myopia	1	2	1	2
Anisometropia	1	0	1	0
Total	112	112	108	108

TABLE 72

THE RESULTS FOR CROSS DOMINANCE
AS CLASSIFIED BY THE OPHTHALMOLOGIST

Group	Normal *		Abnormal **		Total
	Without CD	With CD	Without CD	With CD	
Borderline	57	34	12	9	112
Control	55	40	13	4	112
Learning Disability	57	34	9	8	108
Control	63	32	10	3	108

* Normal - no other ophthalmological deficiencies

** Abnormal - other ophthalmological deficiencies present

TABLE 73

SPECIFIC FINDINGS FROM THE OPHTHALMOLOGICAL EXAMINATION FOR THE BORDERLINE (N=112), LEARNING DISABILITY (N=108), AND RESPECTIVE CONTROL GROUPS

Specific Finding	Borderline	Control	Difference	Learning Disab.	Control	Difference
Pupils Equal	1.000	1.000	.000	1.000	1.000	.000
Pupil Reaction to Light:						
Direct	1.000	1.000	.000	1.000	1.000	.000
Consensual	1.000	1.000	.000	1.000	1.000	.000
Mobility-Versions	.964	.982	-.019	.972	.991	-.019
Corneal Sensation	1.000	.982	.018	1.000	.991	.009
Convergence	.920	.920	.000	.907	.917	-.010
Visual Fields	1.000	.973	.027	.991	.991	.000
Color Vision	.955	.946	.009	.954	.944	.010
Ocular Fundi	1.000	1.000	.000	.991	1.000	.009
Ocular Dominance	.589	.554	.035	.593	.676	-.083
Handedness	.884	.893	-.009	.861	.917	-.056
Accommodation:						
Right Eye	.992	.982	.010	.981	.981	.000
Left Eye	.982	.982	.000	.972	.972	.000
Vision Unaided, Distance:						
Right Eye	.929	.956	-.027	.926	.935	-.009
Left Eye	.929	.956	-.027	.926	.935	-.009
Vision Unaided, Near:						
Right Eye	.964	1.000	-.036	.981	.991	-.010
Left Eye	.955	1.000	-.045	.982	.990	.008

TABLE 73 - Continued

Specific Finding	Border-line	Control	Difference	Learning Disab.	Control	Difference
Vision Corrected,						
Distance:	(N=10)	(N=7)		(N=12)	(N=8)	
Right Eye	1.000	.833	.167**	1.000	.878	.122**
Left Eye	1.000	.833	.167**	1.000	.878	.122**
Vision Corrected,						
Near:	(N=10)	(N=7)		(N=12)	(N=8)	
Right Eye	1.000	1.000	.000	1.000	1.000	.000
Left Eye	1.000	1.000	.000	1.000	1.000	.000
Ocular Coordination:						
Near	.929	.946	-.017	.907	.981	-.074
Distance	.946	.938	.008	.907	.991	-.084
Hyper:						
Near	.955	.982	-.027	.981	.991	-.010
Distance	.955	.982	-.027	.954	.991	-.037
Fusion and						
Stereopsis:	.929	.938	-.009	.899	.973	-.074
Refractive Error,						
Hyperopia:						
Right Eye	.911	.938	-.027	.917	.907	.010
Left Eye	.938	.946	.008	.944	.907	.037
Refractive Error,						
Myopia:						
Right Eye	.955	.938	.017	.944	.898	.046
Left Eye	.946	.929	.017	.935	.907	.028
Refractive Error,						
Astigmatism:						
Right Eye	.982	.964	.018	.981	.935	.046
Left Eye	.973	.938	.035	.963	.917	.046

* p less than .05
** p less than .01

between the groups (those showing significance pertain only to correction of vision with glasses and do not distinguish between the groups in terms of visual defects). In other words, these findings are remarkable in the degree to which they are negative. There were many children in the learning disability and borderline groups who were markedly deficient in learning, for example in reading, but in no instance was a given factor as identified by the eye physician significantly related to such deficiencies. In an average-to-high-opportunity school population, if such disorders are present, presumably they are cared for to the extent that they are not an imposition to learning. Thus no single abnormality of the visual mechanism discriminated between the experimental and control groups. Isolated defects occurred in each group without influencing learning achievement.

Results by Type and Degree of Learning Disability

In the preceding section we considered the eye examination findings for learning disability and borderline groups. An analysis was made in terms of rankings of the subjects from lowest to highest learning quotient, according to type, or types, of deficits in learning. For example, the children whose deficit appeared only in reading obtained learning quotients ranging from 72 to 84. When ranked from the lowest to the highest there were no differences in the incidence of eye defects; rank in reading was not associated with ophthalmological findings. Moreover, as seen in Table 74 , 34 of the 108 children classified as learning disability were so designated because they had deficiencies only in reading. Of these, six had eye defects and 28 did not. Of the 22 having deficits only in nonverbal learning, six had visual disorders, and of the 52 with a mixed type of involvement, only five had eye disorders.

Similar results were obtained for the borderline and the failed criteria groups. These subjects also were ranked within each category of learning deficit; the incidence of visual impairments did not vary according to the degree of involvement. Moreover, the incidence by category of deficit did not reveal a relationship. It can be said that the degree of involvement (within each category) and the nature of the deficiency in learning are not related to disorders of vision in the type of population studied. However, it should be noted that preliminary visual screening eliminated subjects with a deficiency greater than 20/40 on either eye.

Those control subjects who failed the criteria when seen for the intensive evaluation also were tabulated according to type and degree of deficiency in learning. These data appear in Table 75. As can be seen, no pattern of visual involvement was present. In fact, a greater proportion of these control children, in comparison with the experimental, manifested visual defects.

Discriminant Analysis

A discriminant analysis of the 49 behavioral variables was performed for the learning disability and borderline samples and for their respective

TABLE 74

OPHTHALMOLOGICAL RESULTS BY TYPE AND
DEGREE OF DEFICIENCY IN LEARNING

Area Failed	N	LQ Range	Borderline		Control	
			Normal	Abnormal	Normal	Abnormal
Reading	23	85 - 89	19	4	19	4
Nonverbal	20	85 - 89	16	4	13	7
Mixed	69	85 - 89	55	14	63	6
Total	112		90	22	95	17

Area Failed	N	LQ Range	Learning Disability		Control	
			Normal	Abnormal	Normal	Abnormal
Reading	34	72 - 84	28	6	30	4
Nonverbal	22	65 - 84	16	6	21	1
Mixed	52	71 - 84	47	5	44	8
Total	108		91	17	95	13

TABLE 75

COMPARISON OF THE LEARNING DISABILITY AND BORDERLINE SUBJECTS WHO FAILED THE SELECTIVE CRITERIA WITH THE CONTROL SUBJECTS WHO ALSO FAILED THESE CRITERIA--OPHTHALMOLOGICAL EXAMINATION

		Borderline			
Area	N	N with Ophth.	IQ Range	Abnormal	Normal
Reading	6	6	87-89	2	4
Nonverbal	6	6	88-89	2	4
Mixed	19	19	85-89	10	9
TOTAL	31	31		14	17

		Learning Disability			
Area	N	N with Ophth.	IQ Range	Abnormal	Normal
Reading	8	7	74-84	6	1
Nonverbal	4	4	71-83	2	2
Mixed	13	12	75-84	4	8
TOTAL	25	23		12	11

		Control		
Area	N	N with Ophth.	Abnormal	Normal
Total Number Failed	40	39	31	8

control groups. This analysis was made for each group on the basis of the ophthalmologist's classification of abnormal or normal. The behavioral variables which discriminated between these ophthalmological categories are presented for borderlines (Table 76) and their controls (Table 77), and for learning disabilities (Table 78) and their controls (Table 79).

A comparison of the abnormal and normal mean scores for each discriminating variable was made for each group in order to determine whether the variation favored the abnormal or normal sample. To analyze further the possible associations of ophthalmological classification and the discriminant analysis, a chi square test was then applied to ascertain the significance of the relationship between direction of variation and ophthalmological classification when the experimental groups were compared with their control groups. The chi square data are shown in Table 80 .

The data from this analysis are unusual in that they reveal that in the learning disability population the higher mean score is found more often to be for the group of children with normal ophthalmologicals, while for the control group this trend is reversed and the higher mean score is more frequently found in the group with abnormal ophthalmologicals. In the control group three-fifths (21) of the discriminating variables have higher mean scores for those classified abnormal, whereas in the learning disability group only one-fourth (6) of the discriminating variables are represented by higher mean scores for those with abnormal ophthalmologicals. This difference is significant at the .01 level. This reversal does not appear for the borderlines and their controls; in both groups the higher mean score is found more often to be for the children having normal ophthalmologicals.

The significant difference found between the learning disabilities and their controls may be an artifact inasmuch as it occurs in only one of the two control groups and may be influenced by the fact that more children classified as true controls wore glasses, as compared to the experimental population; there was no indication that this could be interpreted to mean that ophthalmological factors were associated with deficiency in learning.

Summary

While there have been many persistant claims to the effect that visual defects are common, if not characteristic, in children with deficits in learning, the results of this investigation indicate otherwise. When children with learning disabilities (who have no additional handicaps) are stringently compared with the normal, they do not show a greater incidence of abnormalities in vision.

The primary contribution of this facet of the research study might be the manner in which it clarifies the nature of a learning disability. Eye defects or visual impairments per se are not an integral part of the problem so far as our results are concerned. By inference we may conclude that this type of handicap cannot be attributed to an inability tc see, hence, there is a need to focus attention on other facets, behavioral and medical.

TABLE 76

DISCRIMINANT ANALYSIS OF FORTY-NINE VARIABLES OF THE PSYCHOEDUCATIONAL BATTERY FOR THE BORDERLINE GROUP ON THE BASIS OF ABNORMAL (N=14)-NORMAL (N=73) OPHTHALMOLOGICAL CLASSIFICATION

Tests Significant at .01	Direction of Mean	F
Oral PSLT Abstract-Concrete	N	2.45
WISC Digit Span	A	2.18
PSLT Syntax	N	2.21
PSLT Abstract-Concrete	A	2.22
Draw-A-Man	A	2.06
WISC Similarities	N	2.03
Detroit Verbal Opposites	A	2.10
Metropolitan Language	N	2.14
Oral PSLT Words Per Sentence	A	2.10
WISC Comprehension	N	2.11
PMA Arithmetic	N	2.19
Metropolitan Arithmetic	A	2.48
WISC Arithmetic	N	2.43
Detroit Free Association	N	2.40
Metropolitan Spelling	A	2.33

Tests Significant at .05	Direction of Mean	F
WISC Vocabulary	N	2.26
WISC Picture Arrangement	A	2.21
Detroit Oral Directions	N	2.15
PSLT Total Sentences	N	2.09
PSLT Total Words	N	2.05
Gates-Russell Oral Words	N	1.96
Gates-McKillop Nonsense Words	N	1.88
Detroit Orientation	A	1.81
WISC Picture Completion	N	1.77
Wide Range Oral Reading	N	1.72

TABLE 76 - Continued

Tests Not Significant	Direction of Mean
WISC Information	N
Mean Verbal MA	N
WISC Block Design	A
WISC Object Assembly	A
WISC Coding	A
WISC Mazes	A
Mean Performance MA	A
Gates-MacGinitie Accuracy	A
Gates-MacGinitie Comprehension	N
Gates-MacGinitie Vocabulary	N
Gates-McKillop Word Parts	A
Gates-McKillop Syllabication	A
Gates-Russell 1 Syllable	N
Gates-Russell 2 Syllables	A
PSLT Words Per Sentence	N
Detroit Words	N
Detroit Sentences	N
Detroit Letters	N
Detroit Designs	A
Leiter	A
Healy I	A
Vineland	A
Kent D	N
Heath Rails	A

TABLE 77

DISCRIMINANT ANALYSIS OF FORTY-NINE VARIABLES OF THE PSYCHOEDUCATIONAL BATTERY FOR THE BORDERLINE CONTROLS ON THE BASIS OF ABNORMAL (N=13)-NORMAL (N=74) OPHTHALMOLOGICAL CLASSIFICATION

Tests Significant at .01	Direction of Mean	F
WISC Information	A	5.66
WISC Coding	N	10.40
Vineland	N	9.52
PSLT Total Words	N	8.88
PSLT Syntax	N	7.92
PSLT Words Per Sentence	N	7.19
WISC Mazes	N	6.46
Detroit Letters	N	5.94
Gates-MacGinitie Accuracy	A	5.71
Oral PSLT Abstract-Concrete	A	5.46
Detroit Oral Directions	A	5.16
PMA Arithmetic	N	4.95
Gates-McKillop Syllabication	A	4.74
Gates-MacGinitie Comprehension	N	4.56
WISC Vocabulary	A	4.56
Draw-A-Man	A	4.60
Detroit Orientation	N	4.60
Oral PSLT Words Per Sentence	A	4.52
Leiter	N	4.37
Detroit Free Association	N	4.23
Detroit Designs	N	4.08
Healy I	N	3.96
PSLT Abstract-Concrete	A	3.89
PSLT Total Sentences	N	3.77
WISC Picture Arrangement	A	3.65
Metropolitan Language	N	3.54
Gates-Russell One-Syllable	A	3.52
WISC Arithmetic	N	3.49
WISC Mean Verbal	A	3.37
Metropolitan Spelling	N	3.24
Gates-Russell Oral Words	N	3.14
Detroit Words	N	3.02
Kent D	A	2.94
WISC Comprehension	N	2.83
Detroit Sentences	N	2.72
(Vineland Removed)		2.85
WISC Picture Completion	N	2.74
WISC Digit Span	N	2.62
WISC Similarities	A	2.52
Gates-Russell Two-Syllables	N	2.42
Wide Range Oral Reading	A	2.31
WISC Block Design	N	2.21
WISC Object Assembly	N	2.11

TABLE 77 - Continued

Tests Significant at .05	Direction of Mean	F
Gates-McKillop Word Parts	N	2.02

Tests Not Significant	Direction of Mean
WISC Mean Performance	N
Gates-MacGinitie Vocabulary	N
Gates-McKillop Nonsense Words	N
Metropolitan Arithmetic	N
Detroit Verbal Opposites	A
Heath Rails	N

TABLE 78

DISCRIMINANT ANALYSIS OF FORTY-NINE VARIABLES OF THE PSYCHOEDUCATIONAL BATTERY FOR THE LEARNING DISABILITY GROUP ON THE BASIS OF ABNORMAL (N=13)-NORMAL (N=72) OPHTHALMOLOGICAL CLASSIFICATION

Tests Significant at .01	Direction of Mean	F
Kent D	N	6.29
Gates-Russell Oral Words	A	5.12
WISC Mean Verbal	N	4.97
WISC Coding	N	4.52
Detroit Designs	N	4.18
Detroit Orientation	N	4.23
Gates-McKillop Nonsense Words	N	3.98
Vineland	N	3.74
Oral PSLT Abstract-Concrete	N	3.55
PSLT Syntax	A	3.43
Gates-Russell One-Syllable	A	3.27
Gates-Russell Two-Syllables	A	3.22
PSLT Words Per Sentence	A	3.07
Metropolitan Language	N	2.90
Detroit Words	A	2.75
WISC Object Assembly	N	2.59
WISC Picture Completion	N	2.46
Gates-MacGinitie Comprehension	N	2.32
Detroit Oral Directions	N	2.19

Tests Significant at .05	Direction of Mean	F
Leiter	N	2.07
WISC Picture Arrangement	N	1.97
Healy I	N	1.88
Metropolitan Arithmetic	N	1.81
PMA Arithmetic	N	1.73

TABLE 78 - Continued

Tests Not Significant	Direction of Mean
WISC Information	N
WISC Comprehension	N
WISC Arithmetic	N
WISC Similarities	N
WISC Vocabulary	N
WISC Digit Span	N
WISC Block Design	N
WISC Mazes	A
WISC Mean Performance	N
Wide Range Oral Reading	A
Gate-MacGinitie Accuracy	N
Gates-MacGinitie Vocabulary	A
Gates-McKillop Word Parts	A
Gates-McKillop Syllabication	A
Metropolitan Spelling	A
PSLT Total Words	A
PSLT Total Sentences	A
PSLT Abstract-Concrete	N
Detroit Free Association	A
Detroit Verbal Opposites	N
Detroit Sentences	N
Detroit Letters	N
Oral PSLT Words Per Sentence	A
Heath Rails	N
Draw-A-Man	N

TABLE 79

DISCRIMINANT ANALYSIS OF FORTY-NINE VARIABLES OF THE PSYCHOEDUCATIONAL BATTERY FOR THE LEARNING DISABILITY CONTROLS ON THE BASIS OF ABNORMAL (N=11)-NORMAL (N=74) OPHTHALMOLOGICAL CLASSIFICATION

Tests Significant at .01	Direction of Mean	F
Detroit Oral Directions	A	4.68
WISC Object Assembly	N	5.20
Healy I	A	4.97
WISC Coding	N	4.74
PSLT Abstract-Concrete	A	4.62
Metropolitan Arithmetic	N	4.51
WISC Information	A	5.31
Gates-MacGinitie Vocabulary	N	5.65
PSLT Total Words	N	5.43
Wide Range Oral Reading	A	5.21
Detroit Letters	A	5.00
WISC Digit Span	A	4.74
PMA Arithmetic	N	4.51
Oral PSLT Words Per Sentence	N	4.35
Draw-A-Man	A	4.19
Metropolitan Spelling	A	3.99
Heath Rails	N	3.80
Leiter	N	3.61
Gates-MacGinitie Accuracy	A	3.45
Gates-MacGinitie Comprehension	A	3.28
Detroit Designs	A	3.11
PSLT Syntax	N	2.97
Gates-McKillop Nonsense Words	A	2.84
Gates-McKillop Word Parts	A	2.72
Oral PSLT Abstract-Concrete	A	2.61
WISC Mean Verbal	A	2.49
Detroit Orientation	A	2.37
WISC Arithmetic	[illegible]	2.27
Detroit Sentences	N	2.17
WISC Picture Arrangement	A	2.08

TABLE 79 - Continued

Tests Significant at .05	Direction of Mean	F
Metropolitan Language	A	1.99
Gates-Russell One-Syllable	A	1.91
WISC Mean Performance	N	1.83
WISC Picture Completion	A	1.76
Detroit Free Association	N	1.69

Tests Not Significant	Direction of Mean
WISC Comprehension	N
WISC Similarities	A
WISC Vocabulary	A
WISC Block Design	N
WISC Mazes	N
Gates-McKillop Syllabication	A
Gates-Russell Oral Words	A
Gates-Russell Two-Syllables	A
PSLT Total Sentences	N
PSLT Words Per Sentence	N
Detroit Verbal Opposites	A
Detroit Words	A
Vineland	N
Kent D	A

TABLE 80

COMPARISON OF THE DISCRIMINANT ANALYSIS
RESULTS BY GROUP (CHI SQUARE)

Direction of Mean	Borderline	Control	Total	X^2
Abnormal	9	15	24	
Normal	16	28	44	.0086
TOTAL	25	43	68	

Direction of Mean	Learning Disability	Control	Total	X^2
Abnormal	6	21	27	
Normal	18	14	32	7.03**
TOTAL	24	35	59	

* p less than .05
** p less than .01

ELECTROENCEPHALOGRAPHIC STUDY

ELECTROENCEPHALOGRAPHIC STUDY

As discussed elsewhere, a primary objective of this project was to ascertain the relevance of various disciplines and procedures in the identification, diagnosis, and treatment of children with learning disabilities. Accordingly, it was agreed that electroencephalography should be included inasmuch as there is a body of knowledge covering the significance of EEG in the study of minimal brain damage.

The research design was the same as that followed in the other areas of the investigation. The EEG reader, a highly qualified scientist in this field, read the records without knowledge of whether the record was that of an experimental or control subject. After reading the record this specialist followed the routine of writing a diagnostic report, including the classification and a discussion of the results, positive or negative. The examiner's clinical classification, as well as his objective findings, were used to explore relationships with the various types of deficits in learning.

The electroencephalographic examinations were administered at the Northwestern University Medical School. A technician with experience with children of the age level of this study was employed for the period of the project to perform the electroencephalograms. The project consultant in electroencephalography read all of the recordings without knowledge of the categories used to classify the children.

The head of each patient was measured with a millimeter ruler and using the 10-20 International System of Electrode Placement, areas were marked for electrode application. The leads were symmetrically placed on the scalp at equal relative distances from each other. The electrodes (22) were secured by means of dried collodion around a 2 x 2 inch gauze square which was placed over them. A conducting paste was applied over each area where activity was monitored.

Both referential (2) and bipolar (6) montages were used during the recording from an 8-channel EEG machine (Grass type 6 or Offner type T). The effect of eye-opening and eye-closure was tested during several montages and the activation of hyperventilation for 5 minutes was assessed. In addition, the effect of repetitive photic stimulation was tested; 7-8 different stimulating frequencies of 1-25/sec. were used for a duration of 8-10 seconds each. Finally, a sleep record was obtained in order to search for any possible epileptiform activity.

Reliability Studies

Because test-retest and reader reliability in EEG have not been adequately evaluated, a study of these variables was deemed necessary. Two questions were postulated. One pertained to the consistency of readers of the EEG record and the other concerned the variability of the EEG output itself. Although it was possible to study these questions only in a limited way, an attempt was made to gather data that would be helpful in interpreting the results of this portion of the investigation.

Two readers were engaged at the outset. One was a highly trained scientist in this field; he is the one who was employed to perform the

EEG examinations for this project. The other was trained in clinical EEG and as a neurologist but he was not a specialist in electroencephalography.

These workers were asked to read the same records twice (intra-reliability). They had no recollection of having seen the records previously and had no knowledge as to whether the results were from a learning disability or control subject; the total number in this part of the study was 20. The findings were revealing; see Table 81 . While the EEG scientist (reader 2) was highly consistent (1.00), the less specialized reader (reader 1) was not (.84). With an error of 16% it was concluded that this worker could not continue as one of the investigators for this project. It is noteworthy also that these readers agreed on the subject's classification only slightly more than 50% of the time (.58).

In view of these findings a second reliability study was conducted. The same EEG scientist who had participated initially was again employed with another EEG specialist (reader 3). The scientist again showed a 100% consistency (1.00); see Table 82 . Moreover, this time the inter-reader reliability was excellent, falling at a level of .95; see Table 83 .

To explore the question of subject consistency, 14 children were given electroencephalographic examinations on two occasions, the time between examinations being four to six weeks. These results revealed a consistency of .85; see Table 84 . Because the scientist who read these records was highly consistent with himself, it appears that subject reliability, though high, is not at a level of 100%. In any event, from these results it seems that the findings from the EEG study can be meaningfully interpreted. Though reader bias cannot be denied, the examinations and the readings were executed by one person, a specialist who was remarkably consistent with himself, and with whom another EEG specialist was in agreement.

Data Recording and Coding

In addition to the report in which the electroencephalographer discussed his findings and conclusions, an EEG record form (see Appendix C) was devised which enabled coding and tabulation of the results for computer analysis. This procedure made it possible to study the clinical classification (normal-abnormal) in relation to deficits in learning, and also to evaluate possible significant associations of the individual objective findings with these deficiencies.

Results

The general classification findings for the borderline and learning disability populations are reported in Table 85 . The significance of the classification as normal or abnormal for these groups in comparison with their respective controls was determined in two ways. A test of the proportion differences of normal versus abnormal was made and a chi square of the difference was computed. Neither of these techniques

TABLE 81

ELECTROENCEPHALOGRAPHIC READER RELIABILITY
AS SHOWN BY PROPORTION OF AGREEMENT FOR CLASSIFICATION
NORMAL OR ABNORMAL - INITIAL STUDY

Reader 1	
Intra-Reader Reliability	.84
Reader 2	
Intra-Reader Reliability	1.00
First Session	
Inter-Reader Reliability	.58
Second Session	
Inter-Reader Reliability	.74

TABLE 82

ELECTROENCEPHALOGRAPHIC INTRA-READER RELIABILITY - FINAL STUDY

Classification Category	Number	First Reading	Second Reading
True Control	5	Normal	Normal
True Control	4	Abnormal	Abnormal
False Experimental	1	Normal	Normal
False Experimental	1	Abnormal	Abnormal
Borderline	1	Normal	Normal
Borderline	1	Abnormal	Abnormal
True Experimental	1	Normal	Normal
True Experimental	5	Abnormal	Abnormal
TOTAL NUMBER	19		

Proportion of agreement = 1.00

TABLE 83

ELECTROENCEPHALOGRAPHIC INTER-READER RELIABILITY - FINAL STUDY

Classification Category	Number	First Examiner	Second Examiner
True Control	2	Normal	Normal
True Control	3	Abnormal	Abnormal
False Experimental	3	Abnormal	Abnormal
Borderline	2	Normal	Normal
Borderline	1	Abnormal	Abnormal
True Experimental	6	Normal	Normal
True Experimental	1	Normal	Abnormal*
Failed Sensory	1	Normal	Normal
Failed Intelligence	1	Normal	Normal
TOTAL NUMBER	20		

Proportion of agreement = .95

* Change from first examiner to second examiner

TABLE 84

ELECTROENCEPHALOGRAPHIC TEST-RETEST RELIABILITY

Classification Category	Number	First Examiner	Second Examiner
True Control	4	Normal	Normal
True Control	2	Abnormal	Abnormal
True Control	1	Normal	Abnormal*
False Experimental	1	Normal	Abnormal*
True Experimental	1	Normal	Normal
True Experimental	2	Abnormal	Abnormal
Borderline	3	Abnormal	Abnormal
TOTAL NUMBER	14		

Proportion of agreement = .85

* Change from first examiner to second examiner

TABLE 85

GENERAL CLASSIFICATION OF THE ELECTROENCEPHALOGRAPHIC EXAMINATION FOR BORDERLINE AND LEARNING DISABILITY GROUPS AND FOR THE RESPECTIVE CONTROL POPULATIONS

Group	N	Classification: Abnormal	Classification: Normal	Proportion	X^2
Borderline	101	48	53	.525	5.218*
Control	101	32	69	.683	
			Difference	.158*	
Learning Disability	99	35	64	.646	2.945
Control	99	26	73	.727	
			Difference	-.081	

* p less than .05

disclosed a significant difference between the learning disability population and their controls. On the other hand, both techniques revealed a difference for the borderline population and their controls, at .05 for both the proportion and the chi square.

It is difficult to explain why these EEG findings reveal a difference for one group but not for the other, particularly when the significance appears for the borderline population - by psychological criteria this is the less involved sample (LQ of 85 to 89). Somewhat the same circumstance exists in relation to the results from the neurological examination because i- this analysis also the more positive findings were mainly for the subjects classified as borderline. Though the significance of these results must be viewed as minimal, it appears that the EEG examination findings (normal versus abnormal) generally are indicative of a greater incidence of disturbances in children who have deficiencies in learning. The exact nature of this relationship is not clear and remains to be explored further. So far as this investigation is concerned, even where a non-clinical type of population was employed, there was evidence that at least, in some respects, a relationship exists between electrocortical disturbances and deficits in learning. In view of the stringencies applied by our research paradigm, it is somewhat surprising that even minor relationships were manifested.

Analysis of Objective Findings

The objective, sub-category EEG findings were analyzed in two ways. First, an analysis was made of the 14 factors coded to represent the type of output manifested; see Table 86 . The borderline and learning disability populations were compared with their respective controls. Testing for differences between proportions of normalcy, the results for the learning disability sample were negative; none of the 14 factors differentiated between the experimental and control populations. For the borderline group, one significant finding appeared. Focal slow waves differentiated between the borderlines and their controls; more children with deficiencies exhibited this abnormality. It should be recalled that it was in the borderline group that the general classification of normal-abnormal showed at .05 level of difference, with more disturbances in those having learning disorders.

Results from a second analysis, using sub-classification, which placed more emphasis on seven areas of the brain, are given in Table 87. In no instance were significant differences revealed. Approximately two-thirds of the learning disability group were classified parison fewer subjects in the borderline group were found to be normal (approximately one-half) and about 70% of the controls were without EEG disturbances. The highest incidence of abnormality found was for positive spikes, and the number with this disturbance was essentially identical for the experimental and control populations.

TABLE 86

ANALYSIS OF THE OBJECTIVE ELECTROENCEPHALOGRAPHIC EXAMINATION FINDINGS FOR BORDERLINE (N=101) AND LEARNING DISABILITY (N=99) GROUPS AND FOR THE RESPECTIVE CONTROL POPULATIONS

Findings	Border-line	Control	Difference	Learning Disab.	Control	Difference
Slow Waves:						
Diffuse	.960	.970	-.010	.949	.960	-.011
Focal	.752	.891	-.139*	.869	.879	-.010
Sharp Waves:						
Diffuse	1.000	1.000	.000	1.000	1.000	.000
Focal	.960	.941	.019	.949	.949	.000
Sharp Waves: (Centrencephalic)						
Under 3/sec.	1.000	1.000	.000	1.000	.990	.010
3 per second	.980	.990	-.010	.990	.990	.000
6 per second	1.000	.990	.010	1.000	.980	.020
Positive Spikes:	.743	.832	-.089	.859	.848	.011
Depression:						
Diffuse	.980	.990	-.010	.990	.990	.000
Focal	1.000	1.000	.000	1.000	1.000	.000
Excessive Fast Waves:	.980	.970	.010	.960	.980	-.020
Background Rhythm:	.495	.485	.010	.515	.485	.030
Hyperventilation:	.970	1.000	-.030	1.000	.990	.010
Photic Driving:	.525	.614	-.089	.556	.636	-.080

* p less than .05

TABLE 87

ANALYSIS OF SUB-CLASSIFICATIONS OF ELECTROENCEPHALOGRAPHIC RESULTS FOR BORDERLINE AND LEARNING DISABILITY GROUPS AND FOR THE RESPECTIVE CONTROL POPULATIONS

Sub-Classification	Borderline	Control	Learning Disability	Control
Normal	53	69	64	73
Positive Spikes	17	14	13	12
Parieto-Occipital Slow Waves	9	5	3	4
Temporal Slow Waves	3	2	5	3
Discharges (focal and diffuse)	4	4	5	1
Other Slow Waves	5	2	4	2
Combinations*	10	5	5	4
TOTAL	101	101	99	99

* Combination of two or more of the abnormal sub-classifications.

Analysis by Type and Degree of Deficiency in Learning

Degree of involvement in general has been considered in the analyses presented above inasmuch as the borderline group represented only minimal deficiency in learning, while the learning disability population represented a substantial deficit in learning. However, possible relationships between the extent of the retardation in learning and EEG results were explored further. The subjects were ranked on the basis of the learning quotient score, according to three types of disabilities: reading, nonverbal, and mixed. The findings from this survey are shown in Table 88 . Learning disability and borderline subjects who failed only reading, only nonverbal criteria, or who failed other parameters, were compared with their respective controls. The incidence of abnormal findings for each classification then was investigated. Again the results essentially indicated a similar distribution of positive findings for experimental and control groups. One significant difference appeared for the borderlines and their controls: a chi square of 7.26 for the nonverbal category represented significance at the .01 level.

The same analysis was made of those subjects who failed the criteria for inclusion in either experimental or control samples. These findings are presented in Table 89 . The sample sizes were small but it appears that these results are consistent with other findings. There were no indications that EEG disorders were more associated with learning when other disabilities (vision, hearing, or anxiety) were present.

Discriminant Analysis

A discriminant analysis utilizing all 49 of the behavioral variables was performed, comparing those with abnormal and normal EEG classifications; this was done for the learning disability and borderline samples and for their respective control groups. The behavioral variables which discriminated at the .05 and .01 levels are presented for the borderlines (Table 90) and their controls (Table 91) and for the learning disabilities (Table 92) and their controls (Table 93).

By comparison of mean scores for the abnormal and normal groups, the direction of each discriminating variable was determined. Thereby it was ascertained whether the variation favored those with abnormal or normal EEG records in each population (Tables 90 and 92). A chi square test was then computed to explore the possibility of an association between EEG classification and the direction of variation for the discriminating variables. These data are presented in Table 94 .

From these findings it appears that the relationship between the direction of the variation and EEG classification is not significantly different when the learning disability group is compared with its control group. However, this is in contrast with the comparison between the borderline group and its control group. For the borderline sample, means of the behavioral variables more often were higher for the children with abnormal EEG, while the controls showed the opposite

TABLE 88

ELECTROENCEPHALOGRAPHIC RESULTS BY TYPE AND DEGREE OF DISORDER IN LEARNING

Type of Disability	N	I.Q Range	Borderline Abnormal	Borderline Normal	Control Abnormal	Control Normal	X^2
Reading	19	85 - 89	10	9	8	11	.422
Nonverbal	18	85 - 89	8	10	1	17	7.259**
Mixed	64	85 - 89	30	34	23	41	.925
TOTAL	101		48	53	32	69	

Type of Disability	N	I.Q Range	Learning Disability Abnormal	Learning Disability Normal	Control Abnormal	Control Normal	X^2
Reading	33	72 - 84	12	21	9	24	.629
Nonverbal	20	65 - 84	6	14	6	14	.000
Mixed	46	71 - 84	17	29	11	35	1.848
TOTAL	99		35	64	26	73	

* p less than .05
** p less than .01

TABLE 89

ELECTROENCEPHALOGRAPHIC RESULTS FOR THE BORDERLINE, THE LEARNING DISABILITY AND CONTROL SUBJECTS WHO FAILED THE SELECTIVE CRITERIA

		Borderline		
Area	N	I.Q Range	Abnormal	Normal
Reading	6	87 - 89	2	4
Nonverbal	6	88 - 89	3	3
Mixed	17	85 - 89	4	13
TOTAL	29		9	20

		Learning Disability		
Area	N	I.Q Range	Abnormal	Normal
Reading	6	74 - 84	3	3
Nonverbal	4	71 - 83	1	3
Mixed	10	75 - 84	4	6
TOTAL	20		8	12

		Control		
Area	N	I.Q Range	Abnormal	Normal
Total Number Failed	36	Not Determined	9	27

TABLE 90

DISCRIMINANT ANALYSIS OF FORTY-NINE VARIABLES OF THE PSYCHOEDUCATIONAL BATTERY FOR THE BORDERLINE GROUP ON THE BASIS OF ABNORMAL (N=34)-NORMAL (N=42) ELECTROENCEPHALOGRAPHIC CLASSIFICATION

Tests Significant at .01	Direction of Mean	F
Heath Rails	N	6.00
WISC Mazes	A	4.87
Vineland	A	3.92
Gates-MacGinitie Accuracy	N	4.14
Detroit Letters	A	4.30
Detroit Oral Directions	N	4.13
Detroit Free Association	A	3.99
WISC Arithmetic	A	3.87
Oral PSLT Abstract-Concrete	N	3.70
PSLT Total Words	A	3.60
PSLT Syntax	A	3.51
Oral PSLT Words per Sentence	A	3.40
PSLT Words per Sentence	A	3.30
Draw-A-Man	A	3.20
WISC Object Assembly	A	3.17
PSLT Total Sentences	A	3.20
Gates-MacGinitie Vocabulary	N	3.16
Metropolitan Spelling	A	3.18
Gates-McKillop Syllabication	N	3.41
WISC Comprehension	A	3.41
Kent D	A	3.38
WISC Picture Completion	A	3.29
Healy I	A	3.17
WISC Picture Arrangement	N	3.05
Gates-Russell Two Syllables	A	2.95
Gates-MacGinitie Comprehension	N	2.85
Detroit Designs	A	2.72
Gates-Russell Oral Words	N	2.62
PSLT Abstract-Concrete	A	2.54
Gates-McKillop Word Parts	A	2.43
Gates-McKillop Nonsense Words	A	2.33
Detroit Sentences	A	2.24

TABLE 90 - Continued

Tests Significant at .05	Direction of Mean	F
Detroit Orientation	A	2.13
WISC Information	N	2.03
Wide Range Oral Reading	N	1.93
Gates-Russell One Syllable	A	1.83
WISC Block Designs	A	1.74

Tests Not Significant	Direction of Mean
WISC Similarities	A
WISC Vocabulary	N
PMA Arithmetic	A
Metropolitan Arithmetic	A
Mean Verbal MA	A
Mean Performance MA	A
WISC Coding	N
WISC Digit Span	A
Metropolitan Language	A
Detroit Verbal Opposites	N
Leiter	A
Detroit Words	A

TABLE 91

DISCRIMINANT ANALYSIS OF FORTY-NINE VARIABLES OF THE PSYCHOEDUCATIONAL BATTERY FOR THE BORDERLINE CONTROLS ON THE BASIS OF ABNORMAL (N=23)-NORMAL (N=53) ELECTROENCEPHALOGRAPHIC CLASSIFICATION

Tests Significant at .01	Direction of Mean	F
Kent D	N	3.11
WISC Block Design	A	4.26
Wide Range Oral Reading	A	4.02
Gates-MacGinitie Accuracy	N	5.03
WISC Similarities	N	4.65
Draw-A-Man	A	4.36
WISC Vocabulary	N	4.59
Gates-MacGinitie Comprehension	N	4.45
Healy I	N	4.37
WISC Mazes	N	4.22
WISC Coding	A	4.00
Gates-Russell Two Syllables	N	3.86
Metropolitan Spelling	A	3.66
Detroit Orientation	N	3.52
Oral PSLT Abstract-Concrete	A	3.43
Gates-Russell Oral Words	A	3.32
Mean Verbal MA	N	3.24
Detroit Sentences	A	3.25
PSLT Abstract-Concrete	N	3.22
WISC Picture Completion	N	3.19
Metropolitan Language	A	3.19
Vineland	N	3.09
Gates-McKillop Word Parts	A	3.00
Heath Rails	N	2.90
PMA Arithmetic	N	2.79
Oral PSLT Words per Sentence	A	2.70
Detroit Letters	A	2.64
Detroit Words	N	2.56
PSLT Total Sentences	N	2.47
PSLT Total Words	N	2.44
WISC Information	N	2.34
WISC Arithmetic	N	2.25
Gates-McKillop Nonsense Words	A	2.16

TABLE 91 - Continued

Tests Significant at .05	Direction of Mean	F
Detroit Free Association	N	2.08
WISC Picture Arrangement	N	2.02
Gates-Russell One Syllable	N	1.96
Gates-MacGinitie Vocabulary	A	1.89
Detroit Verbal Opposites	N	1.81
(Detroit Words Removed)		1.91
WISC Digit Span	A	1.83
PSLT Syntax	A	1.75

Tests Not Significant	Direction of Mean
WISC Comprehension	N
Detroit Oral Directions	N
Mean Performance MA	N
Metropolitan Arithmetic	A
PSLT Words per Sentence	A
Leiter	N
WISC Object Assembly	N
Gates-McKillop Syllabication	N
Detroit Designs	A

TABLE 92

DISCRIMINANT ANALYSIS OF FORTY-NINE VARIABLES OF THE PSYCHOEDUCATIONAL BATTERY FOR THE LEARNING DISABILITY GROUP ON THE BASIS OF ABNORMAL (N=24)-NORMAL (N=54) ELECTROENCEPHALOGRAPHIC CLASSIFICATION

Tests Significant at .01	Direction of Mean	F
PSLT Words per Sentence	A	3.50
Detroit Letters	N	2.54
Detroit Free Association	A	2.36
Draw-A-Man	A	2.14
WISC Object Assembly	N	2.32
WISC Block Designs	A	2.38
Gates-MacGinitie Accuracy	A	2.46
Gates-MacGinitie Comprehension	A	2.60
WISC Picture Completion	N	2.60
PSLT Total Words	N	2.55
Metropolitan Arithmetic	A	2.55

Tests Significant at .05	Direction of Mean	F
WISC Similarities	N	2.39
WISC Information	N	2.27
WISC Comprehension	N	2.19
Kent D	A	2.10
Gates-MacGinitie Vocabulary	A	2.01
WISC Mazes	N	1.97
Gates-McKillop Word Parts	N	1.96
Gates-McKillop Syllabication	A	1.89
Detroit Designs	A	1.82
Oral PSLT Words per Sentence	N	1.79
Healy I	A	1.74
PMA Arithmetic	A	1.71
(Metropolitan Arithmetic Removed)		1.82
Gates-Russell One Syllable	A	1.81
Detroit Sentences	N	1.79
Heath Rails	A	1.79
Leiter	A	1.79
Oral PSLT Abstract-Concrete	A	1.76
WISC Vocabulary	N	1.71
(Gates-MacGinitie Vocabulary Removed)		1.81
Detroit Oral Directions	N	1.75

TABLE 92 - Continued

Tests Not Significant	Direction of Mean
WISC Arithmetic	A
WISC Digit Span	N
Mean Verbal MA	N
WISC Picture Arrangement	A
WISC Coding	A
Mean Performance MA	N
Wide Range Oral Reading	A
Gates-McKillop Nonsense Words	A
Metropolitan Spelling	N
Gates-Russell Oral Words	A
Gates-Russell Two Syllables	A
Metropolitan Language	A
PSLT Total Sentences	N
PSLT Syntax	A
PSLT Abstract-Concrete	A
Detroit Verbal Opposites	N
Detroit Words	A
Detroit Orientation	A
Vineland	N

TABLE 93

DISCRIMINANT ANALYSIS OF FORTY-NINE VARIABLES OF THE PSYCHOEDUCATIONAL BATTERY FOR THE LEARNING DISABILITY CONTROLS ON THE BASIS OF ABNORMAL (N=17)-NORMAL (N=61) ELECTROENCEPHALOGRAPHIC CLASSIFICATION

Tests Significant at .01	Direction of Mean	F
PSLT Words per Sentence	A	4.89
Draw-A-Man	N	4.39
WISC Arithmetic	A	3.89
Detroit Verbal Opposites	N	4.27
Oral PSLT Words per Sentence	N	3.92
WISC Object Assembly	A	3.88
WISC Picture Completion	N	3.69
Detroit Orientation	N	3.52
Metropolitan Spelling	A	3.32
Gates-MacGinitie Accuracy	N	3.34
Gates-Russell One Syllable	N	3.36
Detroit Letters	A	3.35
Detroit Words	N	3.47
WISC Comprehension	N	3.36
Gates-Russell Two Syllables	A	3.27
WISC Mazes	N	3.18
Gates-MacGinitie Comprehension	N	3.10
Gates-MacGinitie Vocabulary	N	2.99
Detroit Oral Directions	A	2.88
Gates-McKillop Word Parts	A	2.77
Gates-McKillop Syllabication	A	2.70
PMA Arithmetic	A	2.64
Detroit Free Association	A	2.61
WISC Mean Performance	A	2.52
Gates-McKillop Nonsense Words	A	2.44
Wide Range Oral Reading	A	2.36
Gates-Russell Oral Words	A	2.38
Healy I	N	2.32
PSLT Abstract-Concrete	N	2.27
WISC Mean Verbal	N	2.19
Detroit Sentences	A	2.12
(Gates-MacGinitie Vocabulary Removed)		2.24
WISC Coding	A	2.17

TABLE 93 - Continued

Tests Significant at .05	Direction of Mean	F
Metropolitan Arithmetic	A	2.09
Metropolitan Language	N	2.00
Detroit Designs	A	1.92
Oral PSLT Abstract-Concrete	A	1.84
Vineland	N	1.77
Leiter	A	1.70
(Detroit Letters Removed)		1.79
PSLT Total Sentences	A	1.71

Tests Not Significant	Direction of Mean
WISC Information	N
WISC Similarities	N
WISC Vocabulary	N
WISC Digit Span	N
WISC Picture Arrangement	A
WISC Block Design	A
PSLT Total Words	A
PSLT Syntax	N
Kent D	N
Heath Rails	A

TABLE 94

CHI SQUARE RESULTS FOR THE DIRECTION OF THE DISCRIMINATING VARIABLES BY GROUP

Direction of Mean	Borderline	Control	Total	X^2
Abnormal	26	16	42	
Normal	11	23	34	6.57*
TOTAL	37	39	76	

Direction of Mean	Learning Disability	Control	Total	X^2
Abnormal	17	22	39	
Normal	13	17	30	.00045
TOTAL	30	39	69	

* p less than .05

trend; normal EEG children more frequently obtained higher mean scores. The chi square for the difference between these groups is significant at the .05 level, nearly reaching significance at .01.

Interpretation of these results again is tenuous. Nevertheless, it is clear that the functions which discriminated between those with normal and abnormal EEG's in the borderline group are very different from those that differentiated for the controls. For example, the only positive result from the motor test battery appeared in this analysis. The Heath Rail Walking Test of locomotor coordination ranked highest in discriminating between children with normal and abnormal EEG's in the sample with borderline deficiencies in learning. Those with the higher motor scores more often had normal electroencephalograms.

More generally these findings again point up the fact that disturbances of electrocortical functioning tended to be associated with the less severe type of learning disability. Conceivably children with a moderate deficiency in learning have a type of brain dysfunction which is more readily detected by electroencephalography. Further research might add to knowledge of this intriguing possibility.

Summary

Summarizing the results of the electroencephalographic study, relationships between electrocortical abnormalities and learning disabilities appeared only for the borderline group. For this sample, those with the least severe deficit in learning, classification on the basis of normal or abnormal favored the control group. Further analysis showed that focal slow waves more often characterized the child in the borderline learning deficient sample.

Another result of considerable interest was the fact that children with nonverbal disturbances of learning much more often than the controls had abnormal electroencephalograms. An implication might be that when the brain involvement is on the right hemisphere, the EEG more often reveals dysfunctioning.

A final analysis disclosed that children in the borderline group more frequently scored lower than the controls on the psychological tests which successfully discriminated between those with normal and abnormal EEG's.

While the findings of this aspect of the total research study are not highly definitive, the results support the initial postulation. Some children with deficits in learning show evidence of having dysfunctions in the brain. Accordingly, electroencephalography not only is useful diagnostically but such studies emphasize the need for medical attention to this type of handicapped child.

PEDIATRIC NEUROLOGICAL STUDY

PEDIATRIC NEUROLOGICAL STUDY

The principal frame of reference for this investigation was that brain dysfunctions are related to certain types of deficits in learning. Hence, a primary objective was to gather data that might clarify the nature of such relationships. Neurology as a field of medical specialization has demonstrated various associations between behavioral anomalies and disorders of the central nervous system. But this knowledge pertains largely to adults. During the past decade or two neurologists have become increasingly aware of the need to broaden the concept of brain dysfunctions, not only to include subtel deviations in learning, but to comprise all age levels, even young children.

As a result there has been rapid growth of a specialization within a specialization. Neurologists now concentrate on organismic involvements, primarily in relation to the central nervous system, as they pertain to children, not only as they appear in adults. This led to the area of concentration designated pediatric neurology. Because of the wide interest in learning disabilities and because of the potential contribution of this recent innovation in neurology it was decided that an extensive research project was needed. Though a number of small studies had been undertaken, there was need for an investigation in which a large sample of children with deficits in learning would be studied neurologically in comparison with a normal control group. Accordingly, in this project a pediatric neurological examination was made of all subjects who failed the psychoeducational screening tests and of a normal comparison group. Consistent with our paradigm the neurologist examined the subjects without knowing whether the child was a member of the learning disability or of the control group.

Examination Procedures

In the general neurological examination, the weight and height were measured and compared with the expected values. The same procedure was followed regarding head circumference. The shape of the head was scrutinized. Auscultation of the head was performed at four points: the temporal areas, over the eyes, over the carotid arteries, and at the suboccipital areas bilaterally.

Facial characteristics, eye characteristics and ear deviations were observed because some developmental disorders, particularly the group of mandibulofacial dysostoses, may affect these structures.

Dentition was inspected for irregularity, the presence of malocclusion, extent of caries, and abnormal lines or dysplasia of enamel; these might reflect insults to the organism during pregnancy or after.

The nose, mouth, and pharynx were inspected with particular attention paid to the palate and its features. The neck was inspected for length, possible webbing, or other local abnormalities.

Blood pressure was taken with a cuff especially made for children. Several readings were taken and a mean value recorded.

The heart was examined in the usual manner. Femoral as well as dorsalis pedis arteries were palpated and inequality or weakness of pulse were noted. The abdomen was inspected for deviation from normal and palpation carefully executed. Genitalia were inspected for deviations, as well as the breasts and other aspects of secondary sexual characteristics. Attention was paid to the skin for features such as engiomato, vitiligo spots, café au lait spots, neuromate and adenoma sebaceum type of lesions. The spine was studied for its configuration and also for characteristics that might lead to spinal dystrophism. The musculoskeletal system also was examined.

Rate of progression included characteristics in walking: speed, stepage, swinging of arms, and turning. As far as station is concerned, this included the patient's ability to stand with his eyes closed, but also comprised a study of tandem walking forward and backwards and standing on one foot with the eyes open and then closed. This activity is demanding so maintaining such posture for 7 - 10 seconds was considered normal.

Deep tendon reflex responses were recorded. For some of the pathological responses, not normally present, the decrease sign was not used. An attempt to elicit clonus was made at the ankles, knees, and at the wrists. Abnormal findings were recorded. Plantar responses were tested by the Babinski, Cheddock, and Oppenheim technique. Superficial abdominal reflexes were elicited with a sharp object in the upper, mid, and lower segments of the abdominal wall. Cremasteric reflexes were tested by applying a sharp stimulus in the reflexogenic zone of L-1. If the reflex were sluggish, actual pinching of the skin was executed to ascertain whether there was a total absence of this reflex. Visceral reflexes included pupillary testing for light accommodation and consensual responses.

The pharyngeal response was tested by using tongue depressors and touching the posterior pharyngeal wall. The scoring was done as indicated on the forms. Visceral reflexes also included evaluation of pilomotor characteristics and asymmetricity of such responses. Similarly, attention was given to the vasomotor characteristics: color of the skin, warmth of skin on both sides, and the vasomotor responses to stroking of the skin.

Sensory evaluation was carried out in the usual manner. This is a particularly meaningful feature of cortical sensory functions. Stereognosis was tested in the same manner on all subjects, using different sizes of coins ranging from a half dollar to a penny. Barognosis was appraised by noting judgment of differences in weight between a half dollar, a quarter, and a nickel; the procedure was applied to each patient in the same manner. Two-point discrimination was performed by utilizing calipers with the distance of the hands at 5 mm. applied to the tips of the fingers bilaterally. Two or three applications were performed on each finger. Two-point discrimination testing also was performed on the legs; the spaces used were not less than 3 to 4 cm. (The reliability of two-point discrimination on the legs with lesser distances is not great).

Skin writing was performed through number writing on the palms of the hands and over the lower extremities. Numbers from 1 to 9 were drawn on these structures in random fashion. Each structure was submitted to at least four tests.

Extinction was tested by applying simultaneous stimuli. This was further refined by applying a stimulus on both sides of the body with the request that the patient identify both localizations. This supplements touch localization which is performed on only one side at a time.

Smell was tested by asking the patient to smell vanilla, coffee, peppermint or soap. Vision was appraised by asking the patient to look at a chart especially designed for this purpose. The fundi were examined to ascertain the state of the disks, retinae, maculae, blood vessels, and also other conditions including the lens and cornea. Optokinetic nystagmus was noted by asking the patient to fixate his eyes on a point on a ruler, which tended to move the eyes to the right or to the left at a certain speed. Differences in response to the right or to the left were noted. Testing of the III, IV, and VI cranial nerves also included external ocular movements and convergence.

Evaluation of jaw movements included study of symmetrical opening of the mouth and movement of the jaw from side to side, with careful attention paid to the dexterity of movement and rapidity. Study of facial movements included scrutiny for asymmetricities in both emotional and volitional efforts. Taste was tested with salt and sugar placed on the anterior two-thirds of the tongue.

Hearing testing included Rinne and Weber, whispering in one ear and then the other, and the distance at which the examiner's watch was heard. (The distance which has been standardized by the examiner is 5 - 9 cm. from the ears.)

Equilibrium characteristics were observed from the other parts of the examination. Further study included having the subject walk 5 steps forward and 5 steps backward with the eyes closed. Significant deviation to the right or to the left was recorded.

Cranial nerves IX and X were studied by observing characteristics of phonation, palatal elevation, and of ability to swallow adequately. Cranial nerve XI was studied by noting shrugging of the shoulders and the patterns of contraction in the sternocleido-mastoic muscles.

The tongue was examined for size, atrophy, and abnormal fissures. Also, the characteristics of protrusion were observed. Then movements in the vertical and horizontal axes were tested with attention paid to the rapidity and dexterity with which these movements were performed. Observations included whether they were confined to the tongue or were contaminated by associative movements occurring in the facial and shoulder musculature.

Cerebellar function included study of all characteristics while performing rapid alternating movements: reflexes, past-pointing, and metria. Abnormal signs such as involuntary movements were carefully noted.

In this group of children a significant aspect of the examination included multiple postural acts, such as closing the eyes, sticking out the tongue, and holding the arms in front. The extent of the associative movements in relation to the activated structures was carefully observed. This is a sensitive test of integrity and maturity of function of the neural structures, particularly those of the extrapyramidal system.

A summary of the findings was dictated. Part one included the general physical examination and part two the neurological examination. A copy of the summary was retained by the examiner for checking the accuracy of the report when the type-written report was returned for signature. No questions were asked that might reveal a history of neurological impairment in the child or in the family as a whole.

The neurologist classified his positive findings as either abnormal or suspect. This was done for individual items of the neurological examination. The designation abnormal meant that the finding, in the opinion of the examining neurologist, was typically associated with a disturbance of the central nervous system. The designation suspect meant that the finding was one that may or may not be of clinical significance. The suspect signs were more of the "soft" variety, whereas the abnormal were more of the "hard" type.

Examiner Reliability

There has been considerable interest in further clarifying the manner in which pediatric neurological facets might be related to behavior, specifically to certain types of learning disabilities. In pursuing this aspect of the nature of minimal brain dysfunctions one must raise the question of the reliability of the neurological examination findings; unfortunately there seems to have been no research on this important question.

Pursuing the recommendations of our consultant committee, during the pilot study year (1965-1966) we conducted an investigation to ascertain intra- and inter-examiner agreement. The pediatric neurologists participating in this study, including the one from Northwestern University who made the examinations for this research project, were highly trained and experienced in this medical specialty; all were associated with well-known medical centers.

Intra-Examiner Consistency

The reliability study included determination of the extent to which our research neurologist was consistent with himself when he examined the same children twice without awareness of his previous findings; he could not have remembered his previous findings inasmuch as he usually reported that he was unaware that he had seen the child before. The test-retest findings are presented in Table 95. The total number of subjects studied for this purpose was 17. Of these, three had been categorized as true control, one as false experimental, two as true experimental, one as borderline, and two as failed criteria. Three out of the 17 were classified differently from one examination to the other; two first classified as normal were found to be abnormal on the second examination; and one first classified as abnormal was categorized as normal when seen the second time. The significance of this variation is reflected statistically by a proportion of agreement of .82.

In addition to determining the agreement of the general classification from one examination to the next, an analysis was made of the specific findings for each evaluation. These results are presented in Table 96. From these results we note that 41 findings were evidenced only on the first examination, 35 only on the second, while 26 were common to both. These variations were not limited to a certain type of subject, such as learning disability or normal. A third analysis revealed the variation of findings per subject; see Table 97. These results reveal no pattern of variability; given neurological signs were not found to be more variable than others.

On the basis of these data we conclude that the pediatric clinical neurological examination findings may vary for the same child from one examination to the next. Despite this variation the general classification (normal or abnormal) shows a degree of consistency which falls substantially above chance. Perhaps one of the implications of this aspect of our research project is that it points up the need for further clarification and standardization of the neurologist's techniques and procedures. On the other hand, it must be emphasized that the children studied in this research were not ill in the commonly accepted meaning of this term. The experimental group had learning deficits but was not clinically ill. The control group was comprised of normal children. The pediatric neurologist may show greater consistency when he has illness symptomatology on which to base his judgments; he is trained largely in terms of disease entities. However, the problem of reliability of neurological examination findings is further complicated by the data obtained from the inter-examiner study.

TABLE 95

NEUROLOGICAL INTRA-EXAMINER RELIABILITY
BY CLASSIFICATION OF NORMAL OR ABNORMAL

Subject Category	Number	First Examination	Second Examination
True Control	1	Normal	Normal
True Control	2	Abnormal	Abnormal
True Control	2	Normal	Abnormal*
False Experimental	1	Abnormal	Abnormal
True Experimental	3	Abnormal	Abnormal
True Experimental	1	Normal	Abnormal*
Borderline	5	Abnormal	Abnormal
Failed Criteria	1	Abnormal	Abnormal
Failed Criteria	1	Abnormal	Normal*
Total	17		

*Change from first to second examination

TABLE 96

NEUROLOGICAL INTRA EXAMINER RELIABILITY
BY SPECIFIC FINDINGS FOR EACH EXAMINATION (N=17)

Signs	Incidence Per Examination 1st Exam Only	2nd Exam Only	On Both
d gait	1	4	0
i base	1	2	0
Deep Reflexes			
i wrist jerk	2	0	0
i ulnar jerk	1	0	0
i knee jerk	0	0	1
i ankle jerk	1	0	0
i snouting	0	0	1
i clonus	1	1	0
Superficial Reflexes			
d babinski	1	2	2
d cremasteric	1	1	1
Sensation: Cortical			
d stereognosis	2	0	1
d barognosis	1	1	0
d two-point discrimination	3	0	0
d skin writing	4	2	4
d touch localization	2	4	0
Cranial Nerves			
d smell	2	1	0
d jaw movement	1	3	3
d R facial movement	2	0	0
i L facial movement	1	0	0
d taste	1	0	0
d hearing	2	0	1
d tongue movement-bilateral	3	2	3
Cerebellar Functions			
d index finger-thumb	3	0	1
d pronation-supination	4	1	3
d F-F-N	0	1	0
d reflexes	0	1	0
associative movements	1	9	5
Total	41	35	26

i=increased
d=decreased

TABLE 97

NEUROLOGICAL EXAMINATION FINDINGS
PER SUBJECT FOR BOTH EXAMINATIONS

Case #	1st Exam Findings	2nd Exam Findings
001	Normal	d touch localization d skin writing d jaw movement slight associative movements
032	Normal	associative movements
065	d 2-point discrimination d skin writing d pronation-supination	d skin writing d bilateral tongue movements associative movements
100	Normal	d cremasteric reflexes d skin writing associative movements
108	Normal	Normal
130	i knee jerk d skin writing d touch localization d bilateral tongue movement d index-to-thumb d pronation-supination	i knee jerk associative movements
144	d skin writing	d skin writing
170	d stereognosis d skin writing d hearing d index-to-thumb d pronation-supination	i base d babinski reflex d stereognosis d skin writing d smell d jaw movement d hearing d pronation-supination associative movements
256	i base i wrist jerk d skin writing associative movements	clonus associative movements

TABLE 97 - Continued

Case #	1st Exam Findings	2nd Exam Findings
307	i wrist jerk i ulnar reflex i ankle jerk clonus d jaw movement d right facial movement d bilateral tongue movement d pronation-supination associative movement	d babinski reflex d barognosis d touch localization d jaw movement d tongue movement d pronation-supination associative movement
362	i snouting path. babinski reflex d 2-point discrimination d skin writing d jaw movement d taste d pronation-supination d index-to-thumb	d gait i base i snouting path. babinski reflex d skin writing d touch localization d jaw movement d tongue movement d index-to-thumb d pronation-supination d F-F-N associative movements
420	d cremasteric reflexes d stereognosis d skin writing associative movements	d gait d cremasteric reflexes associative movements
447	d gait d smell d jaw movement d right facial movement i left facial movement d tongue movement d pronation-supination associative movements	d jaw movement associative movements
463	d babinski reflex d jaw movement d tongue movement associative movements	d gait d tongue movement associative movements

TABLE 97 - Continued

Case #	1st Exam Findings	2nd Exam Findings
506	path. babinski reflex d cremasteric reflexes d hearing d tongue movement d index-to-thumb	path. babinski reflex d touch localization d jaw movement d tongue movement d pronation-supination d check reflexes associative movements
509	d stereognosis d babinski reflex d hearing d tongue movements associative movements	Normal
561	d skin writing d touch localization d 2-point discrimination d pronation-supination	d gait associative movements

i = increased
d = decreased

Inter-Examiner Consistency

It was deemed advisable also to explore the consistency of findings among pediatric neurologists. Arrangements were made to have 20 children examined and classified by three persons experienced in this medical specialty, including the neurologist who served as the examiner for this research project. The two visiting pediatric neurologists examined these subjects on the same day. Our project neurologist had examined them sometime during the previous 30 days. As per our design, no examiner knew whether the child he was examining had been found to have a deficiency in learning or whether he was a member of the control group. Three categories were used for the general classification: normal, abnormal, suspect.

The results for the general classification are presented in Table 98 . A consistent variation appeared in that examiner two (one of the visiting neurologists) did not use the "suspect" category; he classified all subjects as either normal or abnormal. Despite this variation there was agreement by all three examiners on eight out of the 20 subjects. Statistically, this proportion of agreement falls at .40. Further analysis revealed that examiners one and two agreed on 10 subjects, examiners one and three on 12, and examiners two and three on 13. The chi squares are highly significant, hence all examiners differed from each other.

From these findings we conclude that no one examiner was consistent with any other examiner to the extent that statistical reliability is assured. In view of this circumstance it appears that the observations made by a clinical pediatric neurologist are complex, individualistic, and idiosyncratic. So far as this research project is concerned, we employed only one neurological examiner, and although his judgments may not be confirmed by another examiner, his observations can be considered typical of those made by physicians certified in this medical specialty. These findings should not be construed as a reflection on the accuracy with which a pediatric neurologist makes diagnoses in children presenting actual disease problems. The sample utilized in this research was selected on the basis of deficiencies in learning, not on the basis of epilepsy, motor disorders, hyperkinesis, etc. This study of inter-examiner consistency, therefore, indicates only that when confronted with children who have deficits in learning, or who are normal, there is little agreement among the findings of pediatric neurologists.

Though not analyzed statistically, the actual findings per subject for each examiner are shown in Table 99. These tabulations indicate that the inconsistency from one examiner to another covers all observations, including the presence or absence of the Babinski sign.

TABLE 98

INTER-EXAMINER CONSISTENCY AS SHOWN BY
THE CLASSIFICATION OF NORMAL, ABNORMAL, SUSPECT

Classification Category	Number	Examiner One	Examiner Two	Examiner Three
True Control	5	Normal	Normal	Normal
True Control	1	Abnormal	Abnormal	Abnormal
True Control	1	Abnormal	Abnormal	Normal
True Control	1	Abnormal	Normal	Suspect
False Experimental	1	Suspect	Normal	Suspect
False Experimental	1	Normal	Normal	Suspect
True Experimental	1	Abnormal	Abnormal	Abnormal
True Experimental	1	Abnormal	Normal	Normal
True Experimental	1	Suspect	Normal	Suspect
Borderline	1	Abnormal	Abnormal	Abnormal
Borderline	1	Abnormal	Normal	Abnormal
Borderline	1	Suspect	Abnormal	Abnormal
Borderline	1	Suspect	Normal	Normal
Failed Intelligence	1	Suspect	Abnormal	Suspect
Failed Anxiety	1	Suspect	Normal	Normal
Failed Sensory	1	Suspect	Normal	Normal
Total Number	20			

TABLE 99

THE FINDINGS PER SUBJECT FOR EACH OF THE PEDIATRIC NEUROLOGISTS

Case #	Examiner One	Examiner Two	Examiner Three
643	--	skin writing	skin writing
		vasomotor	index-thumb
			drumming
			metria
			tongue movement vert.
			mimic movements
653	tongue movement vert.	--	tongue movement vert.
	standing one foot	--	standing one foot
	wrist jerk	--	--
	mimic movements	--	--
	associative movement	--	--
		snouting	snouting
		pronation-supination	pronation-supination
		drumming	drumming
		--	hopping one foot
		skin writing	--
		metria	--
654	babinski	--	--
	tongue movement vert.	--	--
	associative movement	--	--
			standing one foot
			hopping one foot
677	associative movement	--	--
		drumming	drumming
		mimic movements	mimic movements
		jaw jerk	--
		pronation-supination	--
679	skin writing	--	--
	taste	--	--
	tongue movement horiz.	--	--
	associative movement	--	--
		--	drumming
720	tongue movement horiz.	--	tongue movement horiz.
	pronation-supination	--	pronation-supination
	touch local.	--	--
	associative movement	--	--
		drumming	drumming
		--	index-thumb
		mimic movements	--

TABLE 99 - Continued

Case #	Examiner One	Examiner Two	Examiner Three
723	mimic movements	--	mimic movements
	tongue movement vert.	--	tongue movement vert.
	tongue movement horiz.	--	tongue movement horiz.
	standing one foot	--	standing one foot
	associative movement	--	associative movement
	tandem walking	--	--
	touch local.	--	--
		index-thumb	index-thumb
		drumming	drumming
		pronation-supination	pronation-supination
		metria	metria
		extinction DDS	--
		taste	--
			snouting
			vasomotor
			stereognosis
			hopping one foot
			F-F-N
			check reflexes
736	knee jerk	--	--
	ankle jerk	--	--
	clonus	--	--
	babinski	--	--
	barognosis	--	--
	touch local.	--	--
	tongue movement horiz.	--	--
	pronation-supination	--	--
	tandem walking	--	--
	mimic movements	--	--
	associative movements	--	--
		index-thumb	--
		involuntary movements	--
748	--	--	--
779	biceps jerk	--	--
	wrist jerk	--	--
	barognosis	--	--
	smell	smell	--
	jaw movements	--	--
	associative movements	--	--
		--	skin writing
		--	standing one foot
		snouting	--
		vision	--
		index-thumb	--

TABLE 99- Continued

Case #	Examiner One	Examiner Two	Examiner Three
784	tongue movement horiz.	--	tongue movement horiz.
	mimic movements	--	mimic movements
	associative movement	--	associative movement
	taste	--	--
		palmomental	palmomental
		snouting	snouting
		pronation-supination	pronation-supination
		index-thumb	--
		metria	--
		involuntary movement	--
			knee jerk
			stereognosis
			skin writing
			tongue movement vert.
785	associative movement	--	--
799	skin writing	skin writing	skin writing
	stereognosis	stereognosis	--
	associative movement	--	associative movement
	touch local.	--	--
		temperature	--
			jaw jerk
			taste
			heel-to-shin
			drumming
807	touch local.	touch local.	--
	standing one foot	--	standing one foot
	skin writing	--	--
	tandem walking	--	--
	associative movement	--	--
		metria	--
			drumming
			pronation-supination
			mimic movements
893	skin writing	skin writing	skin writing
	tongue movement horiz.	--	tongue movement horiz.
	pronation-supination	pronation-supination	pronation-supination
	standing one foot	--	standing one foot
	associative movement	--	associative movement
	tandem walking	--	--
		stereognosis	stereognosis
		involuntary movements	--
		palmomental	--
			touch local.
			index-thumb
			drumming
			hopping one foot
			tongue movement vert.

TABLE 99 - Continued

Case #	Examiner One	Examiner Two	Examiner Three
907	drumming	--	drumming
	pronation-supination	--	pronation-supination
	tandem walking	--	--
	tongue movement horiz.	--	--
	associative movement	--	--
		touch local.	--
			palmomental
			mimic movements
966	babinski	babinski	babinski
	skin writing	--	skin writing
	tongue movement horiz.	--	tongue movement horiz.
	pronation-supination	--	pronation-supination
	standing one foot	--	standing one foot
	hopping one foot	--	hopping one foot
	cremasteric reflexes	--	--
	nystagmus	--	--
	tandem walking	--	--
	mimic movements	mimic movements	--
	associative movements	--	--
		index-thumb	index-thumb
		drumming	drumming
976	babinski	--	--
	smell	--	--
	taste	--	--
	hopping one foot	--	--
		drumming	
1010	skin writing	--	skin writing
	drumming	--	drumming
	mimic movements	mimic movements	mimic movements
	associative movements	--	associative movements
	cremasteric reflexes	--	--
	stereognosis	--	--
	touch local.	--	--
	lateral jaw movement	--	--
	hearing	--	--
		pronation-supination	pronation-supination
		involuntary movements	--
			heel-to-shin
			check reflexes
			standing one foot
			hopping one foot
859	taste	--	--
	tongue movement vert.	--	--
	tongue movement horiz.	--	--
	rate of progression	--	--
	associative movement	--	--
		standing one foot	--

Results

Pediatric Examination

The pediatric neurologist conducted a physical examination of each subject, experimental and control. This examination covered 23 aspects, as shown on the record form in Appendix C . These were coded in terms of the incidence of significant findings, and the proportion of occurence was analyzed by group. These results are presented in Tables 100 and 101. In no instance did statistically significant differences appear between the borderline and learning disability samples and their respective control groups. In fact, according to these results, all subjects, with or without deficits in learning, were in good physical condition; the incidence of physical involvement as determined by this pediatric examination was exceedingly low. This might be considered consistent with the design and purpose of this investigation inasmuch as it was decided to conduct this study on children who were otherwise normal. We may conclude that the subjects selected, both experimental and control, were at least in average physical condition. Other phases of this investigation might be interpreted accordingly.

General Classification

As originally determined by our research design, the neurological findings were analyzed in two ways: by general classification (representing the clinician's judgment) and by the actual, objective results as recorded by the examiner. Here we consider the broad findings, utilizing only the parameter of normal-abnormal; the analysis by signs is presented below.

From Table 102 we see that the number of children classified as abnormal is slightly greater in the borderline and learning disability populations, but the difference in comparison with the normal does not reach the .05 level of statistical significance. It should be noted that two control groups were used, a control group for the experimental and another group for the borderline. Though there is a modest trend for a higher incidence of abnormality in the learning deficiency populations, especially in the learning disability group, it is not possible to conclude that the broad classification of normal or abnormal is directly related to the child's status in learning.

The neurologist used the typical five point scale when he recorded his clinical judgment: normal, suspect, mild, moderate, severe. The results for this more specific diagnostic designation are shown in Table 103. Because the number classified as having moderate or severe involvement is limited, these results were not analyzed in terms of level of statistical significance. However, it is clear from inspection that the differences between each of the learning deficient groups and their respective control groups are not noteworthy and may be interpreted as occurring by chance.

TABLE 100

PEDIATRIC PHYSICAL EXAMINATION FINDINGS BY GROUP: BORDERLINE AND CONTROLS (N=104)

Body area	Borderline	Control	Difference
Head shape	.962	.981	-.019
Head bruits	1.000	.990	.010
Facies	1.000	1.000	.000
Eyes	1.000	.990	.010
Ears: size and shape	.962	.971	.009
Ears: otoscopic examination	.971	.990	-.019
Dentition	.683	.750	-.067
Nose	1.000	.981	.019
Mouth	1.000	.990	.010
Pharynx	.962	.942	.020
Neck	.913	.971	-.058
Heartbeat	.971	.990	-.019
Heart	.981	1.000	-.019
Femoral pulse	.981	1.000	-.019
Abdomen	.933	.923	.010
Genitalia	.952	.971	-.019
Skin	.971	.933	.038
Spine	1.000	1.000	.000
Shoulder girdle	1.000	1.000	.000
Pelvic girdle	1.000	1.000	.000
Upper extremities	1.000	.981	.019
Lower extremities	.904	.962	-.058
Neck and trunk	.971	.990	-.019

* p less than .05

TABLE 101

PEDIATRIC PHYSICAL EXAMINATION FINDINGS BY GROUP: LEARNING DISABILITY AND CONTROLS (N=99)

Body area	Learning Disability	Control	Difference
Head shape	.949	.980	-.031
Head bruits	1.000	1.000	.000
Facies	.980	.980	.000
Eyes	.970	.990	-.020
Ears: size and shape	.970	.980	-.010
Ears: otoscopic examination	.970	.980	-.010
Dentition	.636	.707	-.071
Nose	1.000	.980	.020
Mouth	.960	1.000	-.040
Pharynx	.949	.960	-.011
Neck	.980	.980	.000
Heartbeat	.970	.970	.000
Heart	1.000	1.000	.000
Femoral pulse	.970	1.000	-.030
Abdomen	.919	.929	-.010
Genitalia	.960	.980	-.020
Skin	.960	.960	.000
Spine	1.000	1.000	.000
Shoulder girdle	1.000	1.000	.000
Pelvic girdle	1.000	1.000	.000
Upper extremities	.990	.970	.020
Lower extremities	.909	.960	-.051
Neck and trunk	.899	1.000	-.111

* p less than .05

TABLE 102

NEUROLOGICAL EXAMINATION RESULTS BY GROUP WHEN CATEGORIZED AS NORMAL OR ABNORMAL

	N	Classification: Normal	Classification: Abnormal	Proportion of Normalcy	X^2
Borderline	104	55	49	.529	1.969
Control	104	65	39	.625	
				Difference .096	
Learning Disability	99	49	50	.495	2.945
Control	99	61	38	.626	
				Difference -.131	

* p less than .05

TABLE 103

NEUROLOGICAL EXAMINATION RESULTS BY GROUP
WHEN CLASSIFIED BY DEGREE OF INVOLVEMENT

			Degree of Involvement			
	N	Normal	Suspect	Mild	Moderate	Severe
Borderline	104	55	17	25	7	0
Control	104	65	22	17	0	0
Learning Disability	99	49	27	18	5	0
Control	99	61	20	18	0	0

Objective Findings

In addition to analyzing the neurological findings by clinical judgment (normal-abnormal) a comparison of each experimental group with their controls was made for each individual sign as recorded by the examiner. These data for the borderline group and their controls are shown in Table 104 and for the learning disability group and their controls in Table 105; the scores represent the proportion of normalcy occurring in each group.

The only statistically significant differences were for skin writing, right and left, with the control being superior to the borderline subjects. One is disposed to dismiss these significant differences, occurring at the .05 level, as being due to chance, and this may be the case. However, in view of the findings which appear when another analysis was made (see Table 106), there is also the possibility that these are valid results.

One must conclude that the neurological findings, by general classification and by individual signs, are markedly negative. Though this conclusion seems warranted we cannot infer that the neurological study was unrevealing. Positive findings were derived; see below. It is of interest that no severe neurological involvements were noted (Table 103). In this respect the subjects with deficits in learning constituted a selected sample. No child with obvious motor handicaps, etc., was included. The intention was to investigate the associations between neurological dysfunctions and deficiencies in learning in children who otherwise did not have additional handicaps. As such, the findings presented below are of considerable interest.

Moreover, it must be noted that it was not the absence of neurological findings that resulted in no difference between learning disability and non-learning disability subjects. The neurologist observed a number of positive signs but these signs appeared with equal frequency for all groups, with or without deficits in learning. This is illustrated by the findings for "ulnar jerk," especially for the learning disability comparison. A number of children with this degree of deficit in learning showed an abnormality on this sign but an identical number of normal children also demonstrated a positive result on this sign.

Inasmuch as highly similar results appeared for the experimental and control groups, there is a possibility that the abnormalities which appeared are indicators of neurological maturational levels rather than pathological entities. This possibility is supported by other inspection of the results by individual sign. When positive indications were noted they were remarkably uniform for the four samples: borderline, learning disability and respective comparison groups. Though we have not attempted to do so, it may be advantageous to prepare a profile of these findings to further explore the usefulness of these data as indicators of neurological maturation in eight and nine year old children.

TABLE 104

NEUROLOGICAL EXAMINATION FINDINGS BY GROUP-
BORDERLINE AND CONTROLS (N=104)

Sign	Borderline	Control	Difference
Gait: rate of progression	1.000	.971	.029
Base	.990	.981	.009
Right bicep jerk	.837	.808	.029
Left bicep jerk	.827	.808	.019
Right tricep jerk	.875	.856	.019
Left tricep jerk	.875	.856	.019
Right wrist jerk	.827	.817	.010
Left wrist jerk	.817	.817	.000
Right ulnar jerk	.779	.779	.000
Left ulnar jerk	.769	.788	-.019
Jaw jerk	1.000	.981	.019
Right knee jerk	.923	.942	-.019
Left knee jerk	.923	.933	-.010
Right ankle jerk	.962	.913	-.049
Left ankle jerk	.952	.913	.039
Right Hoffman maneuver	1.000	1.000	.000
Left Hoffman maneuver	1.000	1.000	.000
Snouting	.981	1.000	-.019
Sucking	1.000	1.000	.000
Right palmomental	.923	.952	-.029
Left palmomental	.904	.952	-.048
Right clonus	.971	.990	-.019
Left clonus	.962	.981	-.019
Right Plantar B	.942	.971	-.029
Left Plantar B	.923	.962	-.039
Right Plantar C	1.000	.990	.010
Left Plantar C	1.000	.990	.010
Right Oppenheim	1.000	1.000	.000
Left Oppenheim	1.000	1.000	.000
Right superficial abdominal	.981	.981	.000
Left superficial abdominal	.981	.981	.000

TABLE 104 - Continued

Sign	Borderline	Control	Difference
Right Plantar G+	1.000	1.000	.000
Left Plantar G+	1.000	1.000	.000
Right Cremaster++	.925	.970	-.045
Left Cremaster++	.941	.970	-.029
Right pupillary	1.000	1.000	.000
Left pupillary	1.000	1.000	.000
Right light	1.000	1.000	.000
Left light	1.000	1.000	.000
Right accommodation	1.000	1.000	.000
Left accommodation	1.000	1.000	.000
Right consensual	1.000	1.000	.000
Left consensual	1.000	1.000	.000
Right pharyngeal	.990	1.000	.000
Left pharyngeal	.990	1.000	.000
Right pilomotor	1.000	1.000	.000
Left pilomotor	1.000	1.000	.000
Right vasomotor	1.000	.990	.010
Left vasomotor	1.000	.990	.010
Right pin prick	1.000	1.000	.000
Left pin prick	1.000	1.000	.000
Right cotton touch	1.000	1.000	.000
Left cotton touch	1.000	1.000	.000
Right temperature	1.000	1.000	.000
Left temperature	1.000	1.000	.000
Right vibration	1.000	1.000	.000
Left vibration	1.000	1.000	.000
Right position	1.000	1.000	.000
Left position	1.000	1.000	.000
Right stereognosis	.885	.875	.010
Left stereognosis	.894	.885	.009
Right barognosis	.962	.990	-.028
Left barognosis	.962	.990	-.028
Right two point discrimination	.962	1.000	-.038

TABLE 104 - Continued

Sign	Borderline	Control	Difference
Left two point discrimination	.962	1.000	-.038
Right skin writing	.654	.798	.144*
Left skin writing	.654	.798	.144*
Right extinction to DDS	.865	.875	-.010
Left extinction to DDS	.865	.875	-.010
Right touch localization-Bilateral	.865	.971	-.106
Left touch localization-Bilateral	.856	.971	-.115
Smell	.904	.962	-.058
Right vision	1.000	1.000	.000
Left vision	1.000	1.000	.000
Fundi	1.000	1.000	.000
Right opticokinetic nystagmus	.952	.933	.019
Left opticokinetic nystagmus	.942	.933	.009
Right jaw movement - vertical	.990	.971	.019
Left jaw movement - vertical	.990	.971	.019
Right facial movement	.971	.971	.000
Left facial movement	.981	.971	.010
Right taste	.885	.971	-.086
Left taste	.894	.971	-.077
Right hearing	.990	1.000	-.010
Left hearing	.990	.990	.000
Equilibrium	1.000	1.000	.000
Right motion: palate-pharynx	.981	.981	.000
Left motion: palate-pharynx	.981	.981	.000
Right motion: trapezius	1.000	1.000	.000
Left motion: trapezius	1.000	1.000	.000
Tongue protrusion	.990	.990	.000
Tongue - vertical	.993	.923	.010
Right index to thumb	.962	.981	-.019
Left index to thumb	.952	.971	-.019
Right pronation - supination	.885	.875	.010
Left pronation - supination	.885	.875	.010
Right finger-finger-nose	1.000	1.000	.000

TABLE 104 - Continued

Sign	Borderline	Control	Difference
Left finger-finger-nose	1.000	1.000	.000
Right check reflexes	1.000	1.000	.000
Left check reflexes	1.000	1.000	.000
Right past-point	.990	1.000	-.010
Left past-point	.990	1.000	-.010
Right metria	1.000	1.000	.000
Left metria	1.000	1.000	.000
Associative movements with multiple postural acts @ 10"	.740	.779	-.039
Right touch localization-unilateral	.990	.981	.009
Left touch localization-unilateral	.990	.981	.009
Right visual fields	1.000	1.000	.000
Left visual fields	1.000	1.000	.000
Jaw movement - lateral	.865	.894	.029
Tongue alternating movement - horizontal	.769	.817	.048
Right drumming+	.962	.974	-.012
Left drumming+	.962	.974	-.012
Right heel-to-shin+	1.000	.987	.013
Left heel-to-shin+	1.000	.974	.026
Right gait: swinging arms+	1.000	1.000	.000
Left gait: swinging arms+	1.000	1.000	.000
Tandem walking	.856	.856	.000
Right standing on one foot+	.899	.899	.000
Left standing on one foot+	.872	.899	-.027
Right hopping on one foot+	.924	.937	-.014
Left hopping on one foot+	.924	.937	-.014
Romberg+	1.000	1.000	.000
Hand-to-nose, hand-to-ear+	.671	.785	-.114
Grip hands: fingers facing tip-to-tip+	.911	.924	-.013
Pat stomach - rub head+	.861	.924	-.063
Associative movements with multiple postural act 20"+	.734	.785	-.051
Involuntary movements: specific+	1.000	.987	.013

TABLE 104 - Continued

Sign	Borderline	Control	Difference
Right muscle tone: arm+	1.000	1.000	.000
Left muscle tone: arm+	1.000	1.000	.000
Right muscle tone: leg+	1.000	1.000	.000
Left muscle tone: leg+	1.000	.987	.013
Right muscle strength: arm+	1.000	1.000	.000
Left muscle strength: arm+	1.000	1.000	.000
Right muscle strength: legs+	1.000	1.000	.000
Left muscle strength: legs+	1.000	1.000	.000
Power: trunk+	1.000	1.000	.000

* p less than .05
** p less than .01

+ Proportions based on 79 Borderlines and 79 Controls.

++ Proportions based on 67 male Borderlines and 67 Controls.

TABLE 105

NEUROLOGICAL EXAMINATION FINDINGS BY GROUP:
LEARNING DISABILITY AND CONTROL (N=99)

Sign	Learning Disability	Control	Difference
Gait: rate of progression	.990	.990	.000
Base	1.000	.990	.010
Right bicep jerk	.848	.818	.030
Left bicep jerk	.848	.818	.030
Right tricep jerk	.909	.859	.050
Left tricep jerk	.909	.859	.050
Right wrist jerk	.838	.838	.000
Left wrist jerk	.838	.838	.000
Right ulnar jerk	.798	.798	.000
Left ulnar jerk	.798	.798	.000
Jaw jerk	1.000	.970	.030
Right knee jerk	.949	.949	.000
Left knee jerk	.919	.939	-.020
Right ankle jerk	.990	.960	.030
Left ankle jerk	.970	.960	.010
Right Hoffman maneuver	1.000	1.000	.000
Left Hoffman maneuver	1.000	1.000	.000
Snouting	.980	1.000	-.020
Sucking	1.000	1.000	.000
Right palmomental	.949	.990	-.040
Left palmomental	.949	1.000	-.051
Right clonus	.980	.970	.010
Left clonus	.980	.960	.020
Right Plantar B	.939	.960	-.021
Left Plantar B	.949	.960	-.011
Right Plantar C	1.000	.990	.010
Left Plantar C	.990	.990	.000

TABLE 105- Continued

Sign	Learning Disability	Control	Difference
Right Oppenheim	1.000	1.000	.000
Left Oppenheim	.990	1.000	-.010
Right superficial abdominal	.970	.990	-.020
Left superficial abdominal	.980	.980	.000
Right Plantar G+	1.000	1.000	.000
Left Plantar G+	1.000	1.000	.000
Right cremaster++	.885	.935	-.050
Left cremaster++	.897	.923	-.026
Right pupillary	1.000	1.000	.000
Left pupillary	1.000	1.000	.000
Right light	1.000	1.000	.000
Left light	1.000	1.000	.000
Right accommodation	1.000	1.000	.000
Left accommodation	1.000	1.000	.000
Right consensual	1.000	1.000	.000
Left consensual	1.000	1.000	.000
Right pharyngeal	1.000	1.000	.000
Left pharyngeal	1.000	1.000	.000
Right pilomotor	1.000	1.000	.000
Left pilomotor	1.000	1.000	.000
Right vasomotor	1.000	1.000	.000
Left vasomotor	1.000	1.000	.000
Right pin prick	1.000	1.000	.000
Left pin prick	1.000	1.000	.000
Right cotton touch	1.000	1.000	.000
Left cotton touch	1.000	1.000	.000
Right temperature	1.000	1.000	.000
Left temperature	1.000	1.000	.000
Right vibration	1.000	1.000	.000

TABLE 105- Continued

Sign	Learning Disability	Control	Difference
Left vibration	1.000	1.000	.000
Right position	1.000	1.000	.000
Left position	1.000	1.000	.000
Right stereognosis	.859	.889	-.030
Left stereognosis	.859	.889	-.030
Right barognosis	.970	.960	.010
Left barognosis	.970	.960	.010
Right two point discrimination	.990	1.000	-.010
Left two point discrimination	.990	1.000	-.010
Right skin writing	.758	.798	-.040
Left skin writing	.778	.798	-.020
Right extinction to DDS	.859	.869	-.010
Left extinction to DDS	.859	.869	-.010
Right touch localization-Bilateral	.899	.949	-.050
Left touch localization-Bilateral	.899	.949	-.050
Smell	.919	.970	-.051
Right vision	1.000	1.000	.000
Left vision	1.000	1.000	.000
Fundi	1.000	1.000	.000
Right opticokinetic nystagmus	.949	.949	.000
Left opticokinetic nystagmus	.960	.949	.011
Right jaw movement-vertical	.980	.990	-.010
Left jaw movement-vertical	.980	.990	-.010
Right facial movement	.960	.990	-.030
Left facial movement	.990	.990	.000
Right taste	.980	.970	.010
Left taste	.980	.970	.010
Right hearing	.980	.980	.000

TABLE 105 - Continued

Sign	Learning Disability	Control	Difference
Left hearing	.980	.970	.010
Equilibrium	1.000	1.000	.000
Right motion: palate-pharynx	1.000	.990	.010
Left motion: palate-pharynx	1.000	.990	.010
Right motion: trapezius	1.000	1.000	.000
Left motion: trapezius	.990	1.000	-.010
Tongue protrusion	.990	1.000	-.010
Tongue-vertical	.838	.949	-.111
Right index to thumb	.970	.990	-.020
Left index to thumb	.960	.990	-.030
Right pronation-supination	.889	.909	-.020
Left pronation-supination	.889	.909	-.020
Right finger-finger-nose	1.000	1.000	.000
Left finger-finger-nose	.990	1.000	-.010
Right check reflexes	1.000	1.000	.000
Left check reflexes	1.000	1.000	.000
Right past-point	.990	1.000	-.010
Left past-point	.990	1.000	-.010
Right metria	1.000	1.000	.000
Left metria	1.000	1.000	.000
Associative movements with multiple postural acts @ 10"	.667	.788	-.121
Right touch localization-unilateral	1.000	.990	.010
Left touch localization-unilateral	1.000	.990	.010
Right visual fields	1.000	1.000	.000
Left visual fields	1.000	1.000	.000
Jaw movement-lateral	.848	.889	-.041
Tongue-alternating movement-horizontal	.687	.798	-.111

TABLE 105 - Continued

Sign	Learning Disability	Control	Difference
Right drumming +	.935	.948	-.013
Left drumming +	.910	.948	-.038
Right heel-to-shin +	1.000	.987	.013
Left heel-to-shin +	1.000	.987	.013
Right gait: swinging arms +	1.000	1.000	.000
Left gait: swinging arms +	1.000	1.000	.000
Tandem walking	.818	.848	-.030
Right standing on one foot +	.834	.923	-.089
Left standing on one foot +	.807	.923	-.116
Right hopping on one foot +	.948	.923	.025
Left hopping on one foot +	.922	.935	-.013
Romberg +	1.000	1.000	.000
Hand-to-nose, hand-to-ear +	.718	.744	-.026
Grip hands: fingers facing tip-to-tip +	.910	.910	.000
Pat stomach-rub head +	.910	.910	.000
Associative movements with multiple postural act 20" +	.654	.782	-.128
Involuntary movem'ts: specific+	.987	.987	.000
Right muscle tone: arm +	1.000	1.000	.000
Left muscle tone: arm +	1.000	1.000	.000
Right muscle tone: leg +	1.000	1.000	.000
Left muscle tone: leg +	1.000	1.000	.000
Right muscle strength: arm +	1.000	1.000	.000
Left muscle strength: arm +	1.000	1.000	.000
Right muscle strength: legs+	1.000	1.000	.000
Left muscle strength: legs+	1.000	1.000	.000
Power: trunk +	1.000	1.000	.000

* p less than .05
** p less than .01
\+ Proportion based on 78 Learning Disabilities and 78 Controls.

++ Proportion based on 78 Learning Disabilities and 78 Controls.

TABLE 106

SIGNIFICANT DIFFERENCES IN THE NEUROLOGICAL SIGNS FOR THOSE DEFICIENT IN NONVERBAL LEARNING

Skin Writing	Borderline Group (N=20)	Control Group (N=20)	Difference
Right			
Normal	.421	.842	-.421*
Suspect	.421	.158	.263
Abnormal	.158	.000	.158
Left			
Normal	.421	.842	-.421*
Suspect	.421	.158	.263
Abnormal	.158	.000	.158

* p less than .05
** p less than .01

Tongue Movement	Learning Disability Group (N=19)	Control Group (N=19)	Difference
Normal	.500	.900	.400*
Suspect	.450	.100	.350*
Abnormal	.050	.000	.050

* p less than .05
** p less than .01

Incidence of Neurological Signs by Group

Investigation of the neurological study data also included analysis of the number of abnormal and suspect signs that appeared by group. The incidence of each category of neurological sign for each group is shown in Tables 107, 108, and 109.

From the data in Table 107 it is clear that the abnormal signs, representing the more obvious neurological involvement, occurred much more often in the experimental populations (.001 level). Hence, when the number of positive findings per group is used as a parameter, there can be little question but that the more typical neurological involvement is associated with deficiencies in learning.

The data for the suspect (soft) signs also clearly reveal that these too appeared more often in the experimental populations; see Table 108. Again, a comparison between learning disabilities and controls reveals the greater proportion of suspect signs for the learning disability group at the .001 level. This comparison shows a difference at the .01 level for the borderline group and their controls.

A comparison of the incidence was made also on the basis of the extent of the deficit in learning (learning disability versus borderline). These results are shown in Table 109. While no differences appeared for the abnormal (hard) signs, the number of suspect (soft) signs was greater in the borderline sample. The inference seems to be that when the learning deficit is minimal (actually suspect), the neurological finding also more often is minimal (actually suspect).

In addition to the above analyses, the incidence data were treated by side, left and right, and neither (snout reflex, etc., were categorized as neither). The results of this aspect of the investigation were negative. So far as statistical evidence is concerned, though the number of positive signs was related to deficits in learning, this relationship did not pertain to sidedness. It appears that the neurological findings were not more common on either side for either group. Presumably, right versus left hemisphere involvement was not a factor in our experimental population. In fact, the design of the study attempted to prevent a bias of selecting more of one type (left) than of the other (right).

Results by Type and Degree of Deficiency in Learning

We hypothesized that neurological disturbances might be significantly related to a given type of learning deficit. Learning disability and borderline groups were subdivided according to type of deficiency in learning: those deficient only in reading; those having deficits in nonverbal functions; and those having verbal and nonverbal disabilities (mixed). This distribution by group is presented in Table 110. A moderate trend was observed for the experimental populations to show more neurological disturbances than the control groups. To ascertain the significance of this trend a statistical analysis was made, again testing the difference in proportion of normalcy. The only statistically significant difference appeared for the category of nonverbal

TABLE 107

INCIDENCE OF ABNORMAL NEUROLOGICAL SIGNS
BY GROUP

	Number of Abnormal Signs	Proportion	Z Score
Borderline	106	.7681	14.94***
Control	32	.2319	
Total	138	1.0000	
Learning Disability	93	.7323	11.82***
Control	34	.2677	
Total	127	1.0000	

* p less than .05
** p less than .01
*** p less than .001

TABLE 108

INCIDENCE OF SUSPECT NEUROLOGICAL SIGNS
BY GROUP

	Number of Suspect Signs	Proportion	Z Score
Borderline	576	.5232	3.09**
Control	525	.4768	
Total	1101	1.0000	
Learning Disability	528	.5264	3.36***
Control	475	.4736	
Total	1003	1.0000	

* p less than .05
** p less than .01
*** p less than .001

TABLE 109

INCIDENCE OF ABNORMAL AND SUSPECT NEUROLOGICAL SIGNS
FOR LEARNING DISABILITY AND BORDERLINE GROUPS

	Number of Abnormal Signs	Proportion	Z Score
Learning Disability	93	.4673	-1.85
Borderline	106	.5327	
Total	199	1.0000	

	Number of Suspect Signs	Proportion	Z Score
Learning Disability	528	.4783	-2.89**
Borderline	576	.5217	
Total	1104	1.0000	

* p less than .05
** p less than .01

TABLE 110

NEUROLOGICAL FINDINGS BY GROUP
AND TYPE OF DEFICIENCY IN LEARNING

	Learning Disability				Control			
Area Failed	Normal	Suspect	Abnormal	Total	Normal	Suspect	Abnormal	Total
Reading	18	7	8	33	22	2	9	33
Nonverbal	6	10	4	20	13	2	5	20
Mixed	25	10	11	46	27	15	4	46
Total	49	27	23	99	62	19	18	99

	Borderline				Control			
Area Failed	Normal	Suspect	Abnormal	Total	Normal	Suspect	Abnormal	Total
Reading	9	5	6	20	14	4	2	20
Nonverbal	6	3	10	19	12	5	2	19
Mixed	39	9	17	65	40	13	12	65
Total	54	17	33	104	66	22	16	104

in the learning disability population; no differences occurred for this group when analyzed as a total sample without regard for the type of learning deficit. These results are shown in Table 111. When classified as normal, suspect, mild, or moderate, a greater number of learning disability children were categorized as having neurological dysfunctions when compared with the normal group. This is evidenced by the fact that fewer children with nonverbal learning deficits were designated as normal and more with this type of deficiency were classified as suspect.

In addition to the general classifications, an analysis was made of the relationships among specific, individual signs and the type and degree of deficits in learning. These findings are shown in Table 106. Again it was the nonverbal group in which significant differences were manifested; none of the neurological signs differentiated the reading and the mixed groups from their respective controls.

As noted previously, skin writing (right and left) was disturbed in borderline subjects to a greater degree than found for their controls. This sign also differentiated between those having nonverbal disorders of learning and their controls. In other words, fewer borderline subjects with nonverbal deficiencies were designated as normal in skin writing than were their respective controls; this difference fell above the .05 level but below the .01 level.

Analysis by type and degree of involvement revealed another statistically significant difference by neurological sign; again the variation was for the nonverbal disability group. Children in the learning disability sample with nonverbal involvement more often than the controls were inferior in horizontal tongue movement; the level of significance was above .05 but below .01.

Interpretation of these findings should be made with caution. When type and degree of learning disability were considered only three positive indicators appeared, all for the nonverbal type of deficit. These children were less often judged normal neurologically, and they showed greater evidence of being inferior in skin writing and in horizontal tongue movement. In view of the possibility of chance factors, these indications cannot be viewed as conclusive. However, if nonverbal learning deficits implicate the right hemisphere more than the left, then the neurological examination results apparently are more indicative of this type of dysfunction. Further study of this possibility seems warranted.

The Failed Criteria Group

Children selected as experimental and control subjects sometimes failed the criteria established for these categories. Nevertheless, these children were studied intensively to note their behavioral-organic status. The neurological classification for this group, by type of involvement, can be seen in Table 112. Of the 21 selected for the learning disability group, eight were judged normal, nine suspect and four abnormal. For the 29 chosen as borderline subjects, 19 were designated normal, nine suspect and one abnormal. Of the 37 chosen as

TABLE 111

SIGNIFICANT DIFFERENCES IN GENERAL CLASSIFICATION
FOR THOSE DEFICIENT IN NONVERBAL LEARNING:
LEARNING DISABILITY GROUP (N=19)

	Learning Disability Group	Control Group	Difference
Normal	.300	.650	-.350*
Suspect	.500	.100	.400*
Mild	.100	.250	-.150
Moderate	.100	.000	.100

* p less than .05

TABLE 112

LEARNING DISABILITY AND BORDERLINE SUBJECTS WHO FAILED THE SELECTIVE CRITERIA COMPARED WITH CONTROL SUBJECTS WHO ALSO FAILED THESE CRITERIA: NEUROLOGICAL FINDINGS

	Borderline			
Area Failed	Abnormal	Suspect	Normal	Total
Reading	0	1	5	6
Nonverbal	0	1	5	6
Mixed	1	7	9	17
TOTAL	1	9	19	29

	Learning Disability			
Area Failed	Abnormal	Suspect	Normal	Total
Reading	0	3	3	6
Nonverbal	1	2	1	4
Mixed	3	4	4	11
TOTAL	4	9	8	21

	Control			
Area Failed	Abnormal	Suspect	Normal	Total
Number Failed	6	9	22	37

control subjects, and examined by the neurologist, 22 were categorized as normal, nine as suspect, and six as abnormal. Because of the limited size of most of these classifications further statistical analysis was not attempted. By inspection, it appears that these children were not characteristically different from the total sample evaluated by the neurologist.

Discriminant Analysis

A discriminant analysis utilizing all of the 49 behavioral variables was performed for the learning disability and borderline samples and for their respective control groups. Within each group this analysis was made on the basis of the neurologist's classification of normal, suspect, or abnormal. Those behavioral variables which discriminated among the neurological categories at the .05 and .01 levels are presented for the borderline group (Table 113) and their controls (Table 114) and for the learning disability group (Table 115) and their controls (Table 116).

A comparison of the mean scores for the normal and abnormal classifications by variable revealed the direction of the discriminant function; the number of scores favoring each group was tallied. A chi square was computed to ascertain whether there was a consistent direction of these scores. If such differences appeared a relationship between the discriminant functions and neurological status might be assumed. The chi square results are shown in Table 117.

This analysis revealed no difference in the direction of the mean scores for the borderline group. The discriminant functions did not vary for those with minimal deficits in learning (in comparison with the normal) so far as the classifications of abnormal and normal were concerned. Interestingly, the psychoeducational study showed little difference between the borderline and normal in discriminant functions.

The outcome of this analysis is less clear for the learning disability sample. For the control subjects the trend was for the means to favor those classified as normal. An opposite result appeared for the learning disability subjects; the direction of the mean most often favored those designated as suspect. These findings may have been influenced by the fact that many more positive neurological signs were found for children in the learning disability sample; fewer were classified as normal. We can only conclude that the analysis of the direction of the discriminant functions was not revealing.

Summary

There has been much speculation as to the role of neurology in relation to learning disabilities. The data gathered in this research project are useful accordingly. Although the neurologist was restricted, examining the subjects without knowledge of the history, without information as to whether the child did or did not have a learning disability, it was demonstrated that neurological disturbances in certain respects characterized children with deficits in learning.

TABLE 113

DISCRIMINANT ANALYSIS OF FORTY-NINE VARIABLES
OF THE PSYCHOEDUCATIONAL BATTERY FOR THE BORDERLINE GROUP
ON THE BASIS OF ABNORMAL (N=25), SUSPECT (N=13), NORMAL (N=41)
NEUROLOGICAL CLASSIFICATION

Tests Significant at .01	Direction of Mean	F
WISC Coding	N	3.48
WISC Picture Arrangement	N	3.04
PSLT Words Per Sentence	S	2.96
Oral PSLT Words Per Sentence	N	2.71
WISC Arithmetic	N	2.45
Metropolitan Spelling	S	2.36
Gates-McKillop Syllabication	S	2.41
Detroit Letters	N	2.32
Detroit Words	S	2.25
WISC Digit Span	N	2.17
Oral PSLT Abstract-Concrete	A	2.16
Detroit Free Association	S	2.10
Draw-A-Man	N	2.03
WISC Mazes	S	2.08
PSLT Abstract-Concrete	N	2.02
Gates-MacGinitie Vocabulary	N	1.95
WISC Picture Completion	A	1.92
WISC Object Assembly	N	1.87
Gates-MacGinitie Comprehension	N	1.90
Healy I	A	1.89
Gates-Russell One-Syllable	S	1.86
Gates-Russell Two-Syllable	S	1.84
WISC Vocabulary	N	1.81
Wide Range Oral Reading	N	1.75

Tests Significant at .05	Direction of Mean	F
Detroit Designs	N	1.69
Gates-MacGinitie Accuracy	N	1.63
PMA Arithmetic	N	1.58
Metropolitan Arithmetic	S	1.59
WISC Mean Performance	N	1.54
Vineland	N	1.51

TABLE 113- Continued

Tests Not Significant	Direction of Mean
WISC Information	N
WISC Comprehension	N
WISC Similarities	N
WISC Block Design	N
WISC Mean Verbal	N
Gates-McKillop Word Parts	S
Gates-McKillop Nonsense Words	N
Gates-Russell Oral Words	S
Metropolitan Language	N
PSLT Total Words	N
PSLT Total Sentences	N
PSLT Syntax	S
Detroit Verbal Opposites	N
Detroit Sentences	N
Detroit Oral Directions	N
Detroit Orientation	A
Leiter	N
Kent D	N
Heath Rails	N

TABLE 114

DISCRIMINANT ANALYSIS OF FORTY-NINE VARIABLES OF THE PSYCHOEDUCATIONAL BATTERY FOR THE BORDERLINE CONTROLS ON THE BASIS OF ABNORMAL (N=15), SUSPECT (N=16), NORMAL (N=48) NEUROLOGICAL CLASSIFICATION

Tests Significant at .01	Direction of Mean	F
Detroit Sentences	N	5.75
Healy I	S	4.61
Detroit Free Association	N	4.39
Gates-Russell Two-Syllables	N	3.83
Gates-McKillop Word Parts	S	3.92
WISC Picture Arrangement	S	3.73
Detroit Verbal Opposites	S	3.61
WISC Comprehension	N	3.55
Metropolitan Language	N	3.49
Gates-MacGinitie Vocabulary	S	3.47
PSLT Abstract-Concrete	N	3.33
WISC Mazes	S	3.27
Detroit Oral Directions	N	3.26
Metropolitan Spelling	N	3.17
Kent D	N	3.09
Leiter	S	3.09
PSLT Total Words	N	3.04
Draw-A-Man	S	2.99
Oral PSLT Abstract-Concrete	N	2.92
Detroit Designs	N	2.83
Gates-Russell Oral Words	N	2.77
Wide Range Oral Reading	S	2.72
PMA Arithmetic	N	2.73
WISC Block Design	S	2.67
Metropolitan Arithmetic	N	2.62
WISC Coding	N	2.56
WISC Arithmetic	N	2.49
WISC Information	N	2.42
Gates-McKillop Syllabication	N	2.36
Detroit Words	N	2.29

TABLE 114- Continued

Tests Significant at .01	Direction of Mean	F
WISC Digit Span	N	2.23
Heath Rails	N	2.18
PSLT Syntax	N	2.12
WISC Mean Verbal	N	2.08
WISC Vocabulary	S	2.04
Detroit Orientation	N	1.98
PSLT Words Per Sentence	S	1.92
WISC Object Assembly	N	1.87
Gates-MacGinitie Comprehension	N	1.81
Gates-Russell One-Syllable	N	1.74

Tests Significant at .05	Direction of Mean	F
WISC Picture Completion	N	1.67
Gates-MacGinitie Accuracy	S	1.60
Detroit Letters	N	1.53

Tests Not Significant	Direction of Mean
WISC Similarities	S
Gates-McKillop Nonsense Words	S
PSLT Total Sentences	N
Oral PSLT Words Per Sentence	S
Vineland	N
WISC Mean Performance	N

TABLE 115

DISCRIMINANT ANALYSIS OF FORTY-NINE VARIABLES OF THE PSYCHOEDUCATIONAL BATTERY FOR THE LEARNING DISABILITY GROUP ON THE BASIS OF ABNORMAL (N=20), SUSPECT (N=20), NORMAL (N=38) NEUROLOGICAL CLASSIFICATION

Tests Significant at .01	Direction of Mean	F
Gates-McKillop Nonsense Words	S	8.65
WISC Coding	N	6.26
Leiter	A	5.39
WISC Mazes	N	4.81
WISC Picture Completion	A	4.38
Detroit Letters	N	3.93
Detroit Oral Directions	S	3.81
Detroit Words	A	3.58
Detroit Sentences	S	3.84
Healy I	N	3.67
WISC Picture Arrangement	N	3.53
Draw-A-Man	A	3.40
Metropolitan Spelling	S	3.29
PSLT Total Words	S	3.27
WISC Digit Span	S	3.24
PSLT Syntax	S	3.21
Kent D	A and S same	3.14
WISC Similarities	S	3.09
Gates-MacGinitie Accuracy	S	3.04
Metropolitan Language	S	3.14
Vineland	S	3.14
Gates-Russell Two-Syllables	S	3.18
WISC Information	S	3.21
Oral PSLT Words Per Sentence	S	3.20
Gates-McKillop Word Parts	S	3.18
Detroit Free Association	A	3.18
Gates-MacGinitie Vocabulary	S	3.13
Gates-MacGinitie Comprehension	S	3.16
Detroit Designs	N	3.09
WISC Block Design	A	3.02
Gates-McKillop Syllabication	S	2.95
Detroit Verbal Opposites	A	2.90

TABLE 115- Continued

Tests Significant at .01	Direction of Mean	F
WISC Object Assembly	N	2.89
WISC Arithmetic	S	2.84
PSLT Total Sentences	S	2.79
Detroit Orientation	S	2.74
Wide Range Oral Reading	S	2.66
PMA Arithmetic	S	2.58
Metropolitan Arithmetic	S	2.49
Heath Rails	N	2.41
WISC Vocabulary	S	2.35
WISC Comprehension	S	2.28
Gates-Russell Oral Words	S	2.20
Oral PSLT Abstract-Concrete	S	2.10
Gates-Russell One-Syllable	S	2.02
PSLT Words Per Sentence	N	1.92
PSLT Abstract-Concrete	S	1.82

Tests Not Significant at .01	Direction of Mean
WISC Mean Verbal	S
WISC Mean Performance	N

TABLE 116

DISCRIMINANT ANALYSIS OF FORTY-NINE VARIABLES OF THE PSYCHOEDUCATIONAL BATTERY FOR LEARNING DISABILITY CONTROLS ON THE BASIS OF ABNORMAL (N=17), SUSPECT (N=15), NORMAL (N=46) NEUROLOGICAL CLASSIFICATION

Tests Significant at .01	Direction of Mean	F
WISC Digit Span	N	4.47
Draw-A-Man	N	3.53
Detroit Verbal Opposites	A	3.74
WISC Block Design	S	3.64
Oral PSLT Words Per Sentence	S	3.38
Detroit Designs	N	3.17
PSLT Total Sentences	N	2.95
Gates-McKillop Nonsense Words	S	2.85
Leiter	N	2.70
Detroit Free Association	N	2.58
WISC Object Assembly	N	2.44
WISC Mazes	S	2.40
Detroit Orientation	N	2.32
Kent D	N	2.30
Detroit Oral Directions	N	2.29
Heath Rails	N	2.28
WISC Vocabulary	N	2.22
WISC Mean Verbal	N	2.15
Metropolitan Language	N	2.08
Gates-McKillop Word Parts	S	2.03
Gates-Russell Two-Syllables	N	1.98
PSLT Words Per Sentence	S	1.94
WISC Picture Arrangement	A	1.91
Gates-McKillop Syllabication	N	1.85
PSLT Abstract-Concrete	N	1.79
PSLT Syntax	A	1.73

TABLE 116- Continued

Tests Significant at .05	Direction of Mean	F
Oral PSLT Abstract-Concrete	S	1.68
Gates-Russell Oral Words	N	1.62
Detroit Letters	N	1.57
Detroit Words	N	1.53
Gates-MacGinitie Vocabulary	N	1.48

Tests Not Significant	Direction of Mean
WISC Information	N
WISC Comprehension	N
WISC Arithmetic	N
WISC Similarities	N
WISC Picture Completion	N
WISC Coding	N
WISC Mean Performance	N
Wide Range Oral Reading	N
Gates-MacGinitie Accuracy	N
Gates-MacGinitie Comprehension	N
Metropolitan Arithmetic	N
PMA Arithmetic	N
Metropolitan Spelling	N
Gates-Russell One-Syllable	N
PSLT Total Words	N
Detroit Sentences	N
Healy I	N
Vineland	N

TABLE 117

COMPARISON OF THE DISCRIMINANT ANALYSIS RESULTS BY GROUP (CHI SQUARE)

	Borderline	Control	Total	X^2
Suspect+	9	13	22	.708
Normal	18	30	48	
TOTAL	27	43	70	

	Learning Disability	Control	Total	X^2
Abnormal	7	3	10	
Suspect	30	7	37	14.32***
Normal	9	21	30	
TOTAL	46	31	77	

* p less than .05
** p less than .01
*** p less than .001

+ The abnormal category was omitted as it did not meet chi square criteria (three abnormal broderline Ss; 0 abnormal control Ss).

Though no profile of neurological disorders evolved, two individual signs differentiated between the borderline and control groups. The children in the borderline sample showed a disturbance of graphesthesia on both the right and left sides. Those in the learning disability sample were found to be deficient in horizontal movement of the tongue.

A difference appeared for the learning disability sample when the type and degree of the involvement was considered. More children with nonverbal learning deficiencies were classified as abnormal neurologically. If nonverbal deficits are viewed as deriving mainly from the right hemisphere, then this type of disturbance seems to be more ascertainable by the pediatric neurologist.

Perhaps the most noteworthy positive findings were those that derived from analysis of the data by incidence of neurological signs. Both experimental groups (borderline and learning disability) were found to show many more signs of neurological disturbance in comparison with the normal. The borderline exhibited more suspect (soft) signs and the learning disability more clearly abnormal (hard) signs. In terms of the paradigm for this investigation we may conclude that when the deficiency in learning is mild to moderate the neurological involvement also is moderate. Similarly, when the learning deficiency is marked the neurological disturbance also is marked.

Despite the stringencies applied by the research paradigm, this study suggests that relationships exist between neurological disturbance and deficiencies in learning. There are various implications both for neurology and special education. Presumably the needs of this type of handicapped child will be met only when these disciplines combine approaches and provide remediation accordingly.

THE PUPIL RATING SCALE

THE PUPIL RATING SCALE

A primary objective of this research project was to develop techniques that would be useful in identifying children with deficits in learning. Though the emphasis was on neurological, electroencephalographic, ophthalmological and psychological test parameters, it was deemed advisable to obtain teachers' judgments of certain behavioral characteristics which seemed relevant. Accordingly, we evolved a pupil rating scale which focused on aspects of the child's functioning which are difficult to measure directly.

Areas of the Rating Scale

Development of the rating scale was in two steps. A preliminary form was devised on which 500 third and fourth grade children were rated by their teachers. The results from this pilot investigation indicated that the technique was of value. Hence, the scale was redesigned with more attention to definition of categories and each aspect of behavior included. This final form (see Appendix B) constitutes the basis of the data presented below. Five types of behavior were rated: (1) auditory comprehension and listening; (2) spoken language; (3) orientation; (4) behavior; (5) motor ability. A five point rating was employed throughout, with a score of one representing the lowest level of function and a score of five the highest; a score of three was considered average. Composite scores were obtained by category, as well as for individual items within a category. Further description of the five areas to be noted follows:

Auditory Comprehension and Listening: Ability to listen and to comprehend spoken language are directly related to learning, verbally and nonverbally. Yet a standardized measure of such ability is largely unavailable. In the pupil rating scale four aspects of receptive auditory function were included. These covered ability to follow directions, to comprehend class discussions, to retain what is heard, and to comprehend word meaning. Each of these functions was scored and analyzed separately but a total score for the category also was tabulated for statistical purposes.

Spoken Language: Difficulties in using auditory expressive language frequently are mentioned in connection with children who have deficits in learning. In this rating scale our concern was with spoken language only; no ratings were made of speech per se. Five aspects were included: (1) sentence length and structure; (2) vocabulary; (3) ability to recall words for use in expressing ideas; (4) ability to relate experiences in story form; (5) facility in formulating ideas from unrelated facts. These facets of auditory language derive from experience with children who have expressive aphasia. This type of learning disability may be more prevalent than generally assumed. Teacher ratings of this aspect of verbal behavior have proved beneficial when identifying children with deficiencies in learning.

Orientation: Various nonverbal factors have been associated with disturbances of learning. In fact, certain types of deficits, such as poor ability in learning to tell time, seem closely related to dyslexia. In the pupil rating scale four aspects of orientation were covered: (1) time concept; (2) orientation in space; (3) relationships; (4) direction.

Behavior: The area referred to as behavior was rather pervasive, covering eight facets of personal and interpersonal adjustment. These are: (1) cooperation; (2) attention; (3) ability to organize; (4) ability to cope with change and stressful situations; (5) acceptance by others; (6) ability to assume responsibility; (7) ability to complete assignments; (8) degree of tactfulness.

Motor Ability: Motor incoordination often is viewed as a critical indication of organicity if it is associated with disturbances of learning. In this rating scale three types of motor function were included: (1) general coordination; (2) balance; (3) finger-manual dexterity.

Administration

The pupil rating scale was given by the teachers of the third and fourth grade children included in the research project; the total number on whom ratings were obtained was 2176. To assure uniformity, meetings were held with the teachers at which time the scale was discussed in detail. The items were defined and suggestions made to increase the objectivity of the teacher judgments. It is assumed that these instructional meetings with the teachers were highly influential in the successful use of the scale.

Results

As discussed elsewhere, the research sample was comprised of all of the third and fourth graders in four metropolitan school systems. The objective was to ascertain whether teacher ratings could be used in identifying children with learning disabilities. This meant that the rating scale became one of the techniques employed experimentally in an attempt to establish the usefulness of such screening procedures. It was hypothesized that if such a rating scale proved to be reliable it would be an economical means whereby children with deficiencies in learning could be identified. The scale was applied to all of the subjects included in the study, a total of 2176 children. The results for this sample are presented in Table 118. These findings may be viewed as being normative in nature--for third and fourth grade children in regular public schools; this was not a disadvantaged sample. The scores include the five learning areas rated: auditory comprehension; spoken language; orientation; behavior; and motor. For further analysis auditory language (auditory comprehension and spoken language) was isolated from the other three aspects of learning rated. Lastly, a total score was computed per child for the five learning areas.

Teacher Ratings and Screening Test Measures

In addition to the pupil rating scale, a battery of screening

TABLE 118

MEANS, STANDARD DEVIATIONS AND RANGES ON THE PUPIL BEHAVIOR RATING SCALE FOR ALL SUBJECTS (N = 2176)

Learning Area	Mean	SD	Range
Auditory Comprehension	12.75	3.53	4-20
Spoken Language	15.89	3.80	5-25
Orientation	13.35	3.03	4-20
Behavior	26.31	6.09	9-40
Motor	9.57	1.74	3-15
Total Auditory Receptive-Auditory Expressive	28.64	7.10	9-45
Total Orientation, Behavior and Motor	49.22	9.82	19-120
TOTAL SCORE	77.86	16.19	29-120

tests was administered to the entire sample; this was consistent with the objective of exploring various procedures for identification of children with deficits in learning. Accordingly, it was possible to compare the rating scale results with the screening test results; see Table 119. For all of the rating scale areas, this comparison revealed significant differences between those who passed and those who failed the screening tests. In all comparisons the differences favored those who passed.

From these findings it appears that the teacher ratings consistently identified the same children as the screening tests as being deficient in learning. In fact, the agreement is unusual and suggests that the teacher rating technique is a useful screening technique.

The five rating scale areas were comprised of a total of 24 items: auditory comprehension--four; spoken language--five; orientation--four; behavior--eight; motor--three. To investigate the usefulness of each of these, scores per item were compared for those who passed and those who failed the screening tests. These results are presented in Table 120.

Age and Sex Differences

Evaluation of the results also was made on the basis of sex. The findings by sex for the total sample are given in Table 121. The girls were rated higher than the boys on all areas of learning rated; the differences were highly significant statistically. These results are of interest because of their agreement with the findings of various investigators to the effect that females exceed males in many aspects of academic learning. The pupil ratings, likewise, favor the girls. It appears then that the commonly found sex differences were revealed by the teachers' judgments. However, as shown by the data below, sex differences were not influential in the ratings as they pertained to identification of those with learning disabilities. Though sex differences were recognized in the normal, when learning effectiveness per se was rated these differences were not considered consequential.

Analysis by sex was also made on the basis of passed and failed screening (Table 122). Again, the scores are significantly different in all instances and those who passed the screening tests were rated as the most successful learners. The boys who failed, as well as the girls, were rated as showing deficiencies in all of the areas of learning rated.

Further analysis of the rating scale is reported in Table 123. The individual items of the scale were analyzed according to the boys and girls who passed screening and the boys and girls who failed screening. For both passed and failed comparisons, the girls were rated significantly higher than the boys. The only exceptions, where significant differences were not revealed, were ability to retain auditory information, social acceptance, balance, and general coordination. It is clear that girls were rated higher than boys irrespective of whether the subjects passed or failed the screening tests.

TABLE 119

MEANS, STANDARD DEVIATIONS AND t-SCORES ON THE PUPIL BEHAVIOR RATING SCALE FOR THOSE WHO PASSED SCREENING AND THOSE WHO FAILED SCREENING

	Passed (N=1837)		Failed (N=339)		
Learning Area	Mean	SD	Mean	SD	t
Auditory Comprehension	13.24	3.35	10.13	3.33	15.79***
Spoken Language	16.35	3.66	13.39	3.60	13.88***
Orientation	13.68	2.97	11.57	2.73	13.99***
Behavior	26.98	5.95	22.66	5.51	13.09***
Motor	9.68	1.71	8.96	1.80	6.80***
Auditory Comprehension and Spoken Language	29.59	6.77	23.51	6.62	15.48***
Orientation, Behavior and Motor	50.34	9.59	43.19	8.84	13.50***
Total Score	79.92	15.60	66.71	14.68	15.07***

* p less than .05
** p less than .01
*** p less than .001

TABLE 120

MEANS, STANDARD DEVIATIONS AND t-SCORES ON INDIVIDUAL ITEMS OF THE PUPIL BEHAVIOR RATING SCALE FOR THOSE WHO PASSED AND THOSE WHO FAILED THE SCREENING TESTS

	Passed (N=1837)		Failed (N=339)		
Individual Items	Mean	SD	Mean	SD	t
Auditory Comprehension					
Ability to follow oral directions	3.31	.97	2.48	.99	14.46***
Comprehension of class discussion	3.29	.99	2.49	.94	14.39***
Ability to retain auditory information	3.32	.89	2.52	.90	15.41***
Comprehension of word meaning	3.32	.83	2.65	.87	13.40***
Spoken Language					
Complete and accurate expression	3.30	.82	2.74	.79	12.23***
Vocabulary ability	3.26	.78	2.68	.75	13.33***
Ability to recall words	3.27	.79	2.70	.79	12.45***
Ability to relate experience	3.28	.81	2.71	.83	11.63***
Ability to formulate ideas	3.25	.86	2.58	.89	12.88***
Orientation					
Promptness	3.49	.97	2.89	.92	10.95***
Spatial orientation	3.48	.73	3.07	.66	10.30***
Judgment of relationships	3.41	.85	2.84	.83	11.63***
Learning directions	3.30	.84	2.78	.82	10.61***
Behavior					
Cooperation	3.49	1.03	2.96	1.03	8.72***
Attention	3.35	.99	2.65	.98	12.20***
Ability to organize	3.25	1.00	2.50	.93	13.46***
Ability to cope with new situations	3.35	.83	2.82	.78	11.30***
Social acceptance	3.33	.81	2.95	.81	7.92***
Acceptance of responsibility	3.29	.85	2.77	.86	10.20***
Completion of assignments	3.46	.92	2.77	.86	13.27***
Tactfulness	3.47	.82	3.12	.80	7.29***
Motor					
General coordination	3.24	.66	2.99	.73	5.90***
Balance	3.25	.56	3.09	.56	4.82***
Ability to manipulate equipment	3.19	.68	2.89	.75	6.71***

* p less than .05
** p less than .01
*** p less than .001

TABLE 121

MEANS, STANDARD DEVIATIONS AND t-SCORES ON THE PUPIL RATING SCALE FOR TOTAL SAMPLE BY SEX

	Boys (N=1138)		Girls (N=1038)		
Learning Area	Mean	SD	Mean	SD	t
Auditory Comprehension	12.30	3.58	13.25	3.41	-6.35***
Spoken Language	15.34	3.80	16.49	3.72	-7.15***
Orientation	12.96	2.98	13.78	3.03	-6.37***
Behavior	24.82	5.85	27.93	5.92	-12.33***
Motor	9.41	1.83	9.74	1.62	-4.50***
Auditory Comprehension and Spoken Language	27.64	7.12	29.74	6.91	-6.98***
Orientation, Behavior and Motor	47.19	9.54	51.45	9.65	-10.34***
Total Score	74.83	15.81	81.19	15.95	-9.33***

* p less than .05
** p less than .01
*** p less than .001

TABLE 122

MEANS, STANDARD DEVIATIONS AND t-SCORES ON THE PUPIL RATING SCALE BY SEX FOR THOSE WHO PASSED AND THOSE WHO FAILED THE SCREENING TESTS

	Passed Boys (N=921)		Failed Boys (N=217)			Passed Girls (N=916)		Failed Girls (N=122)		
Learning Area	Mean	SD	Mean	SD	t	Mean	SD	Mean	SD	t
Auditory Comprehension	12.91	3.39	9.71	3.16	12.68***	13.56	3.27	10.87	3.52	8.47***
Spoken Language	15.93	3.65	12.81	3.33	11.52***	16.77	3.61	14.40	3.85	6.75***
Orientation	13.37	2.90	11.19	2.63	10.14***	13.98	3.00	12.23	2.80	6.11***
Behavior	25.62	5.76	21.43	4.96	9.89***	28.35	5.82	24.83	5.80	6.27***
Motor	9.57	1.78	8.76	1.93	5.94***	9.80	1.63	9.33	1.49	3.00**
Auditory Comprehension and Spoken Language	28.84	6.79	22.52	6.14	12.56***	30.33	6.66	25.27	7.12	7.82***
Orientation, Behavior and Motor	48.56	9.31	41.38	8.21	10.45***	52.12	9.53	46.39	9.05	6.28***
Total Score	77.41	15.20	63.89	13.53	12.02***	82.46	15.60	71.66	15.41	7.20***

* p less than .05
** p less than .01
*** p less than .001

TABLE 123

MEANS, STANDARD DEVIATIONS AND t-SCORES ON INDIVIDUAL ITEMS OF THE PUPIL RATING SCALE FOR BOYS AND GIRLS WHO PASSED SCREENING AND BOYS AND GIRLS WHO FAILED SCREENING

	Passed Screening					Failed Screening				
	Boys (N=919)		Girls (N=918)			Boys (N=216)		Girls (N=123)		
Individual Items	Mean	SD	Mean	SD	t	Mean	SD	Mean	SD	t
Auditory Comprehension										
Ability to follow oral directions	3.17	.95	3.45	.96	-6.25***	2.35	.94	2.68	1.03	-2.93**
Comprehension of class discussion	3.21	1.03	3.37	.94	-3.53***	2.39	.93	2.67	.94	-2.63**
Ability to retain auditory information	3.27	.90	3.37	.87	-2.46*	2.45	.86	2.64	.95	-1.91
Comprehension of word meaning	3.25	.85	3.39	.80	-3.54***	2.53	.84	2.85	.88	-3.38***
Spoken Language										
Complete and accurate expression	3.18	.81	3.42	.81	-6.29***	2.63	.75	2.94	.83	-3.53***
Vocabulary ability	3.17	.79	3.35	.76	-4.93***	2.57	.74	2.84	.75	-3.14**
Ability to recall words	3.18	.79	3.36	.79	-5.02***	2.58	.77	2.89	.78	-3.47***
Ability to relate experience	3.19	.81	3.37	.80	-4.97***	2.58	.77	2.92	.88	-3.69***
Ability to formulate ideas	3.19	.86	3.30	.85	-2.79**	2.44	.83	2.82	.93	-3.83***
Orientation										
Promptness	3.34	.96	3.64	.96	-6.74***	2.75	.87	3.15	.94	-3.96***
Spatial orientation	3.42	.72	3.54	.75	-3.49***	2.99	.64	3.20	.66	-2.79**
Judgment of relationships	3.35	.84	3.46	.85	-2.86**	2.77	.82	2.96	.82	-2.01*
Learning directions	3.26	.83	3.35	.84	-2.41*	2.68	.80	2.93	.80	-2.73**

TABLE 123 - Continued

	Passed Screening					Failed Screening				
	Boys (N=919)		Girls (N=918)			Boys (N=216)		Girls (N=123)		
Individual Items	Mean	SD	Mean	SD	t	Mean	SD	Mean	SD	t
Behavior										
Cooperation	3.21	1.02	3.77	.95	-12.31***	2.67	.97	3.45	.95	-7.14***
Attention	3.18	.97	3.53	.97	-7.66***	2.47	.90	2.97	1.03	-4.62***
Ability to organize	3.04	.98	3.47	.97	-9.56***	2.32	.85	2.80	.96	-4.73***
Ability to cope with new situations	3.20	.84	3.49	.80	-7.57***	2.63	.76	3.15	.69	-6.26***
Social acceptance	3.27	.84	3.39	.77	-2.99**	2.95	.79	2.94	.83	.16
Acceptance of responsibility	3.13	.84	3.44	.83	-7.82***	2.82	.91	3.03	.87	-2.11*
Completion of assignments	3.29	.91	3.62	.91	-7.77***	2.62	.80	3.02	.88	-4.29***
Tactfulness	3.29	.78	3.65	.82	-9.70***	2.96	.72	3.41	.87	-5.05***
Motor										
General Coordination	3.23	.71	3.26	.61	-1.20	2.91	.77	3.11	.64	-2.37*
Balance	3.24	.57	3.26	.55	-.58	3.06	.60	3.14	.47	-1.32
Ability to manipulate equipment	3.11	.71	3.28	.64	-5.78***	2.79	.81	3.08	.57	-3.55***

* p less than .05
** p less than .01
*** p less than .001

The age range of the sample was from seven through ten years, with most of the subjects falling at the eight or nine year level. In our age analysis we included the seven year olds with the eights and the ten year olds with the nines; see Tables 124 and 125. Except for one comparison (motor function for the eight year old girls) all of the differences were statistically significant. It appears that irrespective of age or sex the teachers were highly consistent in identifying the children who failed the screening tests as being deficient in learning.

Correlation Analysis

To further evaluate the usefulness of the rating scale technique a correlation analysis was made using a random sample of 120. The extent to which the items comprising the scale were intercorrelated was ascertained, as was the degree of correlation of these items with all of the screening test scores; the results are presented in Tables 126, 127, and 128.

When the scale items were intercorrelated (Table 126), the lowest correlation appeared for the motor area; the relationship fell at the level of .53 to .55. In general, with the exception of motor, the inter-area correlations were high, ranging from .79 to .90. We might infer that the motor items were less critical and that the remaining areas (auditory comprehension, spoken language, orientation, and behavior) were equally useful. Or we might conclude that these constitute a global basis on which the teachers relied for making their judgments.

The relationships to intelligence as measured by the screening test battery also were appraised; see Table 127. These correlations were revealing. Of the five areas included on the scale, motor showed the lowest relationship to intelligence; from .06 to .16. Those showing the greatest relationship were auditory language (auditory comprehension and spoken language) and orientation. However, the highest correlation obtained was only .35. From these findings it is apparent that the teacher ratings were not highly influenced by intelligence. This is of considerable interest inasmuch as the scale was designed as a technique for rating effectiveness in learning, not potential for learning. The correlation analysis suggests that this objective, within significant limits, was attained.

Lastly, the relationships to educational achievement were investigated (Table 128). It was assumed that the teacher ratings would be correlated with success in learning academically. This assumption was supported but, perhaps, not at the level anticipated. Again, the lowest correlations were with the area of motor function; ranging from .06 to .24. The highest relationship was between auditory comprehension and spelling (we have often postulated that spelling required a high degree of ability to auditorize). The educational areas with which the highest levels of correlation were found are reading, spelling, and arithmetic; a lower level of association appeared for word knowledge and word discrimination.

TABLE 124

MEANS, STANDARD DEVIATIONS AND t-SCORES ON THE PUPIL BEHAVIOR RATING SCALE FOR EIGHT YEAR OLD BOYS AND GIRLS (OR YOUNGER) WHO PASSED AND FAILED THE SCREENING TESTS

	Passed Boys (N=446)		Failed Boys (N=96)			Passed Girls (N=478)		Failed Girls (N=54)		
Learning Area	Mean	SD	Mean	SD	t	Mean	SD	Mean	SD	t
Auditory Comprehension	12.92	3.37	9.70	2.83	8.72***	13.78	3.27	11.00	3.48	5.88***
Spoken Language	16.02	3.62	12.69	3.07	8.38***	16.99	3.76	14.89	4.00	3.87***
Orientation	13.34	2.93	10.98	2.30	7.43***	14.02	3.04	12.31	2.77	3.94***
Behavior	25.48	5.44	21.42	4.62	6.80***	28.51	5.78	25.15	5.72	4.06***
Motor	9.50	1.80	8.80	1.80	3.43***	9.73	1.65	9.56	1.50	.75
Auditory Comprehension and Spoken Language	28.94	6.76	22.39	5.54	8.88***	30.77	6.79	25.89	7.27	4.97***
Orientation, Behavior and Motor	48.31	9.13	41.20	7.60	7.12***	52.27	9.60	47.02	8.83	3.84***
Total Score	77.25	15.08	63.58	12.11	8.32***	83.03	15.76	72.91	15.23	4.49***

* p less than .05
** p less than .01
*** p less than .001

TABLE 125

MEANS, STANDARD DEVIATIONS AND t-SCORES ON THE PUPIL BEHAVIOR RATING SCALE FOR NINE YEAR OLD BOYS AND GIRLS (OR OLDER) WHO PASSED AND FAILED THE SCREENING TESTS

	Passed Boys (N=475)		Failed Boys (N=121)			Passed Girls (N=438)		Failed Girls (N=68)		
Learning Area	Mean	SD	Mean	SD	t	Mean	SD	Mean	SD	t
Auditory Comprehension	12.90	3.41	9.71	3.42	9.18***	13.33	3.26	10.76	3.57	5.96***
Spoken Language	15.86	3.68	12.91	3.54	7.93***	16.53	3.44	14.01	3.70	5.55***
Orientation	13.41	2.88	11.36	2.86	6.97***	13.94	2.96	12.16	2.84	4.63***
Behavior	25.76	6.04	21.44	5.23	7.21***	28.16	5.86	24.57	5.90	4.70***
Motor	9.63	1.75	8.72	2.03	4.93***	9.87	1.61	9.15	1.47	3.46***
Auditory Comprehension and Spoken Language	28.76	6.83	22.62	6.61	8.88***	29.86	6.50	24.78	7.01	5.94***
Orientation, Behavior and Motor	48.80	9.48	41.52	8.70	7.66***	51.97	9.47	45.88	9.26	4.95***
Total Score	77.55	15.33	64.14	14.60	8.68***	81.83	15.41	70.66	15.59	5.55***

* p less than .05
** p less than .01
*** p less than .001

TABLE 126

INTERCORRELATION OF PUPIL RATING SCALE AREAS

	Auditory Comprehension	Spoken Language	Orientation	Behavior	Motor	Auditory Language Total	Orientation, Behavior, and Motor	Total
Auditory Comprehension		.90	.86	.82	.54	.97	.87	.94
Spoken Language			.82	.79	.53	.98	.83	.92
Orientation				.83	.55	.86	.92	.93
Behavior					.55	.83	.97	.94
Motor						.55	.68	.64
Auditory Language Total							.87	.96
Orientation, Behavior, and Motor								.98
Total								

TABLE 127

CORRELATION OF PUPIL RATING SCALE AREAS WITH INTELLIGENCE

	Verbal IQ	Perceptual IQ	Spatial IQ	Non-Verbal IQ
Auditory Comprehension	.35	.33	.28	.21
Spoken Language	.30	.27	.26	.19
Orientation	.30	.33	.21	.18
Behavior	.21	.24	.18	.15
Motor	.10	.06	.16	.10
Auditory Language Total	.33	.31	.28	.20
Orientation, Behavior, and Motor	.23	.26	.21	.17
Total	.28	.29	.25	.19

TABLE 128

CORRELATION OF PUPIL RATING SCALE AREAS
WITH EDUCATIONAL ACHIEVEMENT

	Word Knowledge GA*	Word Disc GA*	Reading GA	Spelling GA	Arithmetic GA
Auditory Comprehension	.15	.17	.50	.53	.45
Spoken Language	.19	.18	.51	.48	.42
Orientation	.11	.14	.38	.41	.30
Behavior	.11	.10	.33	.39	.32
Motor	.06	.09	.16	.24	.17
Auditory Language Total	.17	.18	.52	.52	.45
Orientation, Behavior, and Motor	.11	.12	.35	.41	.32
Total	.14	.16	.43	.47	.39

* Only 40 members of the 120 sample had this test.

The correlation analysis was revealing in several respects. The scale was shown to have a degree of internal consistency. Moreover, the scale scores seemed not to be highly weighted with differences in intelligence, and a relationship to academic verbal and nonverbal learning was manifested. This analysis, like those reported elsewhere, suggests that the scale can be used in the identification of children with deficits in learning.

Pupil Rating Scale Results for Intensive Study Groups

The research paradigm required that all of the subjects who failed the screening test battery be studied intensively and compared with a normal control group. The intensive follow-up evaluations included psychoeducational studies and certain types of medical examinations. Whenever possible the Pupil Rating Scale scores were analyzed in terms of the results and sample sub-grouping which derived from these follow-up studies.

Table 129 shows the mean and significance test data from comparisons among the various sample groups. Ten comparisons could be made and all but two resulted in significant differences; the false control and borderline groups were not different, nor were the false controls and false experimentals. The pattern was the same as that found for the screening test groups. Those found to be learning normally exceeded those classified as borderline or learning disability, and the borderline were rated superior to those categorized as learning disability.

From these findings we may conclude that, as in the case of the screening tests, the teacher ratings were in remarkable agreement with the objective psychoeducational test scores. The teacher rating scores differentiated among the sub-sample populations to an unusual degree.

The Borderline Group

Our research design resulted in two experimental groups, each having a normal comparison group. One of these, the borderline, included children who failed the screening test criteria but who on intensive evaluation were found to have only a slight deficiency in learning: learning quotients of 85 to 89 inclusive.

The scores for the five learning areas rated for the borderline and a normal control group are presented in Table 130. The normal children were rated higher than those classified as borderline in all instances and the differences were highly significant statistically. Even though by objective test criteria the borderline group was only slightly deficient in learning the teachers correctly identified them as inferior to the normal, average child.

Item Analysis

A comparison also was made for the 24 individual items that comprised the scale. These data are shown in Table 131. Except for the motor scale, all of the items differentiated between the groups at a high level of statistical significance; the motor items attained only the

TABLE 129

DIFFERENCES BETWEEN INTENSIVE STUDY GROUPS
ON THE PUPIL RATING SCALE TOTAL

Groups	N	Mean	SD	t
Learning Disability vs. True Control	77 156	59.81 82.18	11.27 15.82	-12.43***
Learning Disability vs. False Control	77 11	59.81 67.91	11.27 11.10	-2.26*
Learning Disability vs. Borderline	77 90	59.81 66.80	11.27 11.85	-3.91***
Learning Disability vs. False Experimental	77 54	59.81 72.44	11.27 16.97	-4.78***
True Control vs. False Control	156 11	82.18 67.91	15.82 11.10	3.99***
True Control vs. Borderline	156 90	82.18 66.80	15.82 11.85	3.93***
True Control vs. False Experimental	156 54	82.18 72.44	15.82 16.97	3.70***
False Control vs. Borderline	11 90	67.91 66.80	11.10 11.85	.31
False Control vs. False Experimental	11 54	67.91 72.44	11.10 16.97	-1.11
Borderline vs. False Experimental	90 54	66.80 72.44	11.85 16.97	-2.15*

* p less than .05
** p less than .01
*** p less than .001

TABLE 130

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR THE BORDERLINE GROUP AND THE NORMAL CONTROLS ON THE PUPIL RATING SCALE (N=90)

Learning Area	Borderline		Control		
	Mean	SD	Mean	SD	t
Auditory Comprehension	10.43	2.93	14.12	3.26	-7.98***
Spoken Language	13.72	3.11	17.23	4.03	-6.54***
Orientation	11.91	2.32	14.40	3.13	-6.07***
Behavior	22.92	4.73	28.33	6.25	-6.55***
Motor	9.08	1.57	9.83	2.10	-2.74**
Auditory Comprehension and Spoken Language	24.16	5.71	31.36	6.99	-7.57***
Orientation, Behavior and Motor	43.91	6.97	52.57	10.27	-6.62
Total Score	68.07	11.82	83.92	16.31	-7.47

* p less than .05
** p less than .01
*** p less than .001

TABLE 131

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR THE BORDERLINE GROUP AND THE NORMAL CONTROLS ON INDIVIDUAL ITEMS OF THE PUPIL RATING SCALE (N=90)

	Borderline		Control		
Individual Items	Mean	SD	Mean	SD	t
Auditory Comprehension					
Ability to follow oral directions	2.59	.87	3.44	1.01	-6.09***
Comprehension of class discussion	2.49	.85	3.50	.97	-7.41***
Ability to retain auditory information	2.62	.73	3.59	.83	-8.29***
Comprehension of word meaning	2.72	.79	3.53	.85	-6.61***
Spoken Language					
Complete and accurate expression	2.86	.73	3.50	.88	-5.36***
Vocabulary ability	2.74	.66	3.38	.88	-5.45***
Ability to recall words	2.73	.70	3.43	.86	-5.98***
Ability to relate experience	2.74	.71	3.43	.84	-5.95***
Ability to formulate ideas	2.64	.72	3.41	.95	-6.10***
Orientation					
Promptness	2.86	.89	3.63	.97	-5.61***
Spatial orientation	3.15	.56	3.73	.80	-5.59***
Judgment of relationships	3.01	.66	3.56	.90	-4.62***
Learning directions	2.87	.71	3.46	.89	-4.92***

TABLE 131 - Continued

Individual Items	Borderline Mean	Borderline SD	Control Mean	Control SD	t
Behavior					
Cooperation	3.03	.92	3.67	1.03	-4.36***
Attention	2.63	.89	3.58	.99	-6.71***
Ability to organize	2.54	.88	3.36	1.12	-5.43***
Ability to cope with new situations	2.83	.72	3.56	.86	-6.09***
Social acceptance	3.02	.69	3.39	.88	-3.11**
Acceptance of responsibility	2.87	.77	3.43	.82	-4.78***
Completion of assignments	2.80	.77	3.63	.93	-6.56***
Tactfulness	3.10	.81	3.71	.90	-4.79***
Motor					
General coordination	3.09	.62	3.32	.78	-2.22*
Balance	3.14	.50	3.32	.73	-1.99*
Ability to manipulate equipment	2.96	.69	3.18	.77	-2.04*

* p less than .05
** p less than .01
*** p less than .001

level of .05. It is noteworthy that the scores by item favored the normal learning group in every instance. As shown below, there was a sex difference in the motor score, with the learning disability females being equal to the normal but the males with deficits in learning being inferior to normal males. Inasmuch as sex differences in motor function are common it is not unusual that the teacher ratings on this area are not as clearly differentiating as are those for the other aspects of behavior.

Grade and Sex Differences

The pupil ratings for the borderline group also were analyzed by grade and by sex. As shown in Table 132, differences by grade appeared for the normal but not for the borderline group. Normal fourth graders were rated superior to normal third graders on four out of the five learning areas; there was no difference on auditory comprehension. In contrast, no differences were revealed between the third and fourth grade borderline children, and both grades obtained scores below those found for the normal third grade group. It is clear that the teachers differentiated between those with and without deficits in learning irrespective of grade placement.

The entire study using the pupil rating scale revealed consistent sex differences. The same pattern prevailed for this analysis; see Table 133. The girls classified as borderline were superior to the boys in this group on the learning areas designated as behavior and as motor. It is of interest that normal girls exceeded the boys on the area of behavior. Hence the results showing girls to be superior to a degree are consistent for both groups, borderline and normal; all of the significant differences favor the females.

From these data for the borderline sample we find that the Pupil Rating Scale was used effectively in differentiating children with slight deficits in learning from those who showed no deficits.

Discriminant Analysis

One of the statistical procedures used to ascertain the value of our techniques in differentiating the children with learning deficits from the normal was the discriminant analysis. Because the rating scale was one of the techniques used experimentally it was included in this analysis. The variables which discriminated between the borderline and normal comparison groups are shown in Table 134. Not only did the rating scale significantly distinguish between these groups, but it fell at the highest level statistically in comparison with 49 other variables. From these data we can conclude that, while certain objective tests were useful in differentiating these populations, none proved to be more useful than the rating scale.

The Learning Disability Group

The learning disability sample was analyzed in the same manner. The comparisons by learning area are found in Table 135. Again, the

TABLE 132

MEANS, STANDARD DEVIATIONS AND t-SCORES ON THE PUPIL RATING SCALE FOR THE BORDERLINE GROUP AND THE NORMAL CONTROLS BY GRADE (N=90)

Learning Area	Borderline 3rd Graders (N=47) Mean	SD	Borderline 4th Graders (N=43) Mean	SD	t	Control 3rd Graders (N=47) Mean	SD	Control 4th Graders (N=43) Mean	SD	t
Auditory Comprehension	10.19	2.38	10.70	3.44	-.82	13.60	3.29	14.70	3.17	-1.61
Spoken Language	13.47	2.96	14.00	3.29	-.81	16.43	4.05	18.12	3.87	-2.02*
Orientation	11.81	1.71	12.02	2.86	-.44	13.53	2.84	15.35	3.18	-2.86**
Behavior	22.26	3.81	23.65	5.52	-1.41	26.70	5.61	30.12	6.49	-2.68**
Motor	9.13	1.65	9.02	1.49	.31	9.36	2.13	10.35	1.96	-2.28*
Auditory Comprehension and spoken language	23.66	4.97	24.70	6.43	-.86	30.02	7.01	32.81	6.75	-1.92
Orientation, Behavior and Motor	43.19	5.25	44.70	8.46	-1.02	49.60	9.53	55.81	10.16	-3.00**
Total Score	66.85	8.89	69.40	14.35	-1.02	76.62	15.49	88.63	16.04	-2.71**

* p less than .05
** p less than .01
*** p less than .001

TABLE 133

MEANS, STANDARD DEVIATIONS AND t-SCORES ON THE PUPIL RATING SCALE FOR BORDERLINE AND NORMAL CONTROL BOYS AND GIRLS (N=90)

	Borderline					Control				
	Boys (N=61)		Girls (N=29)			Boys (N=61)		Girls (N=29)		
Learning Area	Mean	SD	Mean	SD	t	Mean	SD	Mean	SD	t
Auditory Comprehension	10.21	2.77	10.90	3.24	1.03	13.74	3.22	14.93	3.25	1.64
Spoken Language	13.33	2.88	14.55	3.46	1.76	16.72	4.02	18.31	3.91	1.77
Orientation	11.62	2.26	12.52	2.37	1.73	14.10	3.02	15.03	3.30	1.33
Behavior	21.90	3.73	25.07	5.85	3.11**	27.21	5.87	30.69	6.46	2.54*
Motor	8.72	1.45	9.83	1.56	3.30**	9.79	2.18	9.93	1.94	.30
Auditory Comprehension and Spoken Language	23.54	5.25	25.45	6.47	1.49	30.46	6.93	33.24	6.86	1.79
Orientation, Behavior and Motor	42.25	5.74	47.41	8.06	3.49***	51.10	9.88	55.66	10.56	2.00*
Total Score	65.79	9.90	72.86	14.10	2.75**	81.56	15.64	88.90	16.83	2.03*

* p less than .05
** p less than .01
*** p less than .001

TABLE 134

DISCRIMINANT ANALYSIS OF THE FORTY-NINE VARIABLES
OF THE PSYCHOEDUCATIONAL BATTERY PLUS THE PUPIL RATING SCALE
FOR THE BORDERLINE GROUP AND THEIR NORMAL CONTROLS (N=90)

Variables significant at .01	F
Pupil Behavior Rating Scale Total	55.78
Gates-McKillop Syllabication	40.06
Metropolitan Language	28.36
WISC Comprehension	22.54
WISC Arithmetic	18.85
Gates-Russell Oral Words	16.70
Draw-A-Man	14.80
Gates-MacGinitie Comprehension	13.37
Gates-MacGinitie Accuracy	12.57
Vineland	11.61
Gates-McKillop Nonsense Words	10.82
Detroit Free Association	10.13
Detroit Letters	9.55
Healy I	9.03
WISC Block Design	8.62
Detroit Words	8.22
Metropolitan Arithmetic	7.83
PMA Arithmetic	7.47
WISC Object Assembly	7.16
Kent D	6.87
Mean Verbal M.A.	6.62
Oral PSLT Words Per Sentence	6.39
Oral PSLT Abstract-Concrete	6.17
PSLT Syntax	5.94
Gates-McKillop Word Parts	5.74
Gates-Russell 2 Syllables	5.54
Leiter	5.36
WISC Similarities	5.19
WISC Picture Completion	5.03

TABLE 134 - Continued

Variables significant at .01	F
PSLT Total Words	4.86
Detroit Orientation	4.70
Detroit Oral Directions	4.55
Metropolitan Spelling	4.41
WISC Coding	4.27
Gates-MacGinitie Vocabulary	4.14
PSLT Words Per Sentence	4.01
WISC Picture Arrangement	3.89
WISC Vocabulary	3.76
Detroit Designs	3.64
Heath Rails	3.53
Detroit Verbal Opposites	3.42
PSLT Abstract-Concrete	3.32
PSLT Total Sentences	3.22
Mean Performance M.A.	3.13
(Mean Verbal M.A. Removed)	3.23
WISC Mazes	3.21
WISC Information	3.12
Detroit Sentences	3.03
Wide Range Oral Reading	2.94

Not significant at .01: WISC Digit Span
Gates-Russell 1 Syllable

TABLE 135

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR THE LEARNING DISABILITY GROUP AND THE NORMAL CONTROLS ON THE PUPIL RATING SCALE (N=88)

Learning Area	Learning Disability Mean	SD	Control Mean	SD	t
Auditory Comprehension	8.92	2.60	13.77	3.31	-10.81***
Spoken Language	12.15	3.03	16.65	3.80	-8.68***
Orientation	10.45	2.38	14.05	3.02	-8.77***
Behavior	20.84	4.12	27.15	5.99	-8.14***
Motor	8.45	1.79	9.56	1.79	-4.08***
Auditory Comprehension and Spoken Language	21.07	5.28	30.42	6.83	-10.17***
Orientation, Behavior, and Motor	39.75	7.07	50.75	9.71	-8.59***
Total Score	60.82	11.63	81.17	15.63	-9.80***

* p less than .05
** p less than .01
*** p less than .001

differences between the learning disability group and their controls are significant at the .001 level for all of the five areas rated.

These findings clearly indicate that the teachers rated those with learning disabilities below the normal. Thereby the results are consistent with those for the borderline group. The teachers' observations and judgments were in agreement with the psychoeducational classifications.

Item Analysis

The usefulness of each item also was investigated. These data are presented in Table 136. When individual items were considered, the controls were rated significantly higher, at the .001 level, on 23 of the items. For only one of the 24 items--balance--did the level of significance drop to .01. It is unusual for all of the items on a scale to be useful in differentiating between groups. Albeit, this is the case of the items on the Pupil Rating Scale; this was true for both experimental samples, borderline and learning disability. Accordingly, it appears that the Scale as used is highly effective in identifying children with deficiencies in learning.

Grade and Sex Differences

In contrast to the findings for the borderline group, no difference appeared when the learning disability sample was compared by grade with the normals (Table 137). The third and fourth grade subjects with deficits in learning were not different one from the other, nor were the third and fourth grade normal children. These results are consistent for the learning disability and borderline samples. However, the fourth grade normals were rated higher than the third grade normals in the comparisons made for the borderline control sample, while for learning disability controls no differences appear. The normal comparison group used for the borderline study was rated slightly higher than the one used for the learning disability population, and this may explain the variation of these findings.

Sex differences also were investigated; see Table 138. The only significant difference for the control group was on the area designated as behavior. Consistent with the results for the borderline control group, females were rated higher than the males. In general, comparison by sex showed that the teachers were not evaluating or judging the processes or functions mainly on the basis of sex. Rather they were rating behavioral characteristics irrespective of sex and indicating that these features were of significance in identifying children with deficits in learning.

Discriminant Analysis

Discriminant analysis, using the 49 psychoeducational variables and the rating scale, showed the rating scale to be very successful in distinguishing the learning disability group from their normal controls. The variables which distinguished between the groups are presented in

TABLE 136

MEANS, STANDARD DEVIATIONS AND t-SCORES FOR THE LEARNING DISABILITY GROUP AND THE NORMAL CONTROLS ON INDIVIDUAL ITEMS OF THE PUPIL RATING SCALE (N=88)

Individual Items	Learning Disability Mean	Learning Disability SD	Control Mean	Control SD	t
Auditory Comprehension					
Ability to follow oral directions	2.14	.76	3.32	.97	-9.02***
Comprehension of class discussion	2.27	.77	3.48	1.01	-8.93***
Ability to retain auditory information	2.23	.78	3.56	.84	-10.84***
Comprehension of word meaning	2.36	.76	3.44	.86	-8.84***
Spoken Language					
Complete and accurate expression	2.50	.66	3.34	.84	-7.37***
Vocabulary ability	2.46	.69	3.27	.85	-6.98***
Ability to recall words	2.47	.77	3.31	.84	-6.93***
Ability to relate experience	2.47	.77	3.33	.81	-7.23***
Ability to formulate ideas	2.33	.81	3.35	.91	-7.86***
Orientation					
Promptness	2.60	.72	3.50	.94	-7.14***
Spatial orientation	2.91	.66	3.58	.75	-6.30***
Judgment of relationships	2.48	.80	3.57	.91	-8.45***
Learning directions	2.52	.82	3.43	.88	-7.10***
Behavior					
Cooperation	2.71	.86	3.55	.93	-6.22***
Attention	2.49	.86	3.46	.91	-7.25***
Ability to organize	2.18	.77	3.19	1.05	-7.30***
Ability to cope with new situations	2.60	.69	3.40	.82	-6.95***
Social acceptance	2.76	.79	3.35	.94	-4.53***
Acceptance of responsibility	2.73	.84	3.35	.85	-4.92***
Completion of assignments	2.56	.81	3.51	.90	-7.39***
Tactfulness	2.96	.66	3.53	.80	-5.24***
Motor					
General coordination	2.85	.78	3.25	.75	-3.45***
Balance	2.97	.54	3.25	.65	-3.17**
Ability to manipulate equipment	2.64	.76	3.14	.71	-4.50***

* p less than .05
** p less than .01
*** p less than .001

TABLE 137

MEANS, STANDARD DEVIATIONS AND t-SCORES ON THE PUPIL RATING SCALE FOR THE LEARNING DISABILITY GROUP AND THE NORMAL CONTROLS BY GRADE (N=88)

	Learning Disability					Control				
	3rd Graders (N=47)		4th Graders (N=41)			3rd Graders (N=47)		4th Graders (N=41)		
Learning Area	Mean	SD	Mean	SD	t	Mean	SD	Mean	SD	t
Auditory Comprehension	9.00	2.69	8.83	2.52	.31	13.38	3.31	14.27	3.23	-1.26
Spoken Language	12.19	2.97	12.10	3.14	.14	16.17	3.75	17.10	3.97	-1.13
Orientation	10.34	2.20	10.59	2.59	-.48	13.60	2.78	14.63	3.13	-1.65
Behavior	20.68	4.25	21.02	4.02	-.39	26.26	5.30	28.59	5.95	-1.94
Motor	8.40	1.78	8.51	1.83	-.28	9.40	1.96	9.90	1.76	-1.25
Auditory Comprehension and Spoken Language	21.19	5.31	20.93	5.30	.23	29.55	6.69	31.37	7.00	-1.24
Orientation, Behavior and Motor	39.43	7.19	40.12	6.99	-.46	49.26	9.10	53.12	9.36	-1.96
Total Score	60.62	11.51	61.05	11.90	-.17	78.81	14.64	84.49	15.60	-1.76

* p less than .05

TABLE 138

MEANS, STANDARD DEVIATIONS AND t-SCORES ON THE PUPIL RATING SCALE FOR LEARNING DISABILITY AND NORMAL CONTROL GIRLS AND BOYS (N=88)

	Learning Disability					Control				
	Boys (N=70)		Girls (N=18)			Boys (N=70)		Girls (N=18)		
Learning Area	Mean	SD	Mean	SD	t	Mean	SD	Mean	SD	t
Auditory Comprehension	9.00	2.70	8.61	2.20	-.56	13.46	3.24	15.11	3.22	1.93
Spoken Language	12.06	3.13	12.50	2.68	.55	16.26	3.93	17.94	3.32	1.67
Orientation	10.26	2.45	11.22	1.93	1.55	13.79	2.86	15.22	3.21	1.85
Behavior	20.66	4.41	21.56	2.68	.82	26.56	5.45	30.39	5.77	2.63*
Motor	8.39	1.97	8.72	.83	.71	9.44	1.85	10.39	1.79	1.94
Auditory Comprehension and Spoken Language	21.06	5.50	21.11	4.47	.04	29.71	6.86	33.06	6.34	1.87
Orientation, Behavior and Motor	39.30	7.60	41.50	4.13	1.18	49.79	8.89	56.00	9.80	2.59*
Total Score	60.36	12.37	62.61	8.17	.73	79.50	14.66	89.06	15.66	2.43*

* p less than .05
** p less than .01
*** p less than .001

Table 139. In this analysis the rating scale technique was second in order of statistical significance.

Interpretation of the discriminant analysis data can be made with forthrightness. Of the 50 variables included in the analysis, the rating scale is one of the most discriminating for both learning disability and borderline comparisons. Applied as it was in this investigation, it is a highly useful technique.

Summary

The pupil rating scale was developed experimentally and used in conjunction with a number of other techniques in an attempt to evolve procedures for identification of children with learning disabilities. The results clearly indicate that the teacher ratings obtained on the basis of this scale are of critical usefulness. The rating scale scores successfully discriminated between children with learning disabilities and normals in all of the comparisons utilized. Moreoever, it was demonstrated that these determinations were not contaminated by factors of sex or grade. As a technique, the pupil rating scale was one of the most reliable procedures to come out of this investigation.

TABLE 139

DISCRIMINANT ANALYSIS OF THE FORTY-NINE VARIABLES
OF THE PSYCHOEDUCATIONAL BATTERY PLUS THE PUPIL RATING SCALE
FOR THE LEARNING DISABILITY GROUP AND THEIR NORMAL CONTROLS (N=88)

Variables significant at .01	F
Gates-McKillop Syllabication	111.53
Pupil Behavior Rating Scale Total	78.85
Leiter	59.50
Gates-McKillop Nonsense Words	47.58
Mean Verbal M.A.	39.83
Gates-MacGinitie Comprehension	35.85
Oral PSLT Abstract-Concrete	31.70
Detroit Sentences	28.81
WISC Coding	26.37
Healy I	24.47
WISC Object Assembly	23.00
PMA Arithmetic	21.77
Gates-Russell 1 Syllable	20.62
Gates-McKillop Word Parts	19.81
Heath Rails	18.82
PSLT Total Words	17.80
Gates-Russell Oral Words	16.92
PSLT Total Sentences	16.04
Detroit Verbal Opposites	15.25
Mean Performance M.A.	14.56
Gates-MacGinitie Accuracy	13.93
Metropolitan Arithmetic	13.33
WISC Vocabulary	12.78
Oral PSLT Words Per Sentence	12.27
Gates-Russell 2 Syllables	11.82
WISC Similarities	11.37
WISC Comprehension	10.98
Detroit Oral Directions	10.57

TABLE 139- Continued

Variables significant at .01	F
Draw-A-Man	10.18
Gates-MacGinitie Vocabulary	9.81
WISC Picture Completion	9.47
Detroit Letters	9.13
Detroit Free Association	8.82
Metropolitan Spelling	8.52
PSLT Syntax	8.24
WISC Information	7.97
WISC Picture Arrangement	7.71
PSLT Abstract-Concrete	7.46
WISC Arithmetic	7.22
PSLT Words Per Sentence	7.00
Vineland	6.78
Detroit Orientation	6.57
Kent D	6.37
WISC Digit Span	6.18
Detroit Words	6.00
WISC Block Design	5.83
WISC Mazes	5.67

Not significant at .01: Wide Range Oral Reading
Metropolitan Language
Detroit Designs

APPENDICES

APPENDIX A

PARENT INFORMATION LETTERS

NORTHWESTERN UNIVERSITY

EVANSTON, ILLINOIS 60201

INSTITUTE FOR LANGUAGE DISORDERS

Learning Disabilities Center

Dear Parents:

We have always been able to take pride in the State of Illinois programs of special education. These programs have developed largely because of the interest and cooperation of parents and teachers. Illinois continues to lead the nation in many of these programs and facilities for the exceptional child.

The past several years has seen the growth of interest in the child handicapped in learning. These children have been described as having the basic potential for learning but are unable to achieve that potential in the classroom. The identification and diagnosis of these underachievers has been costly and difficult in the past. The need is to develop simplified yet valid criteria for diagnosis if this problem is to be alleviated. Toward this end the Institute for Language Disorders, Northwestern University, in collaboration with the Neurological and Sensory Diseases program of the United States Public Health Services is presently directing a research study of elementary school children. We are very pleased that your school has accepted the invitation to participate in this important research project.

The study will involve public school children in the third and fourth grades and will have two basic phases. The first concerns screening the children using group tests similar to the ones routinely used in your school. The time required for this screening battery is approximately three hours and we plan to visit each third and fourth grade class for three one-hour sessions on three consecutive days. The testing is scheduled for the weeks of October 25 through November 17, 1965.

The second phase of the study involves 200 children; those who, on the basis of the screening battery, seem to be underachieving, and an equally large group of normal children chosen at random. Both groups will come to Northwestern University for further testing. This will involve a full day of psychometric and educational tests and an opthalmological examination to be done at the Learning Disabilities Center on the Evanston campus. In addition, complete neurological and electroencephalographic examinations will be required; these will be performed at the Northwestern University Medical School in Chicago. There will be no fee for these tests and examinations. There are <u>no</u> shots to be given and the examinations are not painful.

A full report of our findings and recommendations for the children who have participated in the study will be made available to school personnel.

Also a parent conference will be arranged with the staff at the Learning Disabilities Center to discuss the test results. Your school principal will inform you early in December if your child has been selected for the second phase of the study.

We are looking forward to working with you and your children. Our staff is abailable to answer any questions you might have nor or in the future.

Learning Disabilities Center
Northwestern University
Evanston, Illinois

NORTHWESTERN UNIVERSITY

EVANSTON, ILLINOIS 60201

INSTITUTE FOR LANGUAGE DISORDERS

Learning Disabilities Center

Dear________________________:

As you know,______________________ has been chosen to participate in our study of third and fourth grade children. We have arranged an appointment for _______ at the Learning Disabilities Center on

Day:_______________ Date:______________________ Time:______

We will be working with_____________ all day, discussing the test results with you late in the afternoon.

The remaining two appointments, for the ophthalmological examination at the Learning Disabilities Center and for the neurological and EEG examinations at the Medical School in Chicago will be scheduled after this first appointment.

Enclosed you will find a map showing the location of the Speech Building on the Evanston campus of Northwestern University, directions for driving to the campus, and a parking sticker, to be attached to your car, according to the instructions on the back.

Will you please indicate on the enclosed card whether or not you can accept this appointment and return it to us immediately?

Should you have any question prior to your appointment, please call us at 492-7172.

Thank you for your cooperation with us in this study.

Yours sincerely,

____
Research Study on Learning Disabilities

LEARNING DISABILITIES CENTER
Information for Parents

We are beginning the second phase of the Learning Disabilities Study. The first phase of the study was completed successfully and we now have selected certain children to go on with the intensive testing program. We appreciate your interest and cooperation and feel that you and your child will benefit from the experience that the study provides.

You are probably most concerned over how to explain to your child what is going to happen. We hope to answer possible questions in this letter to you, but should others occur fell free to call a member of the research staff (492-7170).

Be honest with your child over aspects of this testing. The intensive testing at Northwestern will be similar to his school work and should give him no concern. If he wonders why he is going and other children are not, tell him that a few children were selected in order to help us at Northwestern understand how children learn.

Enclosed with this letter is an appointment date with a parking sticker and a map of the campus. The Learning Disabilities Center is located on the third floor of the Speech Building (Room 300) and your appointment will be at nine o'clock in the morning. If your child wears glasses, be sure to bring them with him for the testing. (Medication?)

The day at Northwestern will run approximately as follows:

(1) Your child will be working with a member of our staff from nine until noon. At twelve o'clock you are expected to meet him again, take him to lunch, and return him to the Center by one o'clock.

(2) _______________, you will be interviewed as regards your child and his development, medical, and school history. (A baby book will be helpful.) This interview will take approximately one hour. Fathers are welcome and will probably want to attend the afternoon conference, but it is not necessary for them to attend_________________.

(3) The afternoon session will not be completed before 4 P.M. We would like to begin our summary conference with both parents at that time. The group tests and the individual tests will be discussed with you in detail.

At the conclusion of the summary conference with both parents, we will arrange the schedule for the medical examination at the Medical School on the Chicago campus. Pertinent information for the neurological examination and the EEG examination will be given at that time.

As you can see, the testing is extensive and complete. We expect to have extremely helpful information on the relationship of learning, achievement, and the medical status of your child by the end of this study.

We thank you for your cooperation and we look forward to working with you and your child.

PARENT INFORMATION SHEET
NEUROLOGICAL AND EEG EXAMINATIONS

Your appointment at the Medical School on the Chicago campus is at ___________, on ______________________________. Enclosed is directions to help you locate the neurology department. May we ask you to make every arrangement to be on time for your appointment. You will report to The New Research Building, 303 East Chicago Avenue, Chicago, Illinois (Superior Street entrance across the street from the Passavant Hospital - use the entrance which has pillars in front of it). Go to the 11th floor and a receptionist will direct you to the correct office.

The neurological examination will precede the EEG appointment. The entire procedure will take approximately three hours.

Again, assure your child that there will be no shots, no pain, and no discomfort associated with the neurological and electroencephalographical testing.

In preparation for the appointment, please do not let your child have coffee, tea, or cola that morning. He may have milk, fruit, juice, or cocoa with his usual breakfast and lunch. Dress him comfortably in school clothes. Also, the child should have about two hours less sleep than usual, so it would be wise to keep him up later at night and to get him up earlier in the morning. If your child has been taking daily medication this should not be stopped on the day of the examination.

The EEG is a 1½ to 2 hour painless test and has no sensation. A gooey paste-like substance will be put on your child's scalp in order to attach the electrodes. It will probably be necessary to wash this out of his hair when you return home.

Again, we thank you for your cooperation.

OPHTHALMOLOGICAL EXAMINATION

Your appointment for the ophthalmological examination is on Thursday _______________ at_______. This session will not take more than one hour and will take place again in Room 300 of the Speech Building. Enclosed is a parking sticker. Be sure to attach it to your car before you leave the parking lot.

Please assure your child that there will be no pain or discomfort associated with the examination. Many children have had precautionary eye evaluations and this one will not vary greatly from those given in other situations.

The ophthalmologist will discuss the results of the testing with you and any information you desire to be sent on to a family physician will be forwarded.

If your child wears or has glasses, be sure to bring them with you.

Your child may return to school immediately following the examination.

APPENDIX B

PSYCHOEDUCATIONAL SUMMARY SHEETS

AND PUPIL RATING SCALE

Checked____Coded____Checked____ Case #________

RESEARCH STUDY OF LEARNING DISABILITIES

SUMMARY SHEET: SCREENING BATTERY

Name______________________Birthdate________Exam Date______

Father's Name________Address________________Phone No.______

School________________________Teacher________________

Sex M___F___CA__________________Grade 3____4____

Group 1____2____3____4____

PRIMARY MENTAL ABILITIES

Verbal Raw Score____IQ____MA____ CA_______

Nonverbal Higher MA_______(V,NV)

Spa. Rela. Raw Score____IQ____MA____ CA_______

Perceptual Raw Score____IQ____MA____ Total_______

Total IQ____MA____ x_______

Av. Nonverbal IQ____MA____Level of IQ=89_______

METROPOLITAN ACHIEVEMENT TESTS

Reading Raw Score____SS____GRADE____AGE____

Spelling Raw Score____SS____GRADE____AGE____

Arithmetic

Problem Solving Raw Score____SS____GRADE____AGE____

R______

S______

A______

RESEARCH STUDY OF LEARNING DISABILITIES
SUMMARY SHEET--INTENSIVE PSYCHOLOGICAL-EDUCATIONAL BATTERY

NAME________________ BIRTHDATE__________ SEX_____ GRADE_____ CASE_____

EXAM DATE__________ EXAMINERS______________ SCHOOL____________ E----C

C.A.____________

Hi M.A.____________ Verbal--Perform.

G.A.____________ (Total ________)

EXPECTANCY AGE ______________

Level of IQ=89 ______________

WISC VERBAL	RS	SS	AGE
Information	____	____	____
Comprehension	____	____	____
Arithmetic	____	____	____
Similarities	____	____	____
Vocabulary	____	____	____
Digit Span	____	____	____
SUM VERBAL		____*	MEAN V
VERBAL IQ		____	____ M.A.

WISC PERFORMANCE			
Pict. Comp.	____	____	____
Pict.Arrang	____	____	____
Block Design	____	____	____
Obj.Assemb.	____	____	____
Coding	____	____	____
Mazes	____	____	____
SUM PERF.		____*	MEAN NV
PERFORM IQ		____	____ M.A.

FULL SCALE IQ ______

*pro-rated

Hearing P F Vision P F

CLASSIFICATION

1 TE 2 FC

3 FE 4 TC

5 Under-Ach + failed h--v

6 Non-Und-Ach + failed h--v

7 Under-Ach + failed Emot

8 Non-Und-Ach + failed Emot

9 Failed Intelligence

SUMMARY OF PSYCHO-EDUCATIONAL BATTERY

LANGUAGE AREA	AGE
1. Auditory Receptive	________
2. Auditory Expressive	________
3. Reading	________
4. Written Language	________
5. Spelling	________
6. Arithmetic	________
7. Non-Verbal	________

Below IQ= 89 on:

Auditory Receptive
Auditory Expressive
Reading
Written Language
Spelling
Arithmetic
Non-Verbal

VINELAND SOCIAL MATURITY SCALE

Points ______ SQ ______ AGE ______

CHILDREN'S PERSONALITY QUESTIONNAIRE

Anxiety Score ______ P F

AUDITORY RECEPTIVE

	Score	Age
Detroit Orientation	___	___
Kent Scale D	___	___
MEAN AUDITORY RECEPTIVE	___	

AUDITORY EXPRESSIVE

	Score	Age
Detroit Verbal Opp	___	___
Detroit Free Assoc	___	___
Oral PSLT:WPS	___	___
Oral PSLT:A/C	___	___
MEAN AUDITORY EXPRESSIVE	___	

NONVERBAL

	Score	Age
Detroit Designs	___	___
Draw-A-Man		___
MEAN VIS MOTOR	___ (A)	
Healy I	___	___
Leiter		___
MEAN VIS PERCEPTION	___ (B)	
MEAN NONVERBAL	___	

AUDITORY MEMORY

	Score	Age
Detroit: Words	S ___	
	W ___	___
Detroit Sentences	___	___
Detroit Oral Direct	___	___

WORD ATTACK (Reading, Spelling)

	Score	Grade	Age
Wide Range Oral Rd.	___	___	___
Gates-McK Wd Pts	___	___	___
Gates McK Non Wds	___	___	___
Gates McK Syllable	___	___	___
Oral Gates Russell	___	___	___
Gates R. Oral 1 syll	___	___	___
Gates R. Oral 2 syll	___	___	___
Detroit Span Letters	___		___

READING

	Score	Grade	Age
G-M Accuracy	___	___	___
G-M Comprehension	___	___	___
G-M Vocab	___	___	___
MEAN READING	___		

ARITHMETIC

	Score	Grade	Age
Computation-Met	___	___	___
PMA No. Facility	___		___
MEAN ARITHMETIC	___		

WRITTEN LANGUAGE

	Score	Grade	Age
PSLT:TW	___	(___)	___
PSLT: WPS	___	(___)	___
PSLT: SYNTAX	___	(___)	___
PSLT: A/C	___	(___)	___
Met Language Arts	___	___	___
Written Met Spelling	___	___	___
MEAN WRITTEN LANGUAGE	___		

MOTOR TESTING:

	Score	Age
Heath Rail Walking	___	___

Laterality

Kick ___ Throw ___ Catch ___

Write ___ Eye ___

H+F ___ H + E ___ F + E ___

H + F + E ___

LEARNING DISABILITIES CENTER
BOB 68-6559

PUPIL BEHAVIOR RATING SCALE

Instruction Manual

One of the most important techniques for diagnosis in learning disabilities is the Pupil Behavior Rating Scale. This scale is used to assess areas of behavior that cannot be measured by standardized group screening tests. Therefore, your careful rating of individual pupils is necessary.

You are asked to rate each child on these five areas of learning and behavior:

I. Auditory Comprehension and Listening

In this section, you evaluate the pupil as to his ability to understand, follow, and comprehend spoken language in the classroom. Four aspects of comprehension of language activities are to be evaluated.

II. Spoken Language

The child's oral speaking abilities are evaluated through the five aspects comprising this section. Use of language in the classroom, and ability to use vocabulary and language in story form are basic to this ability.

III. Orientation

The child's awareness of himself in relation to his environment is considered in the four aspects of learning which make up this section. You are to rate the child on the extent to which he has attained time concepts, knowledge of direction, and concepts of relationship.

IV. Behavior

The eight aspects of behavior comprising this section relate to the child's manner of participation in the classroom. Self-discipline in relation to himself (i.e., ability to attend) as well as in relation to others is critical to your rating in this section.

V. Motor

The final section pertains to the child's balance, general coordination, and use of hands in classroom activities. Three types of motor ability are to be rated: General Coordination, Balance, and Manual Dexterity. Rate each type independently because a child may have no motor difficulties, only one type of difficulty, or any combination of those listed.

Each of the five areas of behavior should be rated without reference to any other. You rate the children on a five point rating scale: the <u>lower</u> the scale, the <u>poorer</u> the performance; the <u>higher</u> the scale, the <u>better</u> the performance. Please put a large "X" on the statement that best describes the child.

The behavior of each child should be considered carefully before he is rated. Your judgment regarding the child's behavior is a highly important part of the total diagnostic battery for identifying learning disabilities. Your assistance in this research is greatly appreciated.

NORTHWESTERN UNIVERSITY

EVANSTON, ILLINOIS

PUPIL BEHAVIOR RATING SCALE

Name ______ No. ______
Sex ______ Date ______
School ______ Grade ______
Teacher ______

I. AUDITORY COMPREHENSION AND LISTENING

Ability to follow directions

1	2	3	4	5
always confused; cannot or is unable to follow directions	usually follows simple oral directions but often needs individual help	follows directions that are familiar &/ or not complex	remembers and follows extended directions	unusually skillful in remembering and following directions

Comprehension of class discussions

1	2	3	4	5
always inattentive &/or unable to follow and understand discussions	listens but rarely comprehends well; mind often wanders from discussion	listens and follows discussions according to age and grade	understands well and benefits from discussions	becomes involved and shows unusual understanding of material discussed

Ability to retain information that he hears

1	2	3	4	5
almost total lack of recall; poor memory	retains simple ideas and procedures if repeated often	average retention of materials; adequate memory for age and grade	remembers procedures and information from various sources; good immediate and delayed recall	superior memory for both details and content

Comprehension of word meanings

1	2	3	4	5
extremely immature level of understanding	fails to grasp simple word meanings; misunderstands words at grade level	good grasp of grade level vocabulary for age and grade	understands all grade level vocabulary as well as higher level word meanings	superior understanding of vocabulary; understands many abstract words

Learning Disabilities Center
BOE-68-6559

Developed under Research Grant,
USPHS Contract 108-65-42
— Bureau of Neurological and Sensory Diseases

Name________________ No.________
Sex__________ Date______________
School________________ Grade_____
Teacher__________________________

II. SPOKEN LANGUAGE

1. Ability to speak in complete sentences using accurate sentence structure

1	2	3	4	5
always uses incomplete sentences with grammatical errors	frequently uses incomplete sentences &/or numerous grammatical errors	uses correct grammar; few errors of omission or incorrect use of prepositions, verb tense, pronouns	above average oral language; rarely makes grammatical errors	always speaks in grammatically correct sentences

2. Vocabulary ability

1	2	3	4	5
always uses immature or improper vocabulary	limited vocabulary including primarily simple nouns; few precise, descriptive words	adequate vocabulary for age and grade	above average vocabulary; uses numerous precise descriptive words	high level vocabulary; always uses precise words to convey message; uses abstraction

3. Ability to recall words

1	2	3	4	5
unable to call forth the exact word	often gropes for words to express himself	occasionally searches for correct word but adequate for age and grade	above average ability; rarely hesitates on a word	always speaks well; never hesitates or substitutes words

SPOKEN LANGUAGE (cont'd)

4. Ability to tell stories and relate experiences

1	2	3	4	5
unable to tell a comprehensible story	has difficulty relating ideas in logical sequence	average ability to tell stories	above average; uses logical sequence	exceptional ability to relate ideas in a logical meaningful manner

5. Ability to formulate ideas from isolated facts

1	2	3	4	5
unable to relate isolated facts	has difficulty relating isolated facts; ideas are incomplete and scattered	usually relates facts into meaningful ideas; adequate for age and grade	relates facts and ideas well	outstanding ability in relating facts appropriately

Name__________ No.______
Sex______ Date__________
School__________ Grade____
Teacher__________________

III. ORIENTATION

1. Promptness

1	2	3	4	5
lacks grasp of the meaning of time; always late or confused	poor time concept; tends to dawdle; often late	average understanding of time for age and grade	prompt; late only with good reason	very skillful at handling schedules; plans and organizes well

2. Spatial orientation

1	2	3	4	5
always confused; unable to navigate around classroom or school, playground or neighborhood	frequently gets lost in relatively familiar surroundings	can maneuver in familiar locations; average for age and grade	above average ability; rarely lost or confused	never lost; adapts to new locations, situations, places

3. Judgment of relationships: big, little; far, close; light, heavy

1	2	3	4	5
judgments of relationships very inadequate	makes elementary judgments successfully	average ability in relation to age and grade	accurate judgments but does not generalize to new situations	unusually precise judgments; generalizes them to new situations and experiences

4. Learning directions

1	2	3	4	5
highly confused; unable to distinguish directions as right, left, North and South	sometimes exhibits directional confusion	average; uses R vs L, N-S-E-W	good sense of direction; seldom confused	excellent sense of direction

Name__________ No.______
Sex______ Date__________
School__________ Grade___
Teacher______________

IV. BEHAVIOR

1. Cooperation

1	2	3	4	5
continually disrupts classroom; unable to inhibit responses	frequently demands the "spot light"; often speaks out of turn	waits his turn; average for age and grade	cooperates well; above average	cooperates without adult encouragement

2. Attention

1	2	3	4	5
is never attentive; very distractible	rarely listens; attention frequently wanders	attends adequately for age and grade	above average; almost always attends	always attends to important aspects; long attention span

3. Ability to organize

1	2	3	4	5
is highly disorganized; very slovenly	often disorganized in manner of working; inexact, careless	maintains average organization of work; careful	above average ability to organize and complete work; consistent	always completes assignments in a highly organized and meticulous manner

4. Ability to cope with new situations; parties, trips, unanticipated changes in routine

1	2	3	4	5
becomes extremely excitable; totally lacking in self-control	often over-reacts; new situations are disturbing	adapts adequately for age and grade	adapts easily and quickly with self-confidence	excellent adaptation. utilizing initiative and independence

BEHAVIOR (cont'd)

	1	2	3	4	5
5. Social acceptance	avoided by others	tolerated by others	like by others; average for age and grade	well liked by others	sought by others
6. Acceptance of responsibility	rejects responsibility; never initiates activities	avoids responsibility; limited acceptance of role for age	accepts responsibility; adequate for age and grade	enjoys responsibility; above average; frequently takes initiative or volunteers	seeks responsibility; almost always takes iniative with enthusiasm
7. Completion of assignements	never finishes even with guidance	seldom finishes even with guidance	average ability to follow through on assignments	above average ability to complete assignments	always completes assignments without supervision
8. Tactfulness	always rude	usually disregards other's feelings	average tactfulness; occasionally socially inappropriate	above average tactfulness; rarely socially inappropriate	always tactful; never socially inappropriate

Name ______________ No. ________
Sex ________ Date ______________
School ______________ Grade ____
Teacher ______________________

V. MOTOR

1. General Coordination: running, climbing, hopping, walking

1	2	3	4	5
very poorly coordinated; clumsy	below average coordination; awkward	average coordination for age; outstanding but graceful	above average coordination; does well in these activities	exceptional ability; excels in this area

2. Balance

1	2	3	4	5
very poor balance	below average; falls frequently	average balance for age; not outstanding but adequate equilibrium	above average; does well in activities requiring balance	exceptional ability; excels in balancing

3. Ability to manipulate utensils and equipment; manual dexterity

1	2	3	4	5
very poor in manual manipulation	awkward in manual dexterity	adequate dexterity for age; manipulates well	above average manual dexterity	almost perfect performance; readily manipulates new equipment

APPENDIX C
MEDICAL FORMS

NAME ____________
CASE# ____________

RECORD FORM

OPHTHALMOLOGICAL EXAMINATION

CATEGORY	No	YES	COMMENTS
1. History-Ocular			
a) Birth defect			
b) Glasses worn			
bifocals			
c) Orthoptics			
d). Surgery			
e) Trauma			
2. Nystagmus			
	Normal	Abnormal	
3. Pupils			
a) Equal			
b) Reaction to light			
direct			
consensual			
4. Neuro-ophthalmology			
a) Motility-versions			
b) Corneal sensation			
c) Convergence			
d) Visual fields			
5. Color Vision			
6. Ocular fundi			
	Right	Left	
7. Ocular Dominance			

 Case # ________

8. Handedness Right ______ Left _______

	Norm	Mod. Abnorm		Path.		Comments
9. Accommodation						
Right eye						
Left eye						
10. Vision						
a) Unaided distance right						
left						
near right						
left						
b) Corrected distance right						
left						
near right						
left						
11. Ocular Coordination						
a) Near		Eso	Exo	Eso	Exo	
b) Distance		Eso	Exo	Eso	Exo	
c) Hyper distance						
near						
12. Fusion and Stereopsis						
13. Refractive Error (under cycloplegia)						
a) Hyperopia right						
left						
b) Myopia right						
left						
c) Astigmatism right						
left						

EEG #________

LEARNING DISABILITIES CENTER
EEG RECORD FORM

NAME ____________________

DATE ____________________

	DEGREE OF SEVERITY					FOCUS (left)					FOCUS (right)				
	Slight	Sl.Mod.	Mod.	Mod.Sev.	Sev.	F	C	P	O	T	F	C	P	O	T
I. Normal															
II. Abnormal															
A. Slow Waves															
1. Diffuse															
2. Focal															
B. Sharp Waves															
1. Diffuse															
2. Focal															
3. Others															
a. Centrencephalic															
(1) Under 3/sec															
(2) 3/sec															
(3) 6/sec															
b. Positive Spikes															

Sleep Record ______

No Sleep Record ______

Normal Abnormal

EEG # ______

	Slight	Moderate	Severe	(left) F	C	P	O	T	Mid	(right) F	C	P	O	T
C. Depression														
1. Diffuse														
a. L-sided														
b. R-sided														
2. Focal														
D. Excessive Fast Waves														

III. Miscellaneous

A. Frequency of background rhythm:

under 5/sec.	5-5.9	6-6.9	7-7.9	8-8.9	9-9.9	10-10.9	11-11.9	12-12.9	over 13/sec.
(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8	(9)

B. Excessive Hyperventilation Response (duration)	slight		moderate	great
C. Asymmetry of Photic Driving Responses				
Depression on left	slight		moderate	great
Depression on right	slight		moderate	great
D. Quality of Photic Driving Responses	no	poor	good	excellent

Learning Disabilities Center

BOB-68-6559

PEDIATRIC PHYSICAL EXAMINATION CASE # ______

Name____Date of Exam ______________

(1) Weight _____ (2) Height _________(3) Head Circumference ______________

(4) Head Shape & Contour Normal_________Abnormal______________

Bruits Absent _______ Present ______________

(5) Facies Normal ____ Micrognathia_____Low set ears _____ Hypertelorism_____Other

(6) Eyes External Examinations -(lids, cornea, sclera, conjunctiva, ocis)

Normal ________Conjunctivitis_____Mildly prominent eyes ________

Conjunctivitis or photophobic _________ Other ____________

(7) Ears Size and shape (malformed, low set lobes etc.)

Normal ________ Low set lobes ______pinial structure _________ (massive ext. fold)

Large ear lobes_______ Other ________

Otoscopic examination

Normal________ Slightly red Rt.________Left ________

Scarring Rt.________Left ________

Thick tympanic membrane Rt. _______Left________

Calcification Rt. _______Left ________

Drum perforation Rt. _______Left ________

Ear not well developed Rt. _______Left ________

Other Rt.________Left ________

Unable to evaluate Rt. _______Left ________

(8) Dentition Normal__________ Caries __________Malocclusion ______________

Cleft ________ Repaired Cleft __________

Enamel Dysplasia _________Fracture of incisor _________

Braces for malocclusion ___________ Other ____________

(9) Nose Normal _________ Other __________

(10) Mouth Normal ________ High Palate ___________ Other __________

(11) Pharynx Normal __________Injected oro pharynx _______

Inflamed tonsils ________Large tonsils ________Other ________

(12) Neck Normal __________ Nodes _______________

Jugular digastric nodes ____________

Lymphodenopathy _______________

Cervical & jugular digastric _______

Glands _______________________

Scar tissue of thyroglossal cyst ___

Other _________________________

(13) Blood Pressure (arm) Systolic _______________

(14) Heart a) Normal ______ Murmer ________ Thrill ________
Arrhythmiz ______

Heart b) Normal ______ Enlargement ________ Cyanosis ______
Other ________

(15) Femoral Pulse (bilaterally) Normal ______ Present, less ______
well defined ________ left not as good as right ________
other ________

(16) Abdomen Normal ______ wall abnormality (hernia) ______ Spleen ______
liver ______ kidney ______ enlarged lymph node ______
obese ______ appendix scar &/or repaired hernia ______
other ______

(17) Genitalia (Female) Normal ____ Breasts ____ Hair axillary ______
pubic ______
Other ______

(Male) Normal ____ Breasts ____ Hair ______ Other ______

(18) Skin Normal ______ Sunburn ______ Pigmented scarring chickenpox infection ______
cutaneous angioma ______ Mole ______ Cafe au-lait spot ____
neurodermitis ______ skin lesions ______ other ______

(19) Spine Normal ______ Dimple ______ Sinus ______ Tuft ______
Dorsal Scalious ________ Short cervical spine ______ Other ______

(20) Musculo-Skeletal System

Shoulder Girdle Normal ______ Other ______

Pelvic Girdle Normal ______ Other ______
Upper Extremeties Normal ______ Other ______
Lower Extremeties Normal ______ Other ______

Pes planus ____ Pes Varus ____ Underarches ______ Genu valgus ______
Hypertrophy of calf muscles ______ Longer Left or Right Leg varicosities ____
Pes Valgus ______

(21) Neck & Trunk Normal ______ Short Neck ______
Truncal Varicosities ______ Obese ____ Other ______

NEUROLOGICAL EXAMINATION FORM --RESEARCH STUDY OF LEARNING DISABILITIES 1966-67

Name____________________________Date__________________Case _______

CATEGORY		FINDING Norm	Undet	Abnorm		COMMENTS	'SYSTEM'
DEEP REFLEXES							
Biceps Jerk	R						P---X
	L						
Triceps Jerk	R						P---X
	L						
Wrist Jerk	R						P---X
	L						
Ulnar Jerk	R						P---X
	L						
Knee Jerk	R						P---X
	L						
Ankle Jerk	R						P---X
	L						
Hoffmann Maneuver	R						P
	L						
Palmomental	R						P---X
	L						
Clonus	R						P
	L						
Jaw Jerk							P
Snouting							P
Sucking							P
SUPERFICIAL REFLEXES							
Superficial Abdominals	R						P
	L						
Cremasteric	R						P
	L						
Plantar B	R						P
	L						
Plantar C	R						P
	L						

CATEGORY	FINDING				COMMENTS	'SYSTEM'
		Norm	Undeter	Abnorm		
Plantar O	R					P
	L					
Plantar G	R					P
	L					
VISCERAL REFLEXES						
Pupillary	R					X
	L					
Light	R					X
	L					
Accommodation	R					X
	L					
Consensual	R					X
	L					
Pharyngeal	R					X
	L					
Pilomotor	R					X
	L					
Vasomotor	R					X
	L					
SENSORY MODALITIES						
Pinprick	R					Sm
	L					
Cotton touch	R					Sm
	L					
Temperature	R					Sm
	L					
Vibration	R					Sm
	L					
Position	R					Sm
	L					
CORTICAL SENSATION						
Stereognosis	R					Co
	L					
Barognosis	R					Co
	L					
Two-point Discrim	R					Co
	L					

CATEGORY	FINDING				COMMENTS	'SYSTEM'
		Norm	Undet	Abnorm		
Skin writing	R					Co
	L					
Extinction DDS	R					Co
	L					
Touch localization Unilateral	R					Co
	L					
Touch localization Bilat. Simultan.	R					Co
	L					
CRANIAL NERVES						
Smell I						X
Vision II	R					X
	L					
Visual Fields	R					X
	L					
Fundi						X
Optico-kinetic nystagmus III, IV, VI	R					X
	L					
Jaw movement-vertical V	R					P
	L					
Jaw movement-lateral						P---X
Facial Movement VII	R					P---X
	L					
Taste VII	R					X
	L					
Hearing VIII	R					X
	L					
Equilibrium VIII						Ce---X
Motion-palate; pharynx; other IX, X	R					P---X
	L					
Motion-trapezius; sternocleidomast. XI	R					P---X
	L					

CATEGORY	FINDING: Norm	Undet	Abnorm	COMMENTS	'SYSTEM'
Tongue-protrusion in midline . . :XII					P
Tongue-alternating movm't--vertical					Ce---P ---X
Tongue-alternating movm't -horizontal					Ce---P ---X
CEREBELLAR					
Index-to-thumb	R L				Ce---P ---X
Drumming	R L				Ce---P ---X
Pronation-supination	R L				Ce---P ---X
F-F-N	R L				Ce---X
Heel-to-shin	R L				Ce---X
Check reflexes	R L				Ce---X
Past pointing	R L				Ce---S ---X
Metria	R L				Ce
Gait:rate of progression					Ce---P ---X
Gait: swinging arms	R L				P---X
Gait: tandem walking					Ce---P ---X
Standing one foot	R L				Ce---P ---X
Hopping one foot	R L				Ce---P ---X
Romberg					S
Base					Ce---S

CATEGORY	FINDING				COMMENTS	'SYSTEM'
		Norm	Undet	Abnorm		
MIMIC MOVEMENTS						
Hand to nose-hand to ear						X
Grip hands - fingers facing tip to tip						X
Pat stomach-rub head						X
ASSOCIATIVE MOVEMENTS						
with multiple postural acts	10"					P---X
	20"					
PRESENCE OF INVOLUNTARY movements:specify						X
MUSCLE TONE						
Arms	R					P---X
	L					
Legs	R					P---X
	L					
MUSCLE STRENGTH						
Arms	R					P---X
	L					
Legs	R					P---X
	L					
POWER Trunk						P---X

Learning Disabilities Center
BOB-68-6559

RESEARCH STUDY OF LEARNING DISABILITIES
PEDIATRIC CASE HISTORY INFORMATION

Name: ______________________________ Case Number ____ ____ ____

Address: ____________________________ 1 = M 2 = F

Birthdate: __________________________ C. A. ________________________________

Father's name: ______________________ 1 = 3rd grade 2 = 4th grade

Mother's name: ______________________ Teacher __________________ Code ________

Phone number: _______________________ School ___________________ Code ________

Date of Testing: ____________________ 1 = Exp. ______ 2 = Control Classif.____

Examiners: __________________________ Occupation: M___________ F___________

* *

17. No. of preg. 0 = adopted 1 2 3 4 5 6 7 8 9

18. No. of children 0 = adopted 1 2 3 4 5 6 7 8 9

19. Nausea-vomiting past 3rd month
- 1 = no
- 2 = yes
- Blank = do not know
- 9 = adopted

20. Nausea = vomiting
- 1 = 2nd trimester
- 2 = 3rd trimester
- 3 = throughout preg. A. M.
- 4 = throughout preg. P. M.
- 5 = throughout preg., all day

Blackouts

21.
- 1 = no
- 2 = yes
- Blank = do not know
- 9 = adopted

22.
- 1 = 1st trimester
- 2 = 2nd trimester
- 3 = 3rd trimester
- 4 = throughout
- 5 = combination, but not throughout

Spotting

23.
- 1 = no
- 2 = yes
- Blank = do not know

24.
- 1 = 1st
- 2 = 2nd
- 3 = 3rd

9 = adopted

4 = throughout

5 = combination, but not throughout

Infectious diseases

25.
1 = no
2 = yes
3 = don't know (exposed to some infectious disease but not a diagnosed case)
9 = adopted
Blank = don't know at all

26.
1 = 1st
2 = 2nd
3 = 3rd
4 = throughout
5 = combination, but not throughout

Surgery

27.
1 = no
2 = yes
9 = adopted

28.
1 = minor, no anesthesia
2 = surgery, anesthesia

Drugs

29.
1 = no
2 - yes (not vitamins)
9 = adopted
Blank = don't know

30.
1 = some pills, unknown content (not vitamins)
2 = some tranquilizers
3 = sulphus
4 = antibiotic
5 = hormone and/or thyroid
6 = diet pills
7 = diuretic
8 = any combination
Blank = do not know

Delivery (labor)

31.
9 = adopted: information not available
1 = spontaneous
2 = induced
3 = Caesarean section, planned
4 = Caesarean section, unplanned

Additional Factors

32.
1 = precipitous
2 = early rupture of membranes
3 = doctor broke membranes
4 = false start
5 = placenta praevia
6 = breech birth
7 = footling delivery

Duration of labor (from time contractions came at regular intervals)

33. 9 = adopted
    1 = planned Caesarean
    Blank = do not know

34. 1 = less than 6 hours
    2 = 6 - 12 hours
    3 = 13 = 24 hours
    4 = over 24 hours

Duration of labor compared to other pregnancies

35. 9 = adopted
    1 = only child
    2 = Caesarean
    Blank = do not know

36. 1 = similar
    2 = shorter by more than 12 hours
    3 = longer than others
    4 = longer than 1, shorter than other

Forceps

37. 9 = adopted
    1 = no
    Blank = do not know
    3 = yes

38. 1 = low
    2 = high
    3 = scoop
    4 = both high and low forceps
    Blank = do not know

Anesthesia or sedation

39. 9 = adopted
    Blank = do not know
    2 = no anesthetic (not natural childbirth)
    3 = natural childbirth with or without slight anesthetic
    4 = yes

40. 1 = caudal or saddle block
    2 = gas
    3 = combination
    4 = twilight sleep
    5 = injection
    6 = sedative pills
    7 = hypnosis
    Blank = do not know

Mother after birth

41. 9 = adopted
    Blank = do not know

42. 1 = hemorrhage or any similar condition requiring blood transfusion
    2 = delayed placental delivery
    3 = depression or psychiatric distress

2 = healthy

3 = abn

4 = heavy sedation for conv. disorder

5 = kidney, pancreas or bladder prob.

6 = infections

7 = shock

8 = other

Weight at birth

43. 9 = adopted

Blank = do not know

44. 1 = under 5 pounds

2 = 5 - 5 lbs, 15 oz.

3 = 6 - 6 lbs, 15 oz.

4 = 7 - 7 lbs, 15 oz.

5 = 8 = 8 lbs, 8 oz.

6 = over 8 lbs, 8 oz.

Condition of infant

45. 9 = adopted

Blank = do not know

2 = good

3 = problems

46. 1 = cyanotic

2 = jaundiced

3 = undernourished

4 = premature; placed in incubator; received oxygen

5 = breathing problems; received oxygen

6 = other

Postnatal feeding

47. 9 = adopted

Blank = do not know

2 = difficulties

3 = eats well, no problem; regained birth weight

48. 1 = sucking and swallowing problem

2 = colic (diagnosed)

3 = kink in intestine

4 = special diet

5 = any combination

6 = other

Responsiveness to being held

49. 9 = adopted

50. 0 = no opinion

1 = cuddly

2 = liked to be held only when being fed

3 = "Straight-armed" people; did not like to be held close

Developmental Milestones (leave blank for DNK)

51. Sitting
    1 = below 6 mo.
    2 = 6 - 10 mo.
    3 = over 10 mo

52. Pulls to standing
    1 = under 6 mo.
    2 = 6 - 8 mo.
    3 = 9 - 13 mo.
    4 = over 13 mo.

53. Walking
    1 = under 9 mo.
    2 = 9 - 13 mo.
    3 = over 13 mo.

54. Toilet training, complete
    1 = under 18 mo.
    2 = 18 - 24 mo.
    3 = over 24 mo.
    4 = still wets bed at night

55. Babbling
    1 - yes, about 6 mo.
    2 = no

56. First real word
    1 = 9 - 13 mo.
    2 = 14 - 18 mo.
    3 = older than 18 mo.

57. Two word combination
    1 = up to 18 mo.
    2 = over 18 mo.

MEDICAL HISTORY

58. Infant disease (serious)
    9 = adopted
    1 = none
    2 = yes
    Blank = do not know

59. 1 = pneumonia
    2 = virus
    3 = infection
    4 = roseola
    5 = croup

6 = breathing; asthma

7 = rickets

8 = infantile eczema

9 = combination

For all diseases use the following code

1st col. 0 = adopted

Blank = DNK

2 = Vaccine

3 = no

4 = yes, mild

5 = yes, with complications

6 = yes; severe, no complications

2nd col. 1 = had disease under 2 years

2 = had disease between 2 and 5 years

3 = had disease over 5 years

4 = had twice

60,61 Measles (two week)

62,63 German measles

64,65 Mumps

66,67 Whooping cough

68,69 Chicken pox

70,71 Scarlet fever

72,73 Meningitis or encephalitis

74,75 Mononucleosis

17. Infections

1 = gets easily

2 = gets ear infections with colds

3 = used to get infections; not susceptible now

4 = used to get ear infections with colds, not now

5 = sometimes

6 = rarely, if ever

7 = combination

Blank = do not know

18. Flu

1 = easily

2 = sometimes

3 = rarely, if ever

Blank = do not know

19. Colds

1 = easily

2 = sometimes

3 = rarely, if ever

Blank = do not know

20. Allergies

1 = maybe

2 = yes; mild seasonal

3 = yes; severe

4 = yes, but successful desensitivization or had as child

5 = no

6 = mild, not seasonal

Blank = do not know

21. Autonomic dysfunctions

excessive amounts of

0 = none

1 = headache

2 = abdominal pain

3 = vertigo, dizziness

4 = fainting

5 = nausea, vomiting

6 = combination

Blank = do not know

22. Trauma

0 = no

1 = under 2 years, stitches or loosened teeth variety

2 = 2 - 5 years, stitches or loosened teech variety

3 = 5 years, stitches or loosened teeth variety

4 = under 2 years, concussion (blackout, vomiting)

5 = 2 - 5 years, concussion (blackout, vomiting)

6 = 5+ years, concussion (blackout, vomiting)

7 = combination

23. Convulsions

0 = none

1 = had febrile convulsions

2 = had Grand Mal

3 = absences

4 = Salaaming

5 = Myoclonic jerks

6 = diagnosed convulsive disorders

7 = child has not had/ does not have convulsive disorder, but member of family does

8 = seizures at birth

9 = Petit mal seizure

24. Surgery

0 = none

1 = tonsils, under 2 years of age

2 = tonsils, 2 - 5 years

3 = tonsils, over 5 years

4 = other surgery for which anesthesia was given - under 2 years.

5 = other surgery for which anesthesia was given - between 2 and 5 years.

6 = other surgery for which anesthesia was given - over 5 years

7 = any combination

25. Blood type, major categories (ABO)   Mother _______ Father _______

Blank = do not know

1 = same

2 = different

26. Blood type, Rh

Blank = do not know

1 = same

2 = different

27. Hearing problems other than old age

leave blank if adopted

0 = none know

1 = Mother or Mother's family

2 = Father or Father's family

3 = child's sibling

4 = combination

28. Vision problems other than old age

0 = none known

1 = Mother or Mother's family

2 = Father or Father's family

29. Speech problems

0 = none known

1 = Mother or Mother's family

2 = Father or Father's family

3 = child's sibling

3 = child's sibling

4 = combination

4 = combination

30. Learning (reading) problems

0 = none known

1 = Mother or Mother's family

2 = Father or Father's family

3 = child's sibling

4 = combination

5 = Mongoloid in family

31. Twinning

0 = not a twin

1 = child is a twin

32. Bone malformation

0 = no congenital bone malformation

1 = congenital bone malformation

2 = possible, but not sure

33. Toxics

0 = none

1 = overdose of drugs

34. Educational history

0 = kg - grade same community, no grades repeated

1 = no grades repeated, some grade or portion of grade spent in other community

2 = Same community, some grade repeated

3 = Some grade repeated, some grade or portion of grade spent in other community

4 = Special class placement

35. 1 = kg repeated in same school

2 = kg repeated in different school

3 = 1st repeated in same school

4 = 1st repeated in different school

5 = 2nd repeated in same school

6 = 2nd repeated in different school

7 = 3rd repeated in same school

8 = 3rd repeated in different school

9 = anything else

36. Special tutoring

0 = none

1 = speech therapy

2 = school year, reading

3 = school year, math etc; other than reading (not for pleasure and advocation)

4 = summer, reading

5 = summer, other subjects, not reading

6 = school and summer reading

7 = school and summer, subjects other than reading

8 = tutoring suggested, but never accomplished

9 = combination

SUPPLEMENTARY CASE HISTORY

General description of present language behavior: ______________________________

____

____

________ poor vocabulary

________ consistent trouble learning verb tenses

________ pronoun/preposition usage poor

________ omits words

________ skips around unduly when relating sequential material

Comment on memory (note problems mentioned): ______________________________

________________ immediate ________________ distant Names ____________

Judgments about danger ____________________ right-wrong ____________________

Orientation/ confusion ____

What makes child laugh ____

Social awareness: ________________________________ initiative ____________

Emotional status ____

Relationships with children, adults, family ______________________________

____

Use of free time:

Extracurricular activities ________________

Creative activities ________________

Organizations ________________

Kinds of games liked:

____

____

____

FURTHER COMMENTS AND QUESTIONS RAISED

APPENDIX D

PERSONNEL

LEARNING DISABILITY PROJECT

1965-1969

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