The Manitoba Revision and Extension of The Luria-Nebraska Neuropsychological Battery for Children and its Utility in an Educational Setting

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of the requirements for the degree
Doctor of Philosophy

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by

Rune S. Lundin
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THE MANITOBA REVISION AND EXTENSION OF THE
LURIA-NEBRASKA NEUROPSYCHOLOGICAL BATTERY
FOR CHILDREN AND ITS UTILITY IN AN EDUCATIONAL SETTING

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RUNE S. LUNDIN

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Abstract

Golden and coworkers developed the adult version of the Luria-Nebraska Neuropsychological Battery (LNNB) and a corresponding children's version (LNNB-C), suitable for children 8-12 years. The neuropsychological literature revealed much controversy about the diagnostic effectiveness of the LNNB and LNNB-C, the published methodological properties of the batteries, and the conclusiveness of the validation research.

In order to come to terms with the above criticisms of the LNNB-C, this study involved revisions of the LNNB-C to produce two versions of the Manitoba Revision of the Luria Nebraska Neuropsychological Battery suitable for older children 8-12 years (MLNNB-OC) and for younger children 5-7 years (MLNNB-YC).

The MLNNB-YC and -OC were administered to 3 samples of school children: (a) Normal Controls (NC): N = 193, ages 5 - 12 years, grades 1 - 6, about equal numbers of boys and girls, about equal numbers at each year level, good physical and mental health, average with respect to IQ scores, school performance, and socioeconomic status. (b) Learning-Disabled Children (LD): N = 50, ages 5 - 12 years, selected on the basis of strict criteria (i.e., very poor performance in at least one subject, IQ scores 95 - 110, English as first language, no socioeconomic deprivation, good health, freedom from emotional disturbance, good vision and hearing) (c) Brain-Damaged Children (BD): N = 28, ages 5 - 12 years, selected on the basis of neurologically-documented brain damage.

Children from all three samples (NC, LD, BD) were tested on the MLNNB-YC or -OC. In addition, all BD children were also tested on the Halstead-Reitan Neuropsychological Test Battery for Children (HRNTB-C). Thereafter, the HRNTB-C was administered to 28 LD children selected to match the BD children for age and sex.

The NC sample was used to develop a new scoring system for the MLNNB-YC and -OC. The raw scores of the 149 MLNNB-YC or -OC items were converted into 0-1-2 Scores indicating adequate, borderline, or inadequate performance. This conversion is "absolute" in that a child's 0-1-2 Score depends on the adequacy of the child's performance independent of the child's age. The items of each of the 11 MLNNB-YC or -OC scales were then totalled and averaged to produce Scale Scores. The means and standard deviations of Scale Scores of each age level (e.g., 8-year old) were then used to calculate T-Scores appropriate for this age level. T-Scores $>$ 80 (3 standard deviations worse than the mean of normal children) were taken as indicative of impaired performance. The number of scales where a child exceeded T = 80 were used to develop an Impairment Ratio.

Analyses of Scale Scores of NC children revealed substantial age and sex differences for younger children on the -YC, but only modest age and sex differences for older children on the -OC. Group and individual comparisons of the T-Scores of NC, LD, and BD children on the MLNNB-YC, -OC revealed that none of the NC children had T-Scores $>$80 on any scale, LD children typically had T-Scores $>$80 on only one or two scales, while BD children typically had T-Scores $>$80 on four or more scales. Comparisons of NC, LD, and BD children on the HRNTB-C revealed similar trends. However, the MLNNB-YC, -OC showed

more distinctive score profiles for LD and BD children than did the HRNTB-C. The MLNNB-YC,-OC were also somewhat more successful than the HRNTB-C in specifying the nature of the deficit in LD children. Comparisons of carefully-matched NC, LD, and BD individuals on the MLNNB-YC -OC and HRNTB-C supported the conclusions based on group comparisons.

The study also collected some methodological information (e.g., test-retest measures, interscorer reliability, preliminary factor analysis) on the MLNNB-YC, -OC. In general, these results agree with those obtained by Golden on the LNNB-C.

This study suggests that with appropriate age norms and a revised scoring system the MLNNB-YC, -OC can be an effective instrument for the neuropsychological assessment of LD and BD children.

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CHAPTER 1

INTRODUCTION

1.1 Neuropsychology in an Educational Setting

Historically, neuropsychological assessment techniques have been developed to provide information useful in a medical setting. Such assessments have focused on description and localization of brain malfunctions due to varying etiologies. Neuropsychologists assumed a close relationship between brain malfunction and behavioral deficits. Traditionally, neuropsychology has remained within the clinical arena and it is only during the last decade that we have seen a spectacular growth and extension of neuropsychological methods into other areas. For example, neuropsychology can be used as a tool to examine growth and development of the normal human brain from early infancy throughout the childhood years (see e.g., Spreen, 1976, 1978, 1983, 1984), or it can be used in an educational setting to study learning disabilities (e.g., Rourke, 1975, 1976, 1978, 1981, 1982, 1983, Gaddes, 1985; Obrzut and Hynd, 1981; Denckla, 1979). Neuropsychological assessments of school children have typically employed the classical neuropsychological techniques such as the Halstead-Reitan Neuropsychological Test Battery and other well-known tests. (For a review see Hynd and Obrzut, 1981, or Gaddes, 1985.) The purpose behind the testing of school children has generally been to aid educational programming for children with documented brain damage or for children suspected of brain malfunction due to organic causes (Gaddes, 1985). It is important to note that neuropsychological assessment has generally followed the medical (i.e., disease) model.

1.1.1 Problems inherent in neuropsychological assessment:

There are several problems inherent in the use of traditional neuropsychological assessment in an educational setting:

(1.) The medical model probably overlooks a great many children with learning disabilities because they lack sufficient diagnostic signs to qualify as "organics" or "brain damaged".

(2.) Neuropsychological tests for children (in current use) generally comprise downward extensions of adult batteries or adult items (usually the adult items are simplified). These downward extensions have taken place with little regard for variables related to growth, maturation, and qualitative differences between children and adults. The criticism here is, that children may be qualitatively, as well as quantitatively, distinct from adults in terms of brain functions. Optimal pediatric assessment methods should, therefore, incorporate behavioral skills that are developmentally relevant, as well as sensitive to brain dysfunction.

(3.) The clinical categories commonly used in the diagnosis (i.e., brain area affected rather than psychological deficits) might not be particularly useful in terms of recommendations for remediation in an educational setting. The test items were designed to diagnose and localize brain lesions and provide information useful in a medical setting. Therefore, the information that these tests generate is difficult to translate into educational decisions. It makes little sense to tell a teacher that little John has a lesion in Brodmann's area 8, unless one can describe with some degree of accuracy how this type of lesion might affect the child's ability to read, write, or to meet other demands of the school curriculum. (4.) Most traditional neuropsychological-assessment methods are too broad (i.e., too inclusive) to yield information about specific deficits. The high hit rates so often reported in the evaluation literature for these assessment methods are more likely due to the fact that they assess large areas of the brain (and are therefore more likely to detect brain injury). Clearly, the price for high hit rates (ie, rate of sucessful diagnosis) is a decrease in their educational relevance.

1.1.2 Suitable Models for use in Educational Settings: Globality vs Specificity:

A neuropsychological-test battery used in an educational setting should ideally contain elements similar to those utilized in the education testing model, while at the same time, remain faithful to the domains inherent in the brain-behavior model of neuropsychology. For example, one of the major areas of investigation might involve reading skills. In terms of brain functions reading may be conceptualized as a functional system involving a series of component functions (e.g., visual acuity, visual scanning, perceptual identification of letters, recognition of letter combinations, visual-auditory association, receptive speech, expressive speech, motor control of speech muscles). All of these component functions are necessary, but none of them in itself is sufficient, for reading. These component functions may have focal localization in the brain. When a child is reading, the components may function serially (e.g., recognition of letter combination precedes pronunciation of the word) or may function simultaneously (e.g., scanning and perception of letter combinations). The approach to testing such systems needs to involve an analysis of the subject's performance on each of the major components of a particular skill, such as reading. If a nonreader performs very poorly on one or more component function(s), one can attribute the reading problem to (a) specific deficit(s). As a result, specific knowledge of deficits in component functions may provide a sound basis for remediation in school.

1.1.3 Useful criteria for neuropsychological testing of children in the educational setting:

Given the above considerations, a neuropsychological test battery for children that can be useful in an educational setting should meet the following criteria:

1. The battery should be sensitive to developmental changes in the brain. Its scoring method should be based on group norms reflecting age trends and possible sex differences.
2. The test battery should be useful as a clinical tool in identifying and localizing brain impairment.
3. The data obtained from the assessment battery should clarify the educational difficulty and thereby suggest remediation strategies.
4. The test battery should reflect the most recent knowledge about human brain functions. It should permit the addition of new measures, as knowledge increases.
5. The test battery should be suitable for children aged 5-7 to respond to a need for early identification of learning problems leading to early remediation efforts.
6. If the battery is theory based, the underlying theory should agree with current findings in child development and learning.

The theoretical framework of the late Russian neuropsychologist Aleksandr R. Luria seems to be most relevant to the above concerns. It is therefore helpful, to provide a brief outline of his theory and investigative methods.

1.2 Luria's Model of Brain Function

Luria was a major contributor to the development of the scientific discipline of neuropsychology. Although his prolific publications discussing his research and theory building span some forty years, he did not have a major influence upon American neuropsychology until perhaps the middle of the 1960's. For a summary of his work see Luria 1964, 1966, 1969, 1970, 1973, and 1980. Although Luria died in 1977, many of his studies were translated and published posthumously until 1979. Luria's work was influenced both by Vygotski, (a Soviet psychologist primarily interested in linguistic aspects of brain functions), and by Piaget whose "methode clinique" (clinical interview) was adopted by Luria as the preferred research methodology. Golden, Hammeke, and Purisch (1978) noted that American neuropsychologists were reluctant to accept Luria's approach, because Luria focused on qualitative rather than quantitative deficits, and qualitative data were regarded as "subjective". However, current research in neuroscience tends to support Luria's basic model of brain functions (e.g., the studies of blood flow in different regions of the cerebral cortex while the patient is engaged in different psychological activities, e.g., Ingvar and Risberg, 1967; Ingvar and Schwartz, 1974; Lassen, Ingvar, and Skinhoj, 1978).

1.2.1 The functional-systems approach:

The concept of functional systems is central to Luria's theory of brain functions. The functional-systems model represents a major departure from both strict-localization views (i.e., complex functions have distinct and circumscribed loci in the brain) and mass-action views (i.e., all areas of the cortex are involved in all complex cognitive functions, the amount of cognitive deficit depends on the size but not the localization of the lesion). Luria stated that no single area, by itself, is sufficient for carrying out a complex cognitive function. Nor is the whole brain considered to be involved in all behaviors. According to Luria, complex cognitive activities (e.g., reading aloud) involve the dynamic integration of several (simple) component functions (e.g., visual perception, auditory imagery, visual-auditory integration, receptive and expressive speech association, integration of speech muscles, eye coordination, phonetic synthesis) localized in widely separated zones of the brain. Each component has an anatomical locus consistent with localization lore. These components can interact sequentially or concurrently in the fashion described by Das, Kirby, & Jarman (1979). Luria (1964) argues that, if the brain is conceptualized as an interdependent systemic network, "...it becomes completely understandable that a higher (mental) function may suffer as a result of the destruction of <u>any link which is a part of the structure of a complex functional system</u> and ...may be disturbed even when the centers differ greatly in localization" (pp 11-12). According to this notion, each component of the system makes a unique contribution to the over-all (complex) functioning. A given component may participate in more than one functional system. It follows, that a lesion producing a deficit of one particular component would disrupt the functioning of all systems which utilize that component.

The utterance of a syllable may be taken as a grossly simplified illustration of a functional system with three basic components: the auditory comprehension of the phonic elements; the tactile/kinesthetic feedback from the vocal modalities (i.e., mouth and throat movements); and the actual motor output (see Mateer and Kimura, 1976). According to Luria, these three aspects of speech involve different areas of the brain which need to be coordinated. In spite of its oversimplification, the "syllable" example can be used to illustrate Luria's method of neuropsychological assessment. If a patient has difficulty in pronouncing syllables, Luria would devise simple tasks of assessing each of the three component functions. If the patient performs adequately on two component functions, but has a deficit of the third component, Luria would argue that he had diagnosed the reason for the patient's difficulty of pronouncing syllables. If possible, Luria would then look for any localized brain lesion which might correlate with the deficit on that component function.

There appears to be some physiological support for the general idea of functional systems. Studies of increases in regional blood flow (Ingvar & Risberg, 1967; Ingvar & Schwatz, 1974) and computer-enhanced tracer techniques (Lassen, Ingvar, & Skinhoj, 1978) have shown that several small, but spatially separated, areas of the cortex receive increased blood flow during certain kinds of activities (e.g., silent reading, writing, skilled hand movements and other complex functions). The investigators suggest that high blood flow to a given area indicated that this area is very active when a complex task is carried out. For a given task, there are several spatially separated active areas (e.g., frontal eye field, Broca's area, Wernicke's area, auditory association area). A given area (e.g., frontal eye field) may be active in more than one complex task. The findings of these studies support Luria's analysis of psychological functions and his general model of brain organization.

1.2.2 Luria's three "blocks" or subdivisions of the brain:

It is now helpful to outline Luria's broad division of the brain into three major subdivisions which Luria calls "blocks". The three blocks are somewhat similar to the parts of Paul MacLean's phylogenetically-based triune-brain model (MacLean, 1978). Although Luria's three divisions play functionally distinct roles, they are nevertheless involved in all behaviors. Since the role of each block is functionally distinct regardless of the composition of the functional systems, an injury to any of the blocks will result in the disruption of numerous functional systems. However, since each block makes a unique contribution to the operation of a functional system, injuries to different blocks produce different kinds of disruptions, which can be recognized by clinicians. Because the three blocks have implications for growth, development and maturation, they are critical to an understanding of a neuropsychological test battery for children.

"Block one" is also referred to as the arousal unit and is responsible for providing a stable basis for the organization of the various processes in the brain. This block appears to operate on a homeostatic principle. The structures regulating arousal levels include primarily the reticular formation, and those posterior-hypothalamic and brain-stem areas which control sleep and wakefulness. The system consists of a collection of diffuse intertwined neural structures extending from the pons and medulla through the thalamus to the cortex. Injury to block one can result in coma or impaired consciousness. Patient with block-one injury may become confused as manifested by potentially bizarre associations and by a marked difficulty with stimulus distinction. While block one is involved in all activities of the brain, it would seem especially important to the maintenance of a stable tonus and attentional focus in young children.

"Block two" is also referred to as the sensory-input unit of the brain. This unit of the brain has been subjected to more intense studies than any other are of the brain. Therefore, its role in the organization of behavior is quite well known. Block two consists of the area posterior to the central sulcus and is composed of the parietal, occipital, and temporal lobes. This block plays a decisive role in the analysis, coding, and storage of information. According to Luria's model, the different areas of block two that are responsible for the analysis and encoding of different types of stimuli (optic, acoustic, cutaneous, and kinesthetic) are located in their respective regions i.e., occipital, temporal, and parietal lobes respectively. Each of these regions are organized into three hierarchical zones. The primary zone of each area is responsible for sorting and recording incoming-sensory information. The function of the secondary zone is to receive information from the primary zone and then to organize and code the data. The tertiary zone is primarily responsible for cross-modality integration of sensory material. Golden (1981) has pointed out that, with a few exceptions, all the skills measured on the Wechsler Adult Intelligence Scale or the WISC-R are mediated by the tertiary zone of the second block. This is probably true for most tests of abilities, since the obtained scores would be seriously affected as a result of a dysfunction involving integrative skills. For example, auditory-visual integration would affect reading skills, auditory-tactile integration would affect writing skills and visual-tactile integration would seriously affect body location in space, visual-spatial skills such as arithmetic and mazes. Tertiary-zone injury may result in deterioration of grammatical skills, syntax, abstractions, logical analysis, spatial rotation, angle determination, understanding prepositions, and stereognosis to name a few. The disorders of dyslexia, dysgraphia, or dysnomia may be attributed to the loss of the ability to effectively integrate information across the sense modalities. This deficit also holds for more subtle symptoms such as the inability to recognize faces or emotional expressions in others.

"Block three" comprises the (pre)frontal lobes. According to Luria (1970) the prefrontal lobes are involved in the formation of intentions, or, (in computer language) "behavior programming". The prefrontal lobes may also be implicated in aphasias and related conditions (see e.g., Meyer, 1974). It is significant that the brain structures controlling motor functions are located in the posterior frontal lobe, that is, adjacent to the prefrontal block-three structures. The close connections between prefrontal and motor areas facilitates the execution of behavior programs. Generally, prefrontal damage leads to two basic kinds of problems: (a) problems involving the cognitive processes and conscious purposeful action; (b) problems involving emotions and personality structure. A lesion in the prefrontal region does not lead to speech disorders or to disturbances of the elementary sensory-motor functions. A more likely symptom is disturbed voluntary behavior. In other words, the victim's behavior ceases to bear the imprint of an internally formulated plan. The prefrontal lobes also have connections extending to the reticular formation and are, therefore, involved in the activation and regulation of arousal and conscious focus of attention. This activation is extremely important, because it is related to the method by which information is processed in the brain. Kinsbourne (1978) argued that attentional bias for one or the other hemisphere may be one of the possible explanations for hemispheric differences in (simultaneous or serial-order) information processing. It should be noted that Luria believed that intelligence is based on the dynamic interplay between the three blocks of the brain, but that the prefrontal lobes serves an "executive" function. This notion is by no means new. Both Pribram's (1971) and Halstead's (1947) theories of brain functions assign to the prefrontal lobes a major role in intelligent behavior.

Luria's model further sub-divides the three major blocks into "zones". Each block has a (localized) primary, secondary, and tertiary zone. In general, primary zones are involved in simple functions with little integration of information from different brain areas. Tertiary zones mediate complex integration of information from widely separated areas of the brain. The role of secondary zones tends to be intermediary between those of primary and tertiary zones.

Luria's basic concepts suggest that there is no one-to-one correspondence between any specific behavior deficit and a lesion of any specific area of the brain. If a child cannot read for neurological reasons, any one or more of the component functions (in different areas of the brain) of the functional system involved in reading is/are impaired. On the other hand, the absence of a given deficit does not indicate that any particular area of the brain is intact; such absence only indicates that some functional system (and its components) sufficient for that behavior is intact. In general, Luria's theory would predict that complex functions involving many brain areas would be more likely disrupted by brain lesions than would simple functions.

1.3 Luria's Assessment Methods

For Luria, the goal of neuropsychological assessments is not only to "describe the symptoms of the disturbance of higher cortical functions, but also qualification of the defects and an analysis of the 'factors' (components) underlying these behavioral defects" (Luria, 1975, p. 7). Luria's investigative technique focuses on this "qualification-of-the-defects". Neuropsychological tests of complex functions are "multifactorial", in the sense that they assess the integrity of many component functions and their corresponding brain areas. Therefore, a multifactorial test, (e.g., many of the tasks of the Halstead-Reitan Neuropsychological Test Battery or HRNTB; see Reitan, 1964), would assess the integrity of many components and hence would have a good chance of detecting brain damage (i.e., it has a high rate of successful diagnosis). However, a multifactorial test cannot readily identify the component(s) which is/are impaired. Luria, in contrast, used simple tasks that attempt (ideally) to assess specific component functions. Such tasks have a lower hit-rate than multifactorial tests, but are more informative about the nature of the deficit.

Since functional systems may fail because of impairment of any of its component, Luria argued for "qualitative" analysis (i.e., identification of the impaired component) rather than for the "quantitative" (psychometric) assessment of complex functions. The important underlying assumption is that other tasks requiring the impaired component will likewise be disrupted. Luria selected the initial task on the basis of the patient's complaint and on his (Luria's) clinical judgement and intuition as to what might be wrong. The result of the initial task would then determine the next task given. This process would continue until Luria was satisfied that an accurate diagnosis (i.e., identification of the impaired component/s) had been achieved. The assessment of the patient's condition could take ten minutes or last hours, even days. The role of the neurodiagnostician using this approach is to systematically examine the functional integrity of each component and to make judgments regarding its role in the system under investigation.

Luria did not use standardized procedures but selected and administered the tasks as he thought best for a given patient. Each of Luria's examinations can be said to have been specifically designed for each individual patient. The pathognomic-sign approach was used to score the results of his clinical analysis. The patient's performance on a given task was usually rated as "normal", "borderline", or "abnormal". There are several drawbacks to this approach in neuropsychological assessment. First, the approach does not allow evaluation of the effectiveness of any given task (except to note that Luria said it worked). Secondly, replication (a significant aspect of any standardized assessment system) is essentially impossible. In addition, teaching the system would be difficult, especially now that Luria himself is dead.

1.4 An Early Attempt at Standardization of Luria's Assessment Procedures

The first serious attempt to catalogue Luria's investigative techniques was made by Anne-Lise Christensen author of "Luria's Neuropsychological Investigation" (1975). Christensen's work consist of a volume of text, a test manual, and sets of stimulus cards to be used in testing. Like Luria, Christensen felt that standardization and quantification of the test items would restrict the flexibility needed for a valid assessment of a given patient. However, she also felt the need for standard administration "to ensure the process of the investigation would be as thorough and exhaustive as it was designed to be" (Christensen, 1975, p. 9).

One important part of Christensen's work concerns the pre-test interview ("the preliminary conversation"). This part of the examination is for the purpose of establishing the topical diagnosis of brain lesions. Therefore, "the more care and detail paid during the preliminary conversation, the more precise and meaningful will be the subsequent clinical psychological investigation of the patient" (p. 28). As a rule, the basic hypotheses concerning the nature and, sometimes the location, of the pathological processes are disclosed during the preliminary conversation with the patient. The rest of the investigation serves to either support or refute these hypotheses. The questions and assessment procedures used by Christensen were scored using a positive/negative sign approach (adequate/inadequate performance). The major limitations of Christensen's assessment methods are that she gives no performance norms and that she does not quantify the results of her assessment (only qualitative judgment). Consequently, the interpretation of a patient's performance rests entirely on the clinical judgment of the examiner. Furthermore, the lack of psychometric information would make it difficult, if not impossible, to differentiate adequate/inadequate performance among children at various stages of growth and maturation. It is difficult to ascertain what can be expected from a "normal" child of a certain age. It is therefore even more difficult to assess a child suspected of neurological impairment.

1.5 The Luria-Nebraska Neuropsychological Battery(LNNB)

A standardized version of Luria's Neuropsychological Investigation was published by Golden, Hammeke and Purisch in 1980. This instrument is called

"The Luria-Nebraska Neuropsychological Battery" (LNNB). The goal was to create a battery which could take advantage of the Luria's qualification-of-symptom approach and, at the same time, take full advantage of standardization and quantification (Golden, 1981a, 1981b; Golden, Ariel, McKay et al., 1982; Golden, Hammeke, and Purisch, 1978; Hammeke et al., 1978). The battery "was intended to provide a basis for quick and reliable collection of empirical data, while allowing for qualitative analysis as exemplified by Luria's work" (Golden, Ariel, Moses, Wilkening, McKay, MacInnes, 1982, p. 40-41).

An examination of the LNNB will reveal that the battery differs from classical neuropsychological batteries (e.g., HRNTB) in several important ways. The HRNTB has relatively few tests but they tend to be complex (ie., multifactored), while the Luria battery has many simple test (task) items. The HRNTB is an atheoretical-empirical-type of inductive study, basically following the medical model. In contrast, the LNNB is theory based and involves conceptualization of what kind of components can be expected to be involved in a given task. This type of test places greater emphasis on psychological aspects (kind of component functions impaired) and is meant to provide information beyond a mere description of cortical lesions.

1.6 <u>Controversies about methodological properties of the LNNB</u>:

Golden and his coworkers have provided an impressive array of data which, they suggest, unequivocally demonstrate the efficacy of the battery in detecting the presence, lateralization, and localization of brain damage (see Golden, 1979, 1981a, 1981b, 1986; Golden, Hammeke, and Purisch, 1980 for more extensive reviews). A number of reviewers have questioned many of the claims that have been made concerning the battery's clinical utility (Adams, 1980a, 1980b; Crosson and Warren, 1982; Delis and Kaplan, 1982; Spiers 1981, 1982). The tenor of the LNNB-literature controversy is exemplified by Adams (1980a, 1980b) who, in a thinly veiled critique questioned Golden's competence as a researcher. The controversy about the LNNB centers around several issues: standardization of instructions, scoring procedures, summing of item scores, reliability estimates, and validity.

Adams (1980a) expresses his concern that the LNNB's directions for instructions to the subject seem to be a curious blend of an appeal to maintain a standardized format and of invitations to improvise the instructions and test the limits. He felt that, while a certain flexibility is desirable, it is uncertain how this flexibility affects the scoring of the items. This problem is especially crucial when receptive speech functions are assessed. The problem is less serious in the assessment of motor functions where the objective is to elicit motor performance and not to evaluate the subject's ability to understand the instructional language.

A further criticism focuses on the psychometric properties of the item score (0 = normal performance, 1 = borderline performance, 2 = grossly impaired performance on a given task item) and the summation of item scores into scale scores (Adams, 1980b; Spiers, 1981). The critics suggest that the limited score range of items reduces their sensitivity. They argue that the battery would become more sensitive, if items were scored as continuous variables with a greater score range. However, Golden and coworkers (Golden, 1980; Golden, Hammeke, and Purisch, 1978) have pointed out that other scoring schemes with a wider score range were investigated, but that these schemes have failed to improve the LNNB's ability to discriminate neurological from control groups. While the use of continuous variables is appropriate with intelligence and other ability tests (e.g., WISC-R) where the level of children's proficiency is related to age, continuous variables may be much less relevant for neuropsychological measures of detecting impairment of simple functions, where the pathognomic-sign approach is preferred. Russel (1980) criticized the procedure or summing individual LNNB-item scores to yield fourteen major scale scores. He argued that this procedure is meaningless, because the summed item scores may assess the integrity of different brain areas. In reply Golden and coworkers (Golden, Ariel, McKay, et al., 1982; Golden, Hammeke, and Purisch, 1980) stress that scale scores are relevant, because each summary scale assesses a general skill area named in the scale title and that scale scores can be used for preliminary screening. "Impaired" performance on a scale score would direct the clinician's attention to possible failures on individual items. Identification of "failed" items is necessary in order to gain insight into the nature of the neurological impairment.

Hammeke (1978, 1980) assessed intertester reliability for scoring of each item. He used samples of hospitalized neurologically-impaired and medical-control patients. The reported agreement between the two examiners ranged from 92% to 98%. The correlation between the scores for each examiner ranged from .97 to .99. However, it should be noted that the sample sizes were small (5 subjects). It is, therefore, necessary to replicate this study with much larger samples and to study also the effects of varying instructions to the patient. In the current study a sample size of 70 will be used to determine interscorer reliability and a sample of 30 will be used to assess the effects of varying instructions.

Golden, Berg, and Graber (1980) used a sample of patients with static neurological impairment to assess test-retest reliability. They reported that test-retest correlations ranged from r=.77 (Right Hemisphere) to r=.96 (Arithmetic) with a mean correlation of .88. The test-retest interval ranged from 10 to 489 days (Mean = 167 days).

Golden, Fross, and Graber (1981) examined the LNNB's degree of consistency with regard to content sampling (split-half reliability using an odd-even split). They reported that split-half correlations for the summary scales ranged from .89 (Memory) to .95 (Reading) with a mean correlation of .92. The high values of these correlations are surprising as they suggest, in contrast to Golden's views, that the items of the scales are quite homogeneous. However, close examination of the battery reveals that odd-even splits are inappropriate, since many odd-number items test one side of the body and the following even-numbered questions test the other side of the body, while the skill being tested remains the same. An odd-even split would, therefore, spuriously inflate the estimate of internal consistency.

The internal consistency of each scale (item-scale consistency) is generally estimated by correlating each item in the scale with the total score of the scale. Using this procedure Golden and his coworkers (1981, 1982) reported that the items on each scale appear to tap the same general construct suggested by the scale name. Golden, Fross, and Graber (1981) found that of the 269 items in the battery, 250 were more highly correlated with the scale in which they were placed than with other summary scales.

Generally, factor analysis can be used to simplify data so that one can uncover the underlying dimensional structure of an instrument. It can also be used to evaluate a theoretical model. Golden and his coworkers factor analyzed the LNNB scales and reported that, with the exception of the Receptive Speech scale, the LNNB's factor structure is compatible with Luria's (1966, 1973) theory. Unfortunately, there are some methodological problems with the factor analyses which tends to question this conclusion. The first problem is the use of variables which are measured on an ordinal scale with few categories (Comrey, 1978; Kim and Mueller, 1978). Kim and Mueller (1978) argue that a factor analytic model may not be meaningful for dichotomous or trichotomous variables. The second problem is that the factor analyses were performed on the combined data from neurologically intact, psychiatric, and brain-damaged patients, with no consideration that the factor structures could differ in the three populations (Spiers, 1982).

If a new instrument is found to correlate highly with a well-established instrument, one can regard this as evidence for construct validity (provided, of course, that both instruments measure the same construct). Golden, Kane, Sweet, Moses, Cardellino, Templetion, Vincente, and Graber (1981) correlated the fourteen LNNB scales with fourteen variables selected from the Halstead-Reitan Neuropsychological Test Battery (HRNTB). The use of multiple-correlation procedures suggested that the fourteen LNNB scales were highly correlated with each of the fourteen HRNTB variables (mean multiple correlation was .87). This finding suggests that the two batteries overlap considerably in the information they provide. In addition, the LNNB scales have been found to correlate highly with the Verbal and Performance IQs of the Wechsler Adult Intelligence Scale (McKay, Golden, Moses, Fishburne, & Wisniewski, 1981). This finding should not be surprising, if one considers that the WAIS is a measure of adaptive functioning (Matarazzo, 1976) which is also sensitive to brain damage.

In spite of the above mentioned limitations the LNNB for adults has been well received in applied settings. There are probably two major reasons for this wide acceptance. Firstly, the administration time of the LNNB is relatively short (about 2 1/2 hrs); secondly, the LNNB test kit is compact and completely portable.

1.7 Luria's Model of Brain Development and the LNNB-Children's Version (LNNB-C)

Since the LNNB for adults has been very well accepted, Golden and coworkers (Golden, 1981; Plaistead, Gustavson, Wilkening and Golden, 1983) recently published a corresponding children's version of that battery, the LNNB-C. Compared to the adult version, the LNNB-C has fewer items (149 vs.269). Historically, neuropsychological batteries assessing children were downward extensions of adult batteries. However, Golden and his coworkers have pointed out that young children may be qualitatively as well as quantitatively distinct from adults. Therefore, optimal neuropsychological assessment methods for children should assess skills which are not only sensitive to brain functions, but which are also developmentally relevant. The children's version of the LNNB was, therefore, designed to reflect Luria's model of brain development. It is, therefore, helpful to briefly outline, at this point, Luria's model (adapted from Golden, 1981).

Luria's model of brain development: Involves developmental stages which parallel the developmental stages proposed by Piaget (1969). As the child grows older, it passes through a predictable sequence of stages which are characterized by qualitative differences in behavioral capacities:

Stage 1 involves the development of the arousal unit (upper brainstem, reticular formation, or block 1 in Luria's terms). This stage develops from birth to age four months.

Stage 2 involves the development of motor and sensory areas (primary areas and zone 1 in Luria's model). This stage matures concurrently with stage 1 and becomes fully mature at age 4 months.

Stage 3 involves the development of motor and sensory secondary areas (zone 2 in Luria's model). The development of this stage begins at birth but extends to about age five years. Up until approximately age five years most learning is rote and cross-modality learning is not integrative.

Stage 4 involves the development of the sensory tertiary areas (parietal lobe). The child passes through this stage from ages five to eight years. At this stage the child is generally capable of integrative cross-modality learning.

Stage 5 involves the development of tertiary areas involved in output/planning (prefrontal lobe). The development of this stage begins at adolescence and, in some individuals, is not complete until the age of 24 years (Golden, 1981). Therefore, children with prefrontal-lobe damage may remain symptomless until they are 12-15 years or older. As a result, tests measuring stage-5-level skills (e.g., the Category Test of the HRNTB) are not considered appropriate for children aged 8 to 12 years.

The LNNB-C covers the age range from 8 to 12 years. Golden (1981) suggests that neuropsychological assessment of children should wait until age eight, because at this age one can be sure that the child is at stage 4. When constructing the LNNB-C Golden (1981) eliminated from the adult battery items assessing stage 5 (i.e., prefrontal functions). The remaining items were then screened for age appropriateness of the instructions and content. The screening involved, at first, the administration of the adult items to a small group of above-average children followed by testing larger groups of children to ensure appropriateness. Many items were eliminated by such successive screenings. One-hundred-twenty children (24 at each age level from 8 to 1 years) provided norms for the final (fourth) revision. Golden (1981) reported that the results of these standardization studies were "clearly in line with theoretical expectations" (p. 295). Stage-1-3 items showed little improvement with age, while stage-4 items improved with age. A recent study (Carr, Sweet, and Rossini, 1986) involving children with neurological and psychiatric problems as well as normal controls investigated the diagnostic validity of the LNNB-C by comparing it to the WISC-R. A stepwise discriminant analysis showed that the LNNB-C and the WISC-R correctly classified 81% and 85% of the children respectively. The authors argued that similarities and differences in the content of these two instruments should be considered when deciding which instrument to administer.

1.8 The Manitoba Revision and Extension of LNNB-C

The above-mentioned criticisms of the adult LNNB are especially valid with respect to the LNNB-C: There is a need for better norms providing information about age trends and possible sex differences. The scoring system needs improvement. More importantly, the method used by Golden (1981) to select test items may not accurately reflect brain development. Specifically, the elimination of adult items, because they were unsuitable for children, does not establish that these items are prefrontal-lobe items, or even stage-5 items. Finally, the usefulness of the LNNB-C for educational settings (e.g., its ability to detect learning disabilities) remains to be demonstrated.

In order to overcome some of the above-mentioned limitations of the LNNB-C, Lundin (1982) revised the LNNB-C. This revision which is suitable for children aged 8 to 12 years is called the Manitoba Revision of the LNNB for Older Children or MLNNB-OC. The revision involves changes in scoring procedures and the instructional language for the individual test items as well as the addition of a preliminary-examination section. The preliminary examination was adapted from Christensen (1975) with some alterations designed to rule out peripheral-nervous-system disorders and spinal-cord/cerebellar damage. Further, the preliminary examination can be used to direct attention to specific areas suspected of impairment. The examiner can use the results of the preliminary examination to leave out portions of the MLNNB-OC which are not directly relevant to the child being tested.

The LNNB-C and the MLNNB-OC can be administered to children 8 years or older. At that age, however, children with neurological impairment and learning disabilities have experienced academic problems for several years. Valid neuropsychological tests for younger children are needed, because early identification of neurological problems and the resulting decisions about remedial programs should be made as early as possible (see e.g., Spreen 1978). In order to meet this need Lundin (1982) revised the LNNB-C to be suitable for children aged 5 to 7 years. This preliminary version is called the Manitoba Revision of the LNNB for Young Children or MLNNB-YC. The MLNNB-YC also has a preliminary-examination section. Several LNNB-C scales have been revised completely. Some scale names have been changed to reflect readiness skills rather than proficiency skills (ie., the Reading scale is renamed Reading Readiness Skills). Since it is uncertain whether children aged 5 to 7 function at the stage-4 level, stage-4 items have been either simplified or eliminated.

Practically all psychological tests including the LNNB and its adaptations rely on verbal instructions and assume that the teste's receptive speech is intact. Such an assumption cannot be made in the case of brain-damaged or learning-disabled children. It is not certain to what extent poor receptive speech influences the performance on other LNNB scales. The LNNB and its children's version have Receptive Speech tests placed somewhere in the middle of the battery. Since receptive-speech impairment may influence the scores of other items/scales in the battery, the Receptive Speech Scale is administered first in testing children with the MLNNB-YC and MLNNB-OC.

Halldórsson (1984) made an Icelandic Adaptation of the LNNB-OC by translating an earlier version of the MLNNB-OC (Lundin, 1982) into Icelandic and by adapting it for use with Icelandic school children. He used a sample of 261 normal school children with "average" school performance in socioeconomically "average" schools to establish age norms. He significantly modified the scoring system of Golden's LNNB-C by using an age-independent "absolute" scoring of items. Thus a given item was scored in the same way regardless of the child's age. Thereafter, he totalled item scores into scale scores and converted the scale scores into age-corrected T-scores. Halldorsson also tested 53 children labelled "learning disabled" and 10 children with verified brain damage. With appropriate cut-off criteria the Icelandic LNNB-OC could correctly classify all the normal, learning-disabled and brain-damaged children. Learning-disabled children exceeded the cut-off criterion on one or two scales, while brain-damaged children usually exceeded the criterion on more than five scales. None of the normal children exceeded the cut-off criterion on any scale. However, the study had problems in the area of subject selection, in the sense that teacher judgement was relied on to identify normal and LD children and a physician's judgement was relied upon to identify BD children. The present study, following Halldorsson's scoring system, employed more rigorous criteria for selecting normal, "learning-disabled" and "brain-damaged" children.

1.9 Neuropsychological Assessment and Learning Disabilities

Both empirically and clinically, the study of "learning disabilities" (LD) has largely focused on the investigation of developmental-reading disorders. There is a lack of agreement about the definition of "learning disability". Recently, many clinicians have argued that "learning disability" is not a single diagnostic entity but a group of several distinct syndromes (eg., Benton, 1978; Mattis, French, and Rapin, 1975; Spreen, 1976). Denckla (1979) has identified as many as ten common syndromes of LD. Her subgroups are based on a clinical-inferential classification system. Other investigators have found similar subgroups (Boder, 1973; Denckla and Rudel, 1976; Kinsbourne and Warrington, 1963; Mattis, 1980; Pirozzolo and Rayner, 1979).

It is estimated that about six percent of North American school children suffers from "learning disabilities" (Gaddes, 1985). Neurological studies tend to attribute the etiology of learning disabilities to cerebral dysfunctions. Evidence from neuropsychological investigations employing a wide variety of methodologies point to this conclusion. Studies of tachistoscopic half-field word recognition (Marcel, Katz, and Smith, 1974; Marcel and Rajan, 1975; Pirozzolo and Rayner, 1979; Witelson, 1977; Yeni-

Komshian, Isenberg, and Goldberg, 1975), dichotic listening (Obrzut, Hynd, Obrzut, and Pirozzolo, 1981), dichaptic shape discrimination (Witelson, 1977), reading and spelling errors (Boder, 1973; Obrzut, 1979; Pirozzolo and Hess, 1976), language-test performance (Mycklebust, 1968), eye movements recorded during reading (Pirozzolo, 1979; Pirozzolo and Rayner, 1979; Zangwill and Blakemore, 1972), neuropsychological and educational assessments (Rourke, 1975, 1976a, 1976b, 1978a, 1978b, 1981a, 1981b, 1982, 1983), saccadic latency (Pirozzolo, 1979), and other neuropsychological test performance measures (Mattis et al., 1975) all argue for such an explanation. In general, neuropsychological research in this area has shown that there are probably several subtypes of these disabilities. With respect to reading disorders, at least two major forms have been identified, an auditory-linguistic type and a visual-spatial type (Rourke, 1981a, 1981b). There is evidence suggesting other subtypes as well (Denckla, 1979). Rourke and his coworkers (Rourke and Finlayson, 1978; Rourke and Strang, 1978) have found that the type of LD may vary with the age of the child. Between the ages of 5 and 15 there is a decline in the prevalence of visual-spatial disorders while psycholinguistic problems increase.

Neuropsychological assessment of LD children focused on delineation of the type of LD involved. Luria's model of brain functions and the current conceptualizations (e.g., Rourke and coworkers) about LD assume that most component skills are intact, with only one or a few component skills impaired. Thus diagnostic testing of LD children focuses on identifying the impaired components. Rourke's studies (Rourke, 1981 in Filskov and Boll vol.1 pp.464-474) suggest that LD children tend to show normal performance on most WISC subtests with clear deficits on one or two subtests. On the on most WISC subtests with clear deficits on one or two subtests. On the other hand, the same studies show that the broadly-based Halstead tests (e.g., HRNTB for children) were not able to identify the impaired components in LD children. The Halldorsson study, mentioned above, suggest that LD children function within the normal range on most LNNB-OC scales but are very deficient on one or two scales. This finding suggests that the MLNNB-YC and MLNNB-OC might be fruitful in identifying specific deficits in LD children.

1.10 Research Goals

The basic research goals in the current study were:

1. To extend Luria's model of brain development to younger children in response to a need for early identification of learning deficits, and to investigate the downward extension of Luria's battery to ages 5-7 years, and thereby assess its suitability. In Piaget's stages this is the beginning of the concrete operational stage.
2. To improve and to work out the basic methodological properties of the LNNB-YC, and -OC.
3. To obtain good age norms and to devise an improved scoring system for the test.
4. To observe and document for normal children age trends and possible sex differences in different abilities.
5. To examine the sensitivity of the MLNNB-YC, and -OC to delineate patterns of LD by comparing LD children with controls through performance levels, pattern profiles, and other diagnostic criteria. According to Luria's model it is hypothesized that greater diagnostic sensitivity will be displayed by Luria's tests in comparison to the Halstead-Reitan tests. Greater sensitivity is defined in terms of

pointing out the specific problems of malfunction which should be shown by the MLNNB-YC, -OC.

6. To provide evidence for the validity of the MLNNB-YC and -OC by comparing them with the children's version of the HRNTB. The batteries will be compared for their capability to identify brain damage in a group of children with documented brain lesions.
7. To examine the current model of LD which postulates that LD children perform normally on most component functions, but have severe deficits on one or two functions.

CHAPTER 2

METHOD

2.1 Subjects

2.1.1 The normative sample (normal controls or NC)

The normative sample comprised "normal" children attending elementary school (grade 1-6) in Winnipeg. Children were selected from five different schools located in areas considered "middle class". The principal of the school asked the teachers to select a number of children with "average" school performance. The children were then selected from this original pool, on the basis of average grades and average scores on the Metropolitan Readiness Test (Nurss and McGauvran, 1974). Further criteria for inclusion in this study were: general good health as indicated by school-nurse records; freedom from any signs of emotional instability or behavioral abnormalities; the absence of any sign of cultural deprivation. A special effort was made to obtain an equal number of boys and girls for each age group. The parents of 200 children meeting all these criteria received a letter explaining the study and requesting their written consent to their children being tested. The final sample consisted of 193 children distributed across the six grades as depicted in table 1 (p. 35).

2.1.2 Children with learning disabilities (LD)

The "learning disabled" or LD children were selected from an original pool of 200 children referred to the Child Guidance Clinic of Greater Winnipeg for various learning problems. The criteria described by Rourke (1975; 1980; 1981, p.453) were then used to select the LD children. According to these criteria the "learning-disabled" children of this study were selected to have all of the following characteristics: a) a marked performance deficit in at least one academic subject, according to teacher ratings and report cards; b) WISC-R (Wechsler, 1974) IQ scores within the normal range (for this study, 95-110); c) freedom from primary emotional disturbance; d) adequate visual and auditory acuity; e) residence in communities where socioeconomic deprivation is not a factor; f) a medical history with only the usual childhood illnesses; g) regular school attendance since age five; h) English as their native language.

Additional criteria used for selecting some LD children were: (a) selected score deficits on a number of school-administered tests (Metropolitan Readiness Test, Nurss and McGauvran, 1974; Peabody Picture Vocabulary Test, Dunn, 1965) and (b) on a test for the early identification of reading readiness (Ready Steps, Hillerich and Johnson, 1977) which was administered by a reading clinician to children with suspected LDs. Reading clinicians were also asked to assist in identifying LD children who had been tested with either the Braun-Nielsen Pre-Reading Inventory (Braun and Nielsen, 1979) or the Detroit Test of Learning Aptitude (Baker and Leland, 1959).

Parents of children identified as "learning disabled" were then asked to give permission for their children's anticipation in this study. Only children for whom written permission from parents was secured participated in the study. The final sample of LD children consisted of 50 Children. These LD children came from the same schools as the children of the normative sample. In some later analyses the LD children were matched pair-wise with children from the normative sample. (ie., controls of same age/sex and similar background as LD subjects).

2.1.3. Children with documented brain damage (BD)

Twenty-eight children with documented brain injury (BD) were selected for this study. Eighteen of these came from the same schools as did the NC and the LD children. The BD children had independent and definitive neurological evidence of having sustained structural brain damage or neurological diseases. No attempt was made to select for type of brain damage. In order to compare the relative power of the MLNNB-C vs. the HRNTB-C in localizing and correctly diagnosing brain lesions detailed neurological information was not obtained until the completion of the neuropsychological testing. The only restrictive criterion for inclusion in the BD sample was testability (i.e., ability to understand instructions, adequate vision and hearing, and relative freedom from peripheral-nervous-system defects). Table 1 compares the age and grade distribution of the BD children with that of the NC and LD children. In some later analyses the BD children were matched pair-wise with children drawn from the normative sample (i.e., controls of same age/sex and similar background as BD subjects). As the onset of injury in the BD sample is an important variable, data on onset of injury was considered worthy of documentation (summarized in table 2).

Table 1

Grade, Sample size; Mean and Standard Deviations of Ages of the three groups of children

	NC Sample			LD Sample			BD Sample		
Grade	N	Age	SD	N	Age	SD	N	Age	SD
1	30	80	2.3	7	79	3.4	6	84	3.7
2	33	94	4.1	9	93	3.2	5	96	4.2
3	30	108	4.2	10	108	2.8	5	112	3.8
4	34	119	3.8	10	124	2.9	5	123	4.3
5	30	131	4.7	8	129	3.6	4	133	2.4
6	36	144	3.2	8	146	3.8	3	148	5.5

Note: The mean age is given in months. NC = normal control children, LD = learning-disabled children, BD = brain-damaged children.

Table 2

Brain-damaged children classified according to grade and time interval between onset of injury and time of testing

Grade	Congenital N	Four Years N	Three Years N	Two Years N	One Year or less
1	1	2	0	3	0
2	0	1	2	2	0
3	0	0	2	2	1
4	0	0	2	2	1
5	0	1	0	3	0
6	0	0	0	2	1
Total:	1	3	6	14	1

2.2 Tests

2.2.1 The Manitoba Revision of the Luria-Nebraska Battery for Older Children (MLNNB-OC).

The MLNNB-OC was used with children aged 8-12 years. Basically, all the test items of the LNNB-Children's Version (Golden et al., 1981) were retained. However, in order to facilitate the test administration to language-disordered children some slight modifications were made in the instructional language. The general scoring and administration instructions for the LNNB-C (Golden et al., 1980) advises that the task instructions "may be paraphrased as long as the intent with each item is not subverted" (p. 14, Manual). The intent of each item is to elicit a behavioral response which allows the examiner to evaluate some labelled dimension (e.g., Expressive Speech). Therefore, it has been found to be desirable to have easy instructions that lead to a scorable response on the particular dimension to be evaluated. With the exception of some items on the Receptive-Speech scale the intent of most other test items is not to assess the child's ability to comprehend instructions, but rather to evaluate the integrity of a particular component function. The Preliminary Investigation, (a pre-test interview and history taking see Appendix A) advocated by Luria was revised to some extent and added to the battery. This addition prolongs testing time, but can be of great value for interpreting the test results. Appendix B gives the items of the MLNNB-OC.

Generally, the battery consists of 150 items distributed among eleven major scales: Motor, Rhythm, Tactile, Visual Functions, Receptive Speech, Expressive Speech, Writing, Reading, Arithmetic, Memory, and Intellectual Process. The number of items in each scale varies with the scale. Three additional scales were generated by selecting test items that have lateralizing significance (Left- and Right-Hemisphere Scales) or pathognomic significance (Pathognomic Scale). These scales were composites of items selected from among the eleven major scales mentioned above. Some scales are further subdivided into subscales each of which attempts to measure some aspect of the title scale. There are 52 sub-scales in all.

2.2.2. The Manitoba Revised Extension of the Luria-Nebraska Battery for Young Children (MLNNB-YC).

The MLNNB-YC was used with children aged 5-7 years. This version of the battery has retained all the major characteristics described above for the MLNNB-OC in terms of general structure, number of items, major scales and sub-scales. However, some of the items have been simplified. The Writing, Reading, and Arithmetic scales were reconstructed so that they assess readiness skills in these areas rather than proficiency. For instance, one cannot test reading skills in a child who is barely beginning to learn how to read. The simplified YC items can be found in Appendix A.

2.2.3. The Halstead-Reitan Neuropsychological Test Batteries for Children.

The 28 BD children were tested on one of the two Halstead-type batteries: (a) Children aged 5 to 8 years were tested on the Reitan Indiana Neuropsychological Battery for Children's or RINB-C. (b) Children aged 9 to 12 years were tested on the Intermediate Version of the Halstead-Reitan Neuropsychological Test Battery for Children or HRNTB-C. In addition, 28 LD children of the same age and sex as the BD children were tested on the RINB-C or HRNTB-C. The two Halstead-type batteries have almost identical items, but they have different scoring systems and age norms. The RINB-C is a down-scaling of the HRNB-C.

The following tests were administered as part of the RINB-C or the HRNTB-C (For a more complete description see Knights, 1980; and Reitan and Davidson 1974):

(1) Tapping (Finger Oscillation Test): The child is asked to tap a telegraph key (Meylan finger counter, Knights and Moule, 1967) as quickly as possible with the index finger. Tapping alternates between the dominant and nondominant hand. Motor speed is assessed. The score is the mean of the fastest three out of five 10-second trials of each hand.

(2) Marching: This test consists of connecting circles with a crayon ("marching up the page") as quickly as possible. The test is scored by recording the number of circles the child is able to complete in the time allotted. This test evaluated gross-skeletal- muscles functions.

(3) Seashore Rhythm Test: In this test the child is asked to say whether pairs of rhythms are the same or different. The score is an error score.

(4) Speech Sound Perception Test: The child listens to nonsense syllables consisting of consonants before and after the vowel sound "ee". The child is asked to select the correct syllable from four alternatives. The score is an error score.

(5) Tactual Performance Test or TPT: The child is blind-folded and asked to fit different-shaped blocks into holes of a form board. The child performs the task first with the dominant hand, then with the nondominant hand, and finally with both hands. The Time scores are the times taken for each of the three trials. The form board is then hidden and the blind fold is then removed. The child is given a piece of paper and is asked to draw the holes of the form board. The Memory is the number of correct shapes the child

draws regardless of location. The Location score is the number of correct shapes in the correct locations.

(6) Trail Making Test for Children: The test consists of two parts. In Part A the child is asked to connect numbered circles with a pencil line in numerical sequence (i.e., 1-2-3-) as quickly as possible. In Part B the child is asked to connect circles with numbers and circles with letters in an alternating sequence (i.e., 1-A-2-B-). The scoring consists of the time taken and the number of errors made.

(7) Aphasia Screening Test or AST: The child is asked to do a number of standardized pathognomic tasks traditionally used in neurological examinations: such as naming common objects, spelling,reading, and copying simple words, counting, copying simple shapes, identify body parts, differentiate left from right. The scoring was according to the method described by Telegdy, Richardson, and Knights, (1969).

(8) Auditory and Target tests (Reitan, 1969): The test involves Speech Discrimination/Perception, Auditory Closure, Sentence Memory, Verbal Fluency, Mimicry, and Target (following with a pencil on paper a pathway traced by the examiner on a board attached to a wall). In this study, the Speech Discrimination (Strong) was used as part of the RINB-C. The score is total out of 25. Speech Perception (Reitan) was as part of the HRNTB-C. The score is total out of series A,B,C, 30 trials. The Auditory Closure (Kass) score is the total number of words produced correctly. The score of Sentence Memory (Benton) is the total number of sentences repeated. The score of Verbal Fluency (Strong) is the mean number of correct words obtained in two 60-second trials. The score of Mimicry is an error score. The score for Target is the number of paths correctly drawn.

(9) Progressive Figures or PF: The test consists of simple figures within other simple figures (e.g., a circle within a triangle). The child is asked to start with the first inside figure #1 trace a path to an outside figure #2 which matches the inside figure #1, then trace a path from inside figure #2 to another outside figure #3 which matches inside figure #2 etc. There are time and error scores. In this study the Matching Pictures subtests 1 to 4 (Knights, 1980) is added to this test. The Matching Pictures score was an error score.

(10) Individual Performance or Ind. Perf. Test: In the first part Matching "V"'s the child is asked to match stimulus figures (i.e., "V"s) in accordance to the sizes of the angles involved. In the second part Star the child is asked to copy a six-sided star. In the third part the child is asked to copy a figure made up of concentric circles. Scoring of all three parts is in terms of time taken and errors.

(11) Category Test or Cat.: The child responds to stimulus figures projected on a screen by pressing one out of four colored buttons. The child is asked to find a principle which suggests which button should be pressed in response to the stimulus figures. There are five series of stimulus figures. The figures of a given series follow the same principle. Correct responses are followed by a chime and incorrect responses are followed by a buzz. The score is the number of incorrect responses.

The above 11 tests were used in the statistical analyses of this study and in the calculation of the Impairment Ratios (see 3:2:3). Knights' (1980) age norms were used to obtain age-corrected scores and to evaluate the test results. In addition to the above 11 tests, two additional tests were also administered to all children: Maze Coordination (Reitan and Davison, 1974, p.378) and WISC-R. Moreover, a composite Laterality Index was developed from laterizing indicators of the above 11 test. Maze Coordination, WISC-R and the Laterality Index were used in the clinical-neuropsychological assessment of individual children, but were not used in the statistical analyses of this study.

2.3. Procedure

2.3.1. Testing:

The MLNNB-OC, or the MLNNB-YC were administered according to standardized procedures to every child in the NC, the LD and the BD groups. All children were given the entire battery in one session and all of them had a complete set of test scores. Testing occurred in a room located in the school attended by the child. This room had good illumination and a low extraneous-noise level. Individual information was coded to insure the anonymity of all children. Since the HRNTB-C is not portable, it was administered in the Child-Guidance Clinic. The children taking the HRNTBC came to the clinic accompanied by their parents. The children tested with the HRNTB-C were, at the time of testing, referred to the Clinic for diagnostic evaluation, rather than for research purposes. Written parental permission was obtained to analyze the results of this clinical testing for research purposes.

2.3.2 Revised scoring procedure for the MLNNB-OC,YC:

A new method of scoring MLNNB-YC and MLNNB-OC items and scales was developed for this study. Only "Raw Scores" were recorded during the testing of each child. The method of obtaining Raw Scores was basically that of the LNNBC (Golden et al., 1980). These Raw Scores of the test items are very heterogeneous: some items have time scores; other items are scored in terms of number of responses within the time limit; other items are scored in terms of pass/fail criteria; other items count the number of errors; while other items involved qualitative evaluation according to some criterion. In order to make these heterogeneous Raw Scores comparable, methods were devised to convert these Raw Item Scores into a 0-1-2 system of scores (0 = best,2 = worst). An "absolute" rather than an age-corrected scoring system was decided upon, which means that a particular child's 0-1-2 Score on each item depends on the child's performance relative to "Best-Performance Norms" and does not depend on the child's age. The method of establishing Best-Performance Norms varied with different kinds of Raw Scores. For test items yielding continuous scores (e.g., time scores, error scores) the performance of the oldest age group (i.e., the 7-year olds for MLNNB-YC, the 12-year olds for the MLNNB-OC) was taken as the standard. The means and standard deviations of this oldest group were calculated. Children of any age whose Raw Score were within one standard deviation of the oldest group were given the score 0; those whose performance was between one and two standard deviations worse than the oldest group were given score 1; and those whose performance was more than two standard deviations worse than the oldest group were given the score 2. The Raw Scores of pass/fail items were converted into 0-1-2 Scores in a dichotomous way (i.e., pass = 0, fail = 2). The performance on items requiring qualitative scoring (e.g., drawings) was initially scored in terms of Point Violations. The Point Violations of the oldest group were then used as the "Best-Performance Norms" against which the scores of children of all ages were then converted into 0-1-2 Scores. Appendix C gives concrete examples as to how Raw Scores were converted into 0-1-2 Scores. This "absolute" 0-1-2 item-scoring system implies that as children grow older their 0-1-2 Scores can be expected to improve (ie., fewer 1's and 2's).

The 0-1-2 Scores of individual items were then used to calculate Scale Scores and T-Scores. Scale Scores were calculated by adding up, for each individual, the 0-1-2 Scores associated with a given scale (e.g., Rhythm) and by then dividing this total by the number of items in that given scale. The Scale Scores may be regarded as averaged 0-1-2 Scores with numerical values between 0 and 2. Since Scale Scores are not age-corrected one can expect that younger children have generally higher Scale Scores than older children. For each age group of the normative sample (e.g., 8-year old children) the means and standard deviations were calculated for each Scale Score. This information was then used to convert the Scale Sores of each age group into T-Scores with a mean of 50 and a standard deviation of 10. In contrast to the 0-1-2 Item and Scale Scores the T-Scores are age corrected. Appendix E shows the means and standard deviations of each age/sex group for each scale and also gives tables for converting Scale Scores into T-Scores.

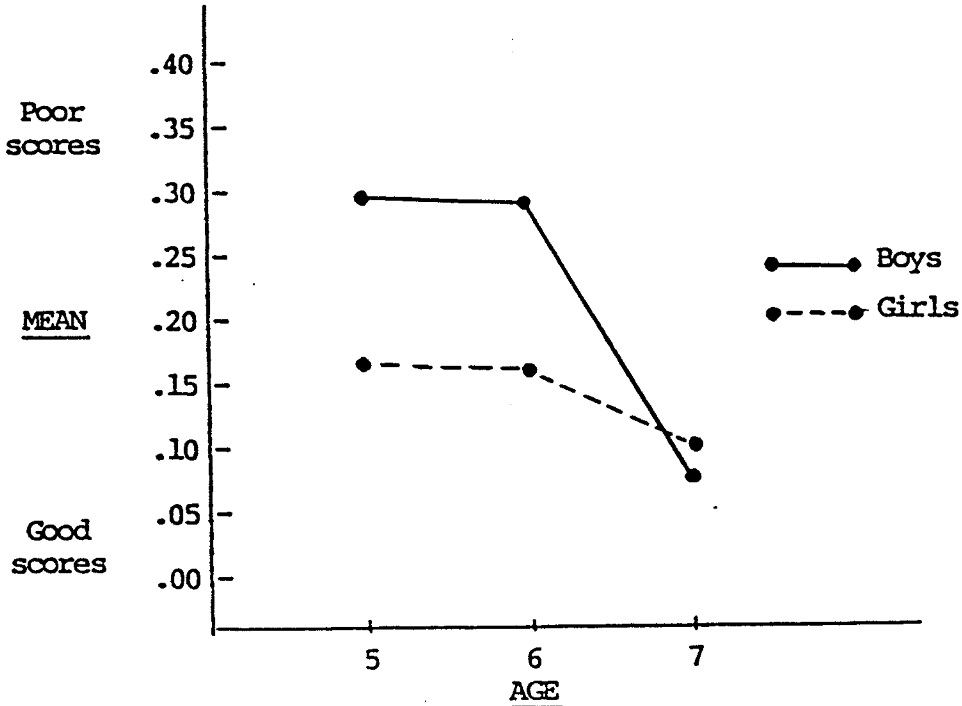
On the basis of Halldorsson's (1984) study it was decided to count a T-Score > 80, that is three standard deviations worse than the mean of normal children of one's age group as indicative of "impaired" performance on a given scale (see also 3.2.1). For a given child, the number of scales with T-Scores > 80 (" failed scales" indicative of "impaired" performance) was then divided by the number of major scales (i.e., 11) to calculate his/her "Impairment Ratio". Since the data of this study were also used to develop and evaluate the new scoring system, sections of Chapter 3 will present results related to the new scoring system.

CHAPTER 3

RESULTS

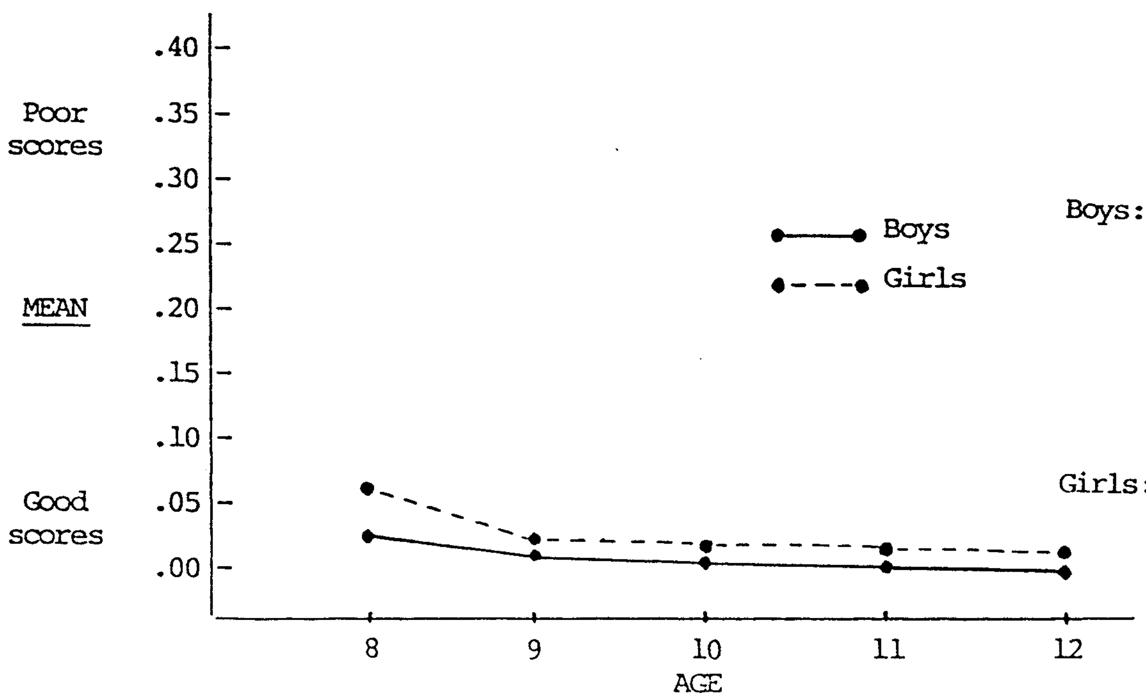
3:1 Age Trends and Sex Differences

The averaged Scale Scores (see 2.3.2) and corresponding standard deviation were calculated for each age/sex group (e.g., 5-year-old boys). These data were then plotted on graphs for each of the eleven major scales. Separate graphs were made for MLNNB-YC and MLNNB-OC scales. Two-way analysis of variance were performed to determine whether age effects and sex differences (whenever they occurred) were statistically significant and whether there were any interaction effects. Where the analysis of variance was significant, *t*-tests were used to determine those age groups with significant differences. The few statistically significant age and sex differences were all at the $p < .05$ level of a 2-tailed test. Figures 3:1 - 3:12 show age trends and sex differences for all the eleven major scales and the combined (average over all scales) scale. Only significant differences are reported under the figures.



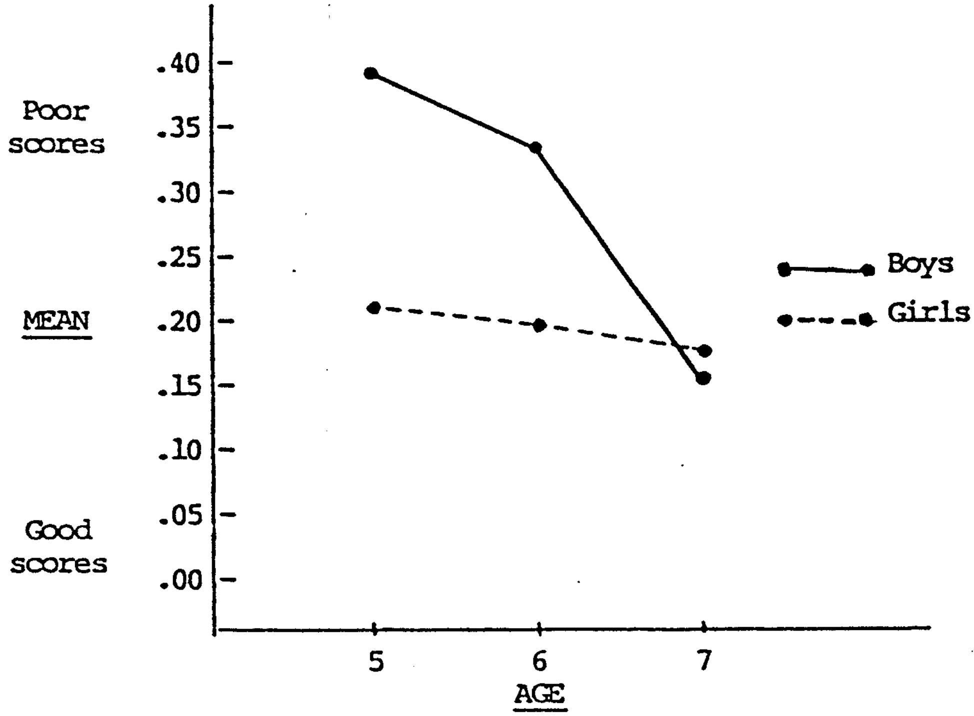
Boys:	Age	SD
	5	.48
	6	.52
	7	.33
Girls:	5	.52
	6	.39
	7	.34

Figure 3:1a. Age trends and sex differences on the MOTOR SCALE for the younger children's version of the battery (YC). Age: F 2,47=3.31*;6-7 years t=13.7*. SEX:F 1,47=6.03*, t= 14.24*. * p<.05.



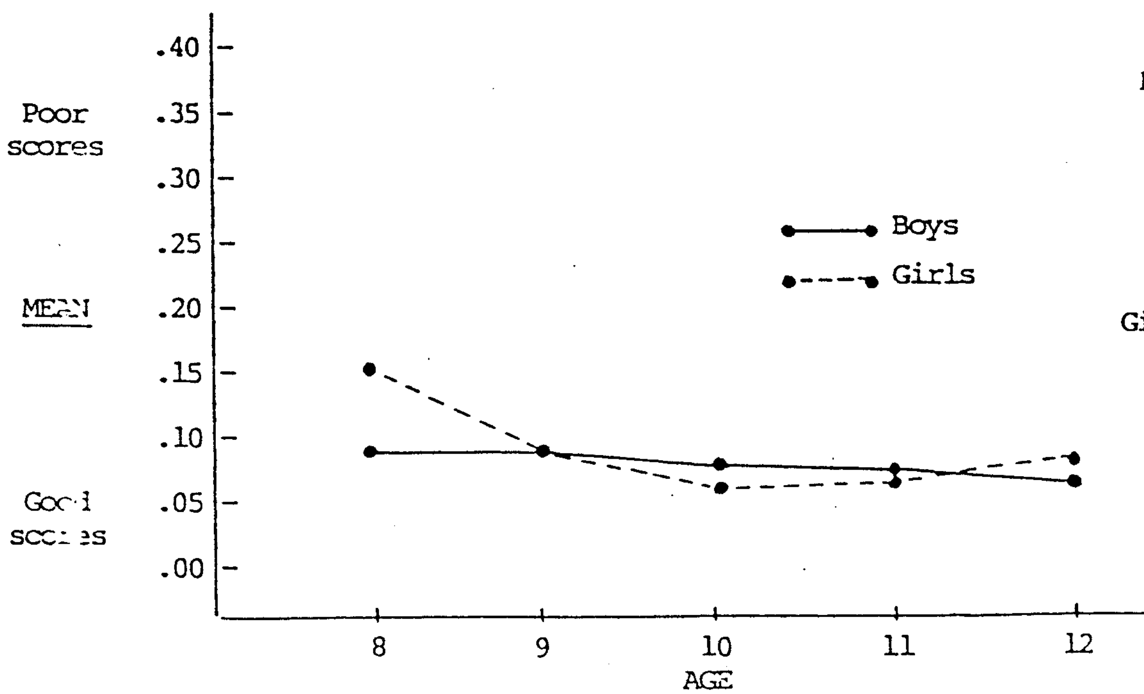
Boys:	Age:	SD
	8	.28
	9	.26
	10	.24
	11	.19
	12	.17
Girls:	8	.29
	9	.25
	10	.22
	11	.20
	12	.14

Figure 3:1b. Age trends and sex differences on the MOTOR SCALE for the older children's version of the battery (OC).



	Age	SD
Boys:	5	.66
	6	.57
	7	.33
Girls:	5	.38
	6	.43
	7	.15

Figure 3:2a. Age trends and sex differences on the TACTILE SCALE for the younger children's version of the battery (YC). Age: F= 2,47= 3.26*; 5-7 years (boys) t=6.31*. Sex: F 1,47=4.36*; t= 12.3* * p<.05.



Boys:	8	.42
	9	.36
	10	.19
	11	.16
	12	.17
Girls	8	.16
	9	.23
	10	.13
	11	.09
	12	.12

Figure 3:2b. Age trends and sex differences on the TACTILE SCALE for the older children's version of the battery (OC).

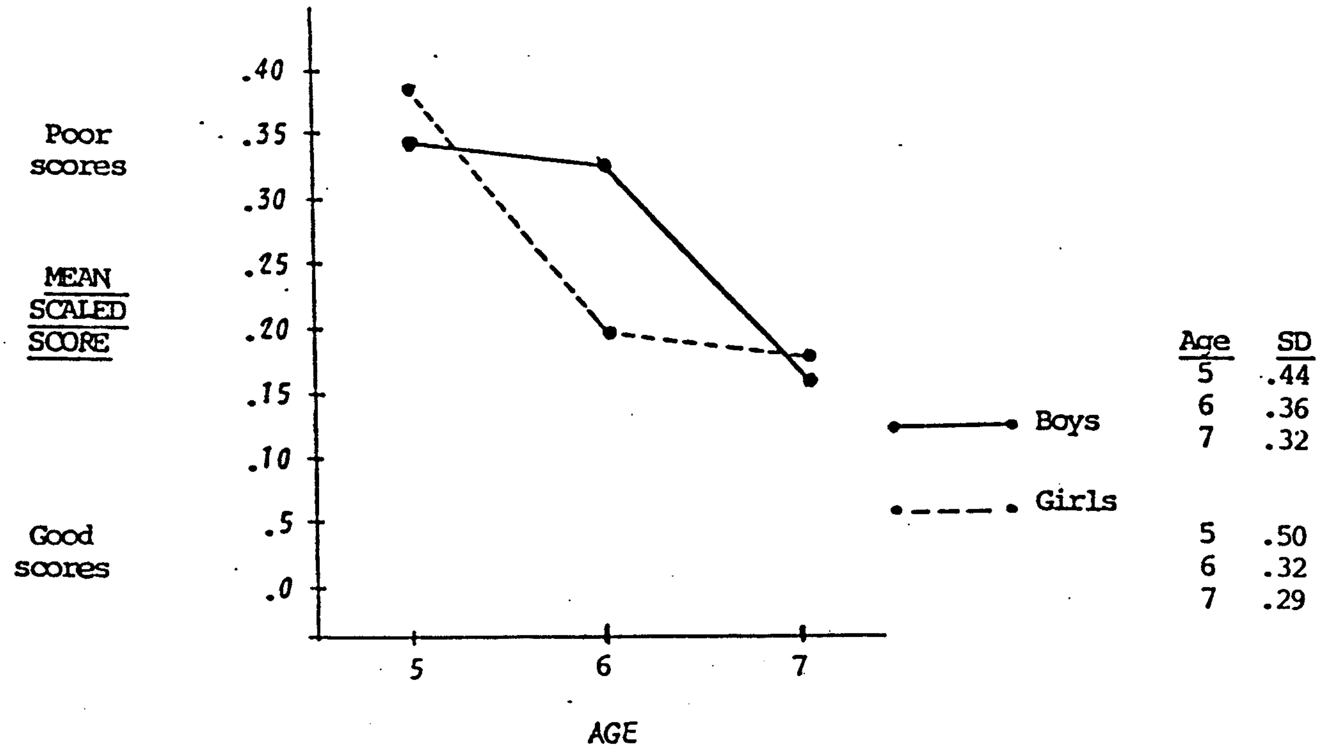


Figure 3:3a. Age trends and sex differences on the VISUAL SCALE for the younger children's version of the battery (YC). Age; F 2,47= 4.92* 5-7 years t= 6.23*; Sex: F 1,47 =4.16* (6) t= 13.9*. * $p<.05$.

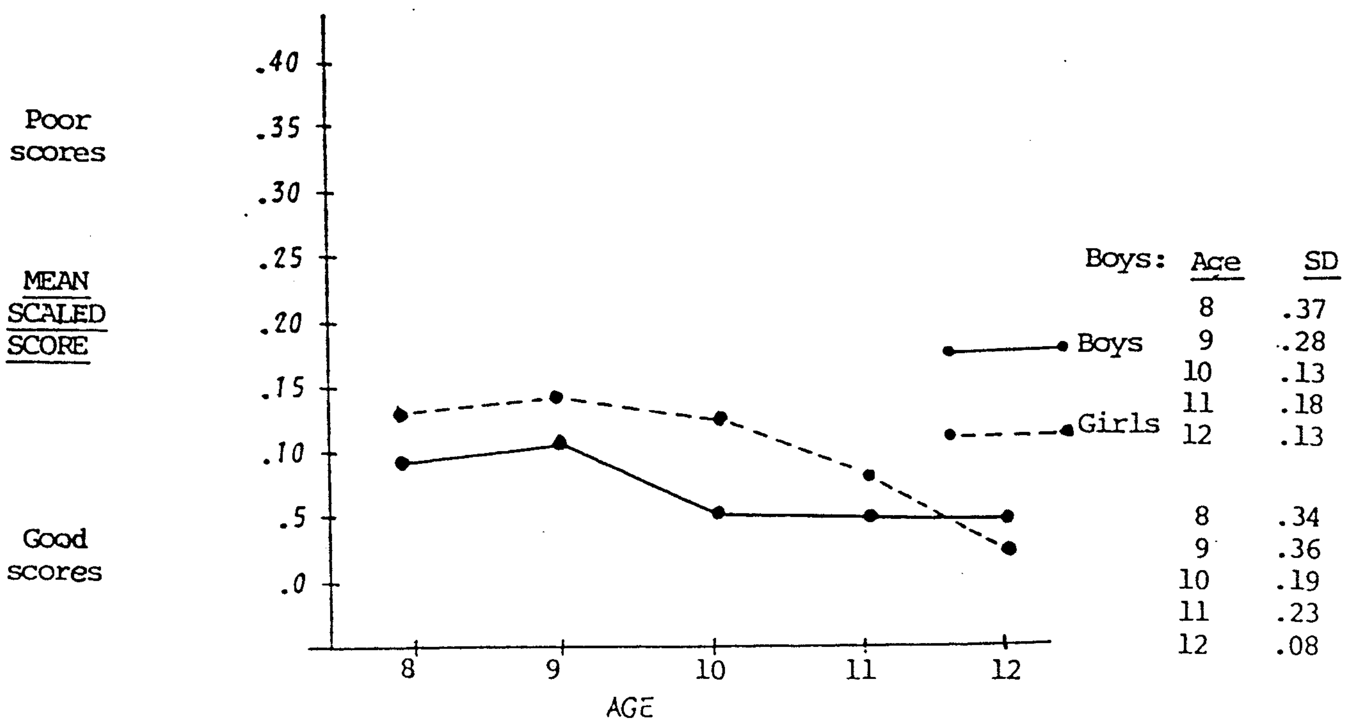
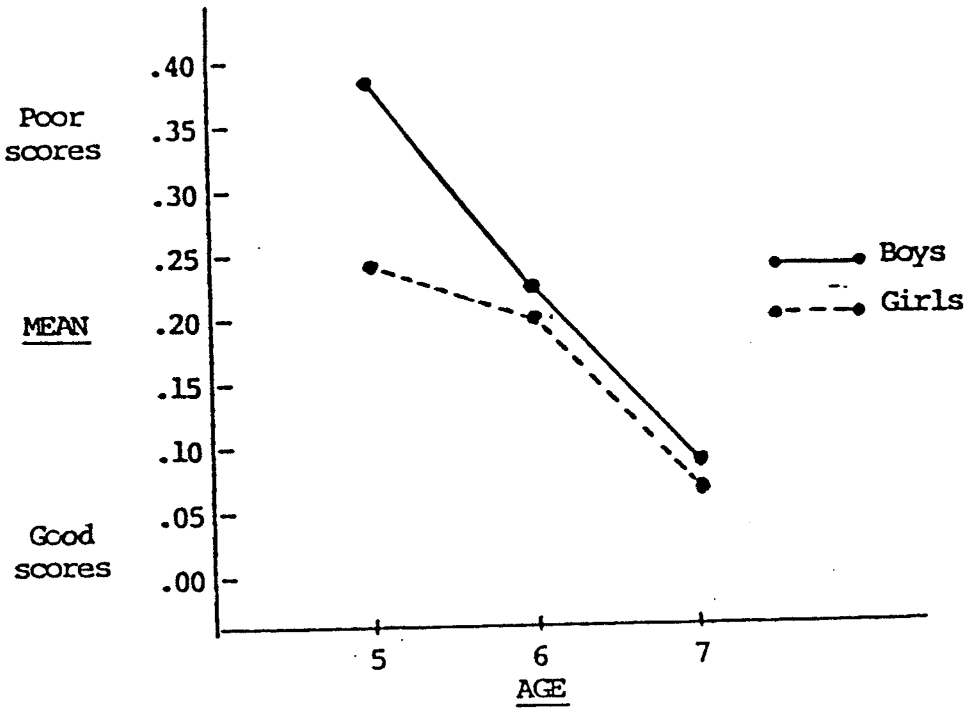
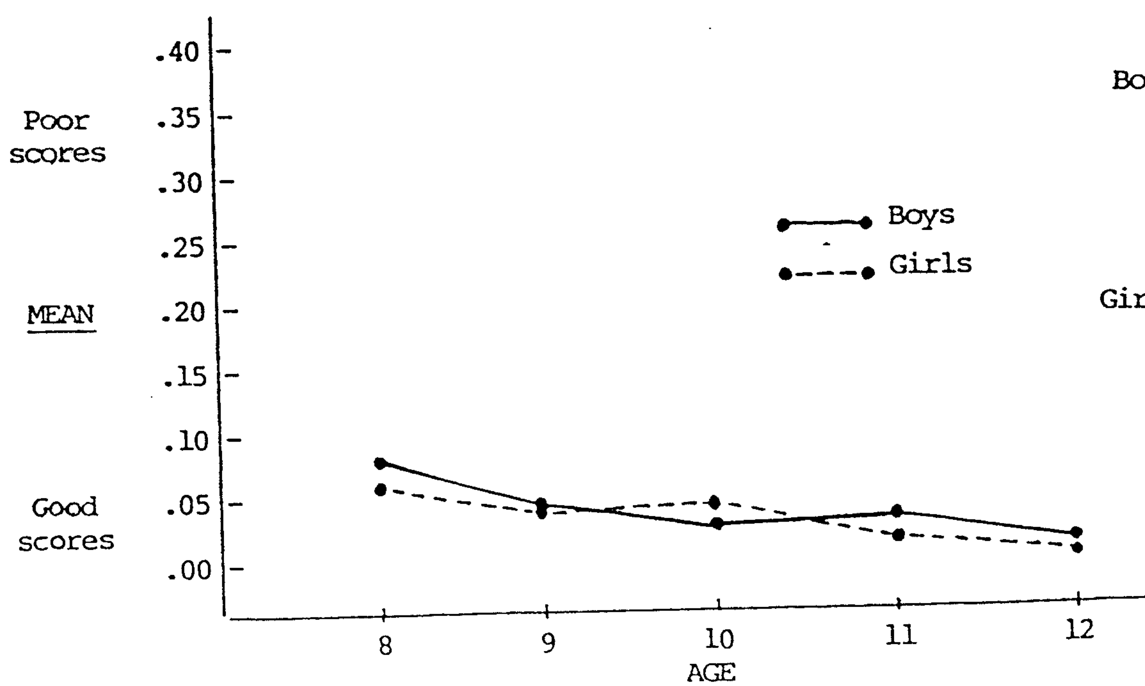


Figure 3:3b. Age trends and sex differences on the VISUAL SCALE for the older children's version of the battery.



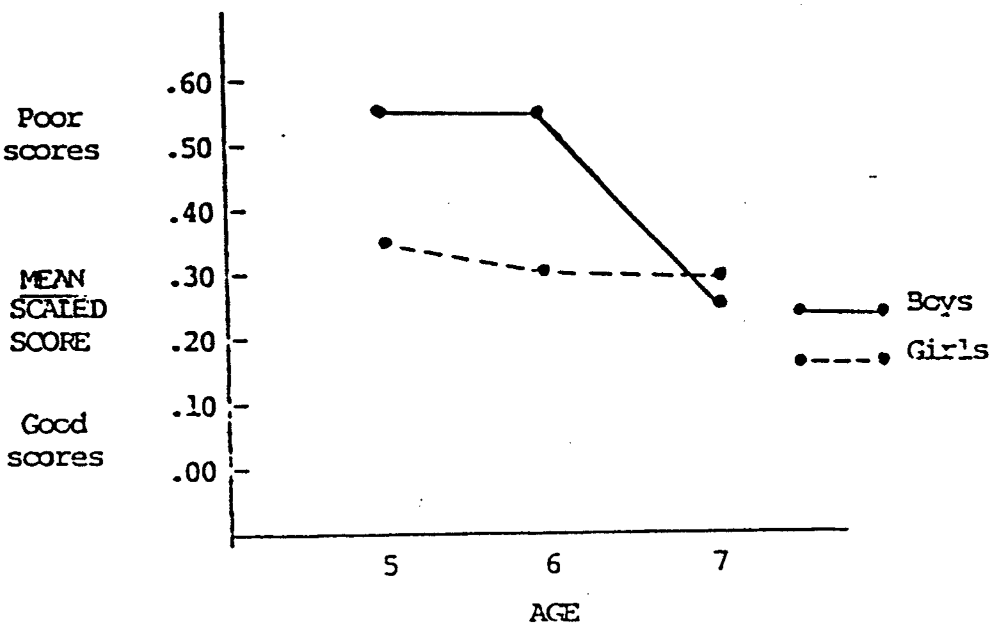
Boys:	Age	SD
	5	.62
	6	.36
	7	.32
Girls	5	.50
	6	.32
	7	.29

Figure 3:4a. Age trends and sex differences on the EXPRESSIVE SPEECH SCALE for the younger children's version of the battery (YC). Age: F 2,47 =4.93*; 5–7 years t= 6.33*;Sex:F 1,47 = 4.28*, t (5) = 12.1*. * $p < .05$.



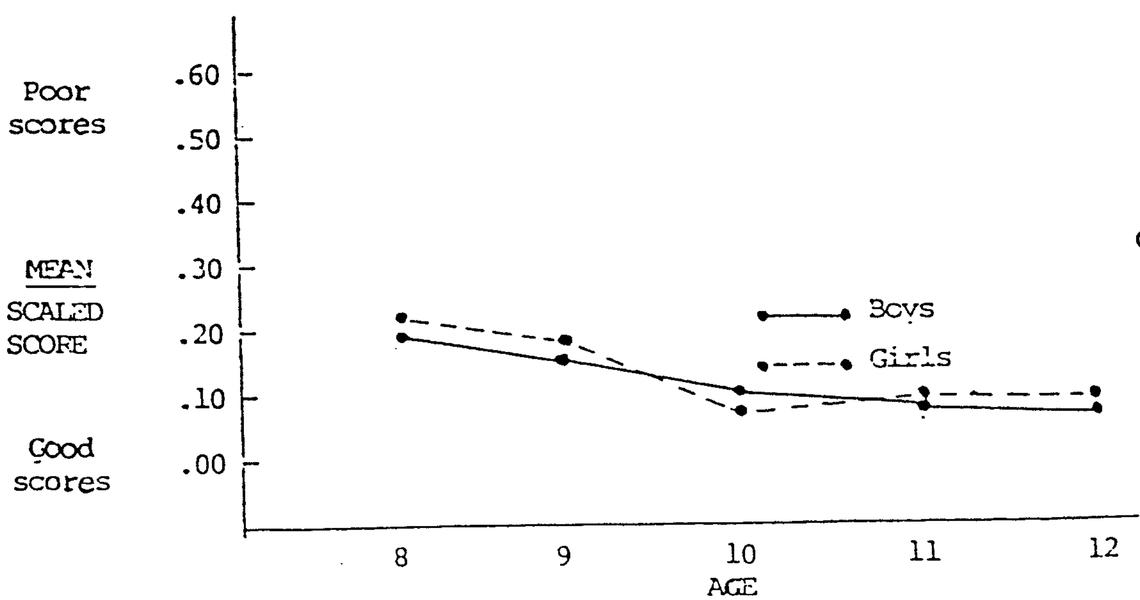
Boys:	Age	SD
	8	.37
	9	.28
	10	.16
	11	.19
	12	.08
Girls:	8	. 5
	9	.29
	10	.22
	11	.19
	12	.15

Figure 3:4b. Age trends and sex differences on the EXPRESSIVE SPEECH SCALE for the older children's battery (OC).



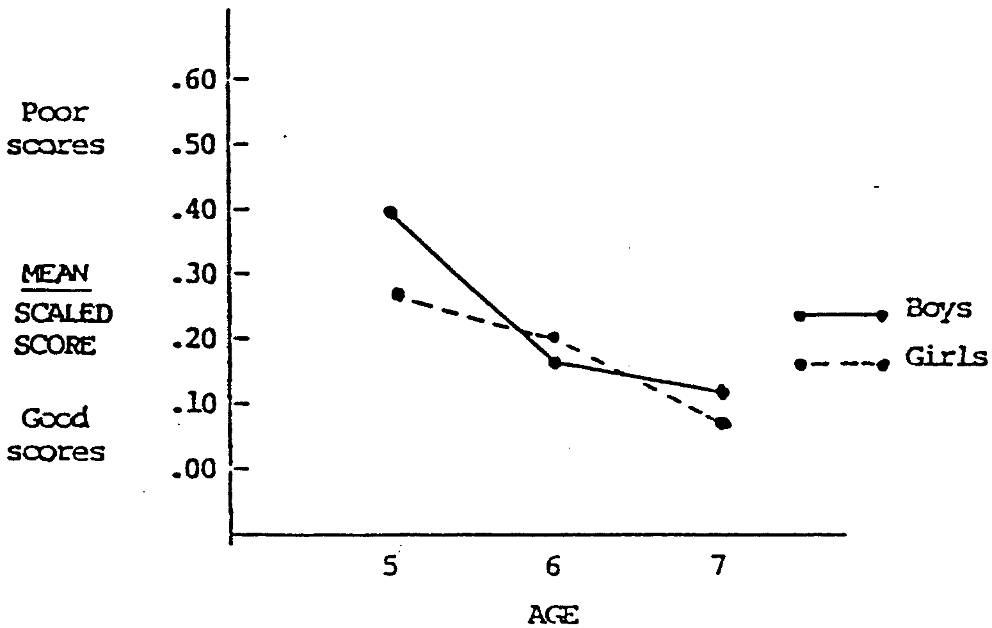
	Age	SD
Boys	5	.63
	6	.66
	7	.48
Girls	5	.71
	6	.35
	7	.42

Figure 3:5a. Age trends and sex differences on the RHYTHM SCALE for the younger children's version of the battery (YC). Age: F 2,47=3.29*; 6-7 years (boys) t=13.6*. Sex: F 1,47=4.16*; t=13.2*. * p<.05.



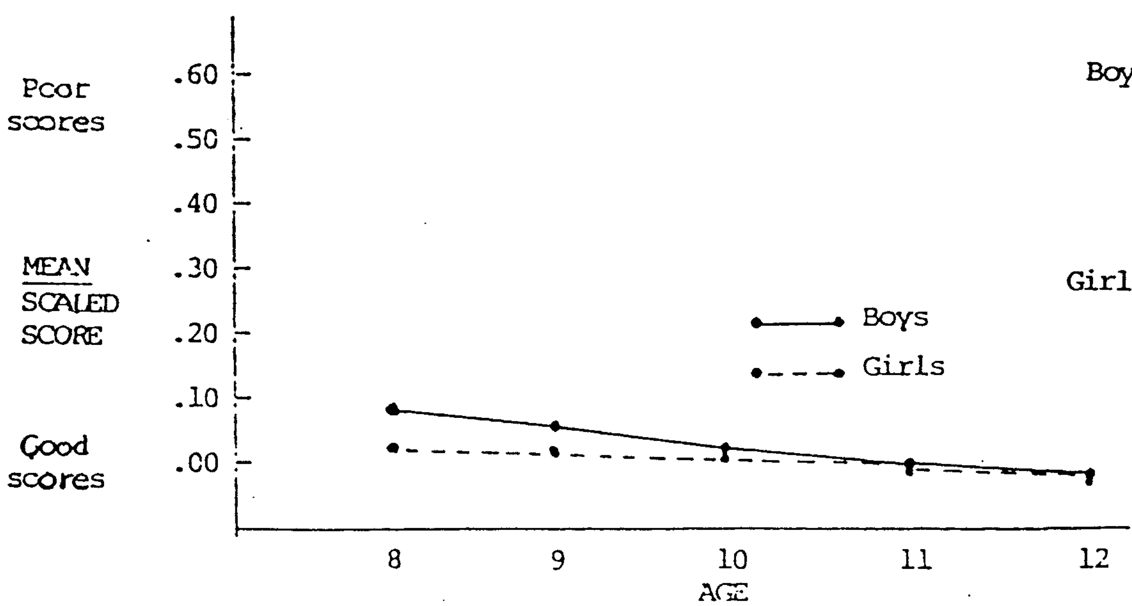
	Age	SD
Boys	8	.36
	9	.24
	10	.23
	11	.18
	12	.20
Girls	8	.32
	9	.27
	10	.28
	11	.19
	12	.23

Figure 3:5b. Age trends and sex differences on the RHYTHM SCALE for the older children's version of the battery (OC).



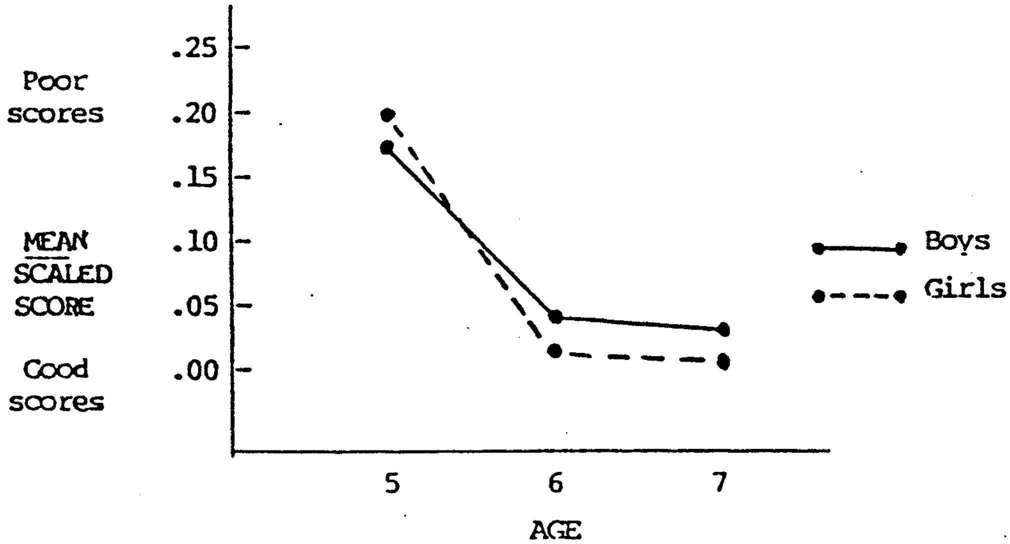
	Age	SD
Boys	5	.44
	6	.37
	7	.31
Girls	5	.36
	6	.33
	7	.26

Figure 3:6a. Age trends and sex differences on the RECEPTIVE SPEECH SCALE for the younger children's version of the battery Age: $F_{2,47}=3.22^*$; 5-7 years $t=6.33^*$. Sex: NS. * $p<.05$



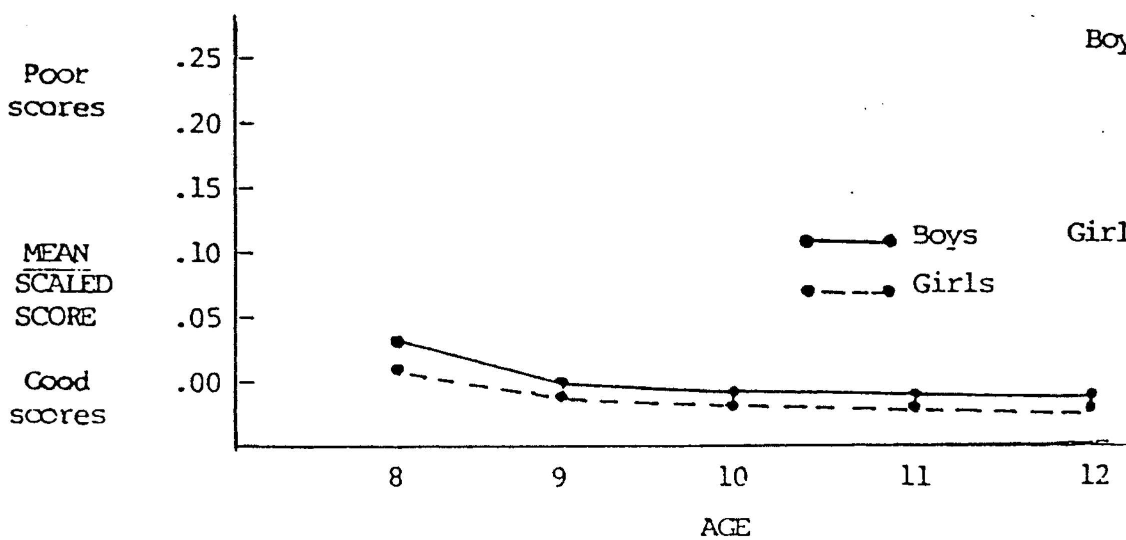
	Age	SD
Boys	8	.29
	9	.20
	10	.22
	11	.17
	12	.12
Girls	8	.23
	9	.21
	10	.18
	11	.14
	12	.12

Figure 3:6b. Age trends and sex differences on the RECEPTIVE SPEECH SCALE for the older children's version of the battery (OC).



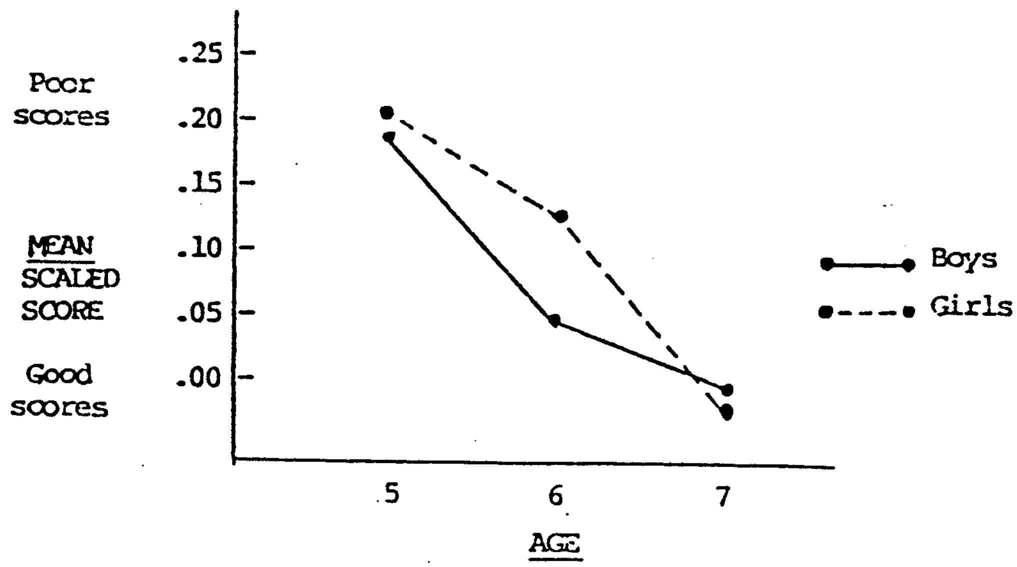
	Age	SD
Boys	5	.48
	6	.52
	7	.33
Girls	5	.52
	6	.39
	7	.34

Figure 3:7a. Age trends and sex differences on the WRITING SCALE for the younger children's version of the battery (YC). Age: F 2,47=3.44*; 5-6 years t=5.92*. Sex: NS. * $p<.05$.



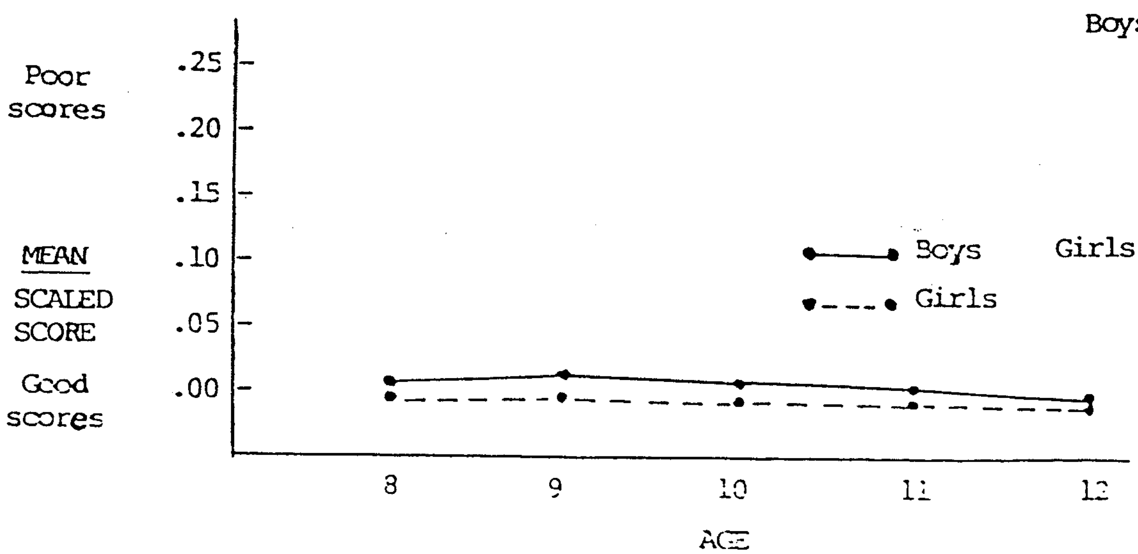
	Age	SD
Boys:	8	.31
	9	.18
	10	.23
	11	.14
	12	.12
Girls:	8	.29
	9	.26
	10	.16
	11	.08
	12	.12

Figure 3:7b. Age trends and sex differences on the WRITING SCALE for the older children's version of the battery (OC).



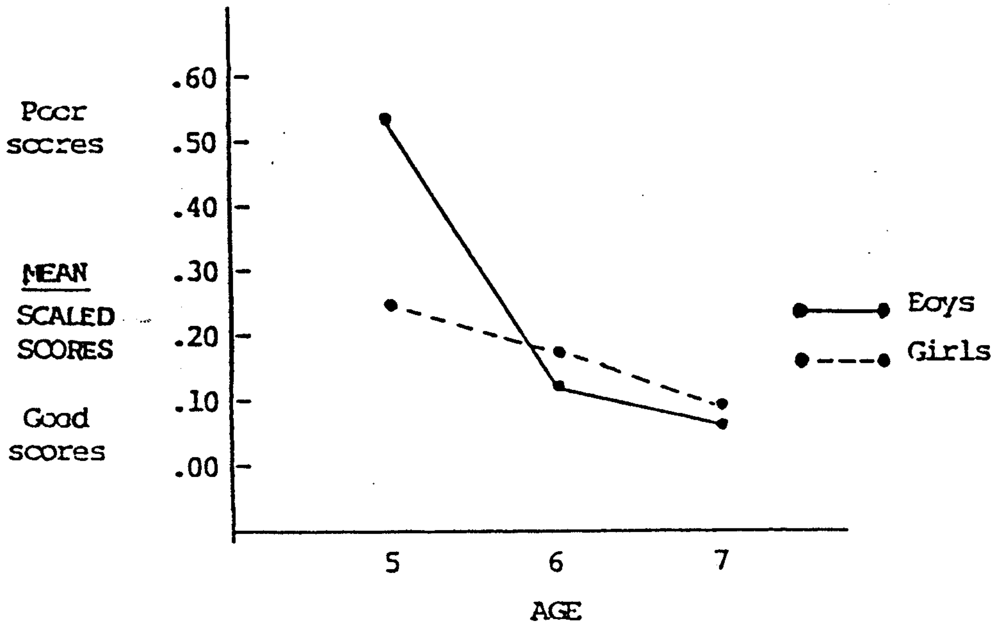
Boys	Age	SD
	5	.66
	6	.57
	7	.30
Girls	5	.38
	6	.43
	7	.51

Figure 3:8a Age trends and sex differences on the READING SCALE for the younger children's version of the battery(YC).Age: F 2,47=3.15*; 5-7 years t=5.98*. Sex: NS.* $p < .05$



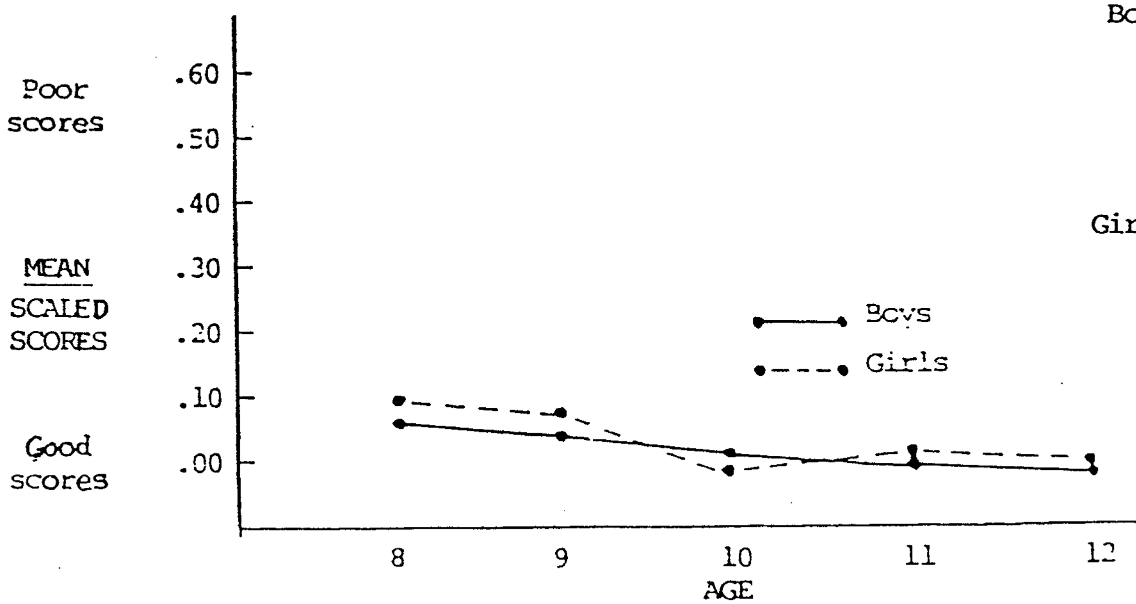
Boys	Age	SD
	8	.25
	9	.18
	10	.07
	11	.12
	12	.11
Girls	8	.22
	9	.18
	10	.21
	11	.08
	12	.09

Figure 3:8b. Age trends and sex differences on the READING SCALE for the older children's version of the battery(OC).



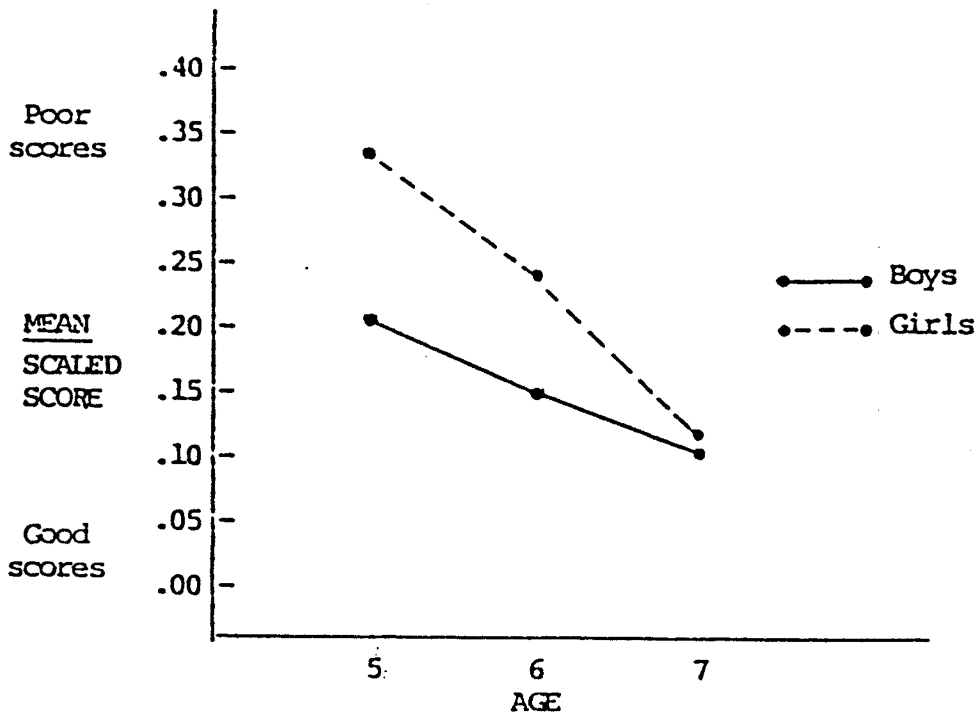
Boys	Age	SD
	5	.42
	6	.31
	7	.40
Girls	5	.40
	6	.38
	7	.27

Figure 3:9a Age trends and sex differences on the MEMORY SCALE for the younger children's version of the battery (YC). Age: $F_{2,47}=4.02^*$; 5-6 years (boys) $t=14.2^*$. * $p < .05$.



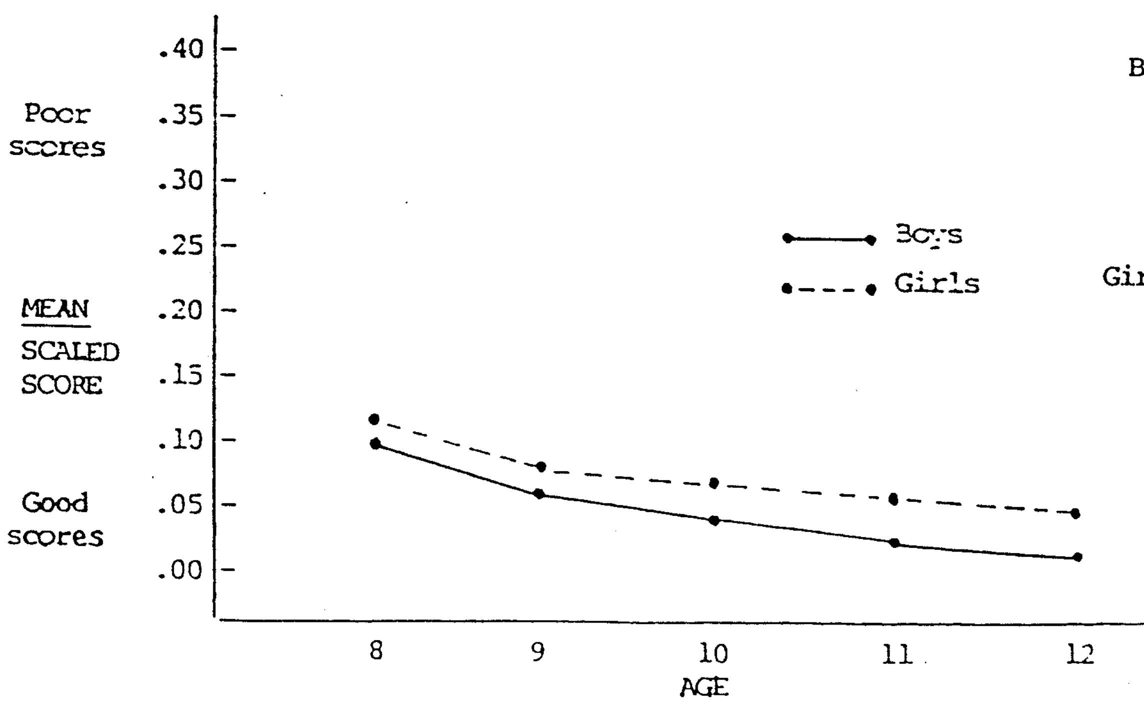
Boys	Age	SD
	8	.22
	9	.23
	10	.13
	11	.20
	12	.17
Girls	8	.19
	9	.22
	10	.17
	11	.24
	12	.16

Figure 3:9b Age trends and sex differences on the MEMORY SCALE for the older children's version of the battery (OC).



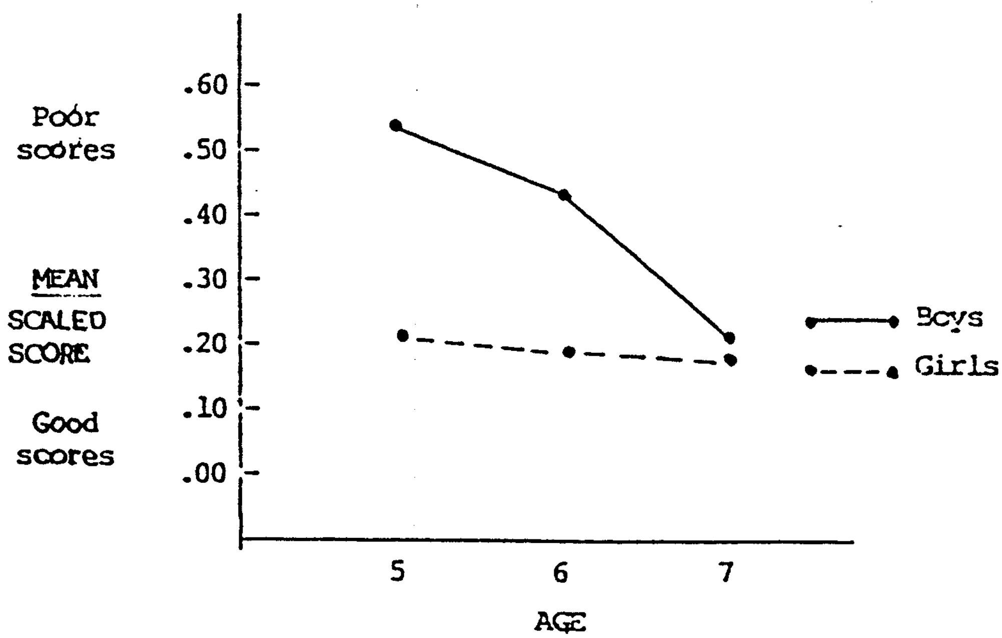
Boys	Age	SD
	5	.42
	6	.36
	7	.28
Girls	5	.35
	6	.29
	7	.22

Figure 3;10a. Age trends and sex differences on the ARITHMETIC SCALE for the younger children's version of the battery (YC).
Age: F 2,47=4.96*;5-7 years t=5.73*.Sex: F 1,47=4.05*;
5-6 t=12.90*. * $p < .05$.



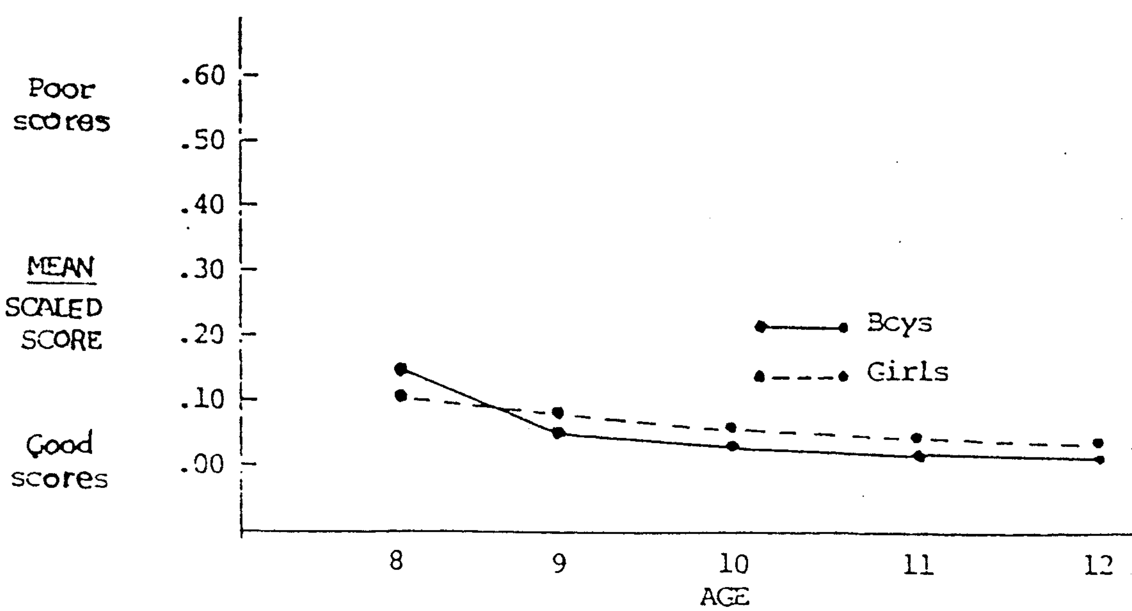
Boys	Age	SD
	8	.19
	9	.21
	10	.09
	11	.09
	12	.06
Girls	8	.22
	9	.23
	10	.17
	11	.14
	12	.12

Figure 3:10b Age trends and sex differences on the ARITHMETIC SCALE for the older children's version of the battery (OC).



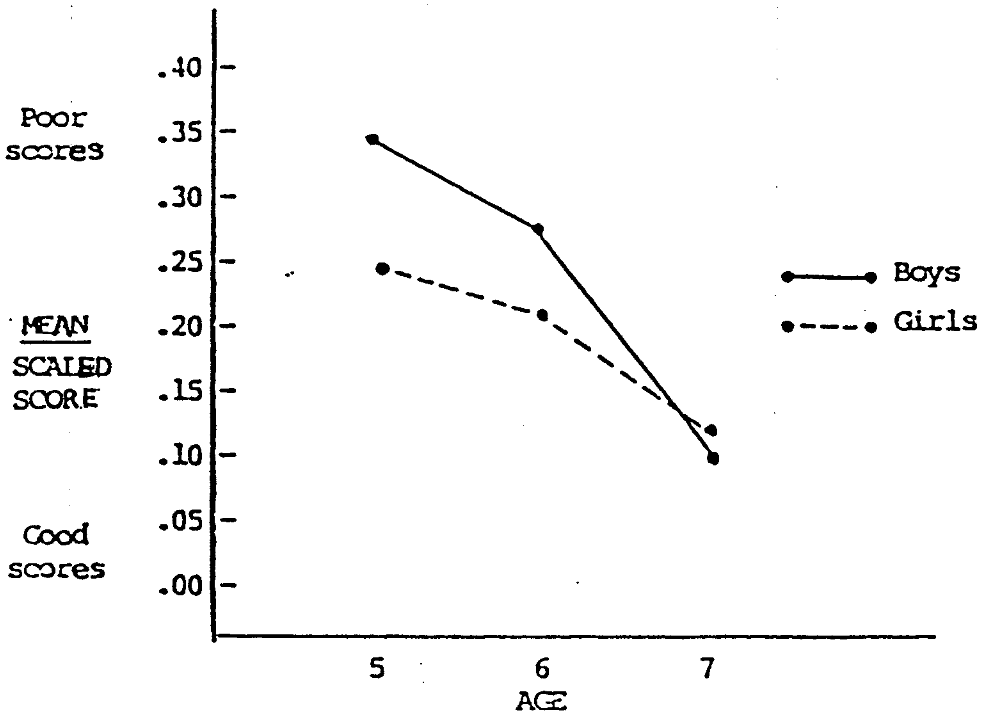
	Age	SD
Boys:	5	.39
	6	.41
	7	.32
Girls:	5	.37
	6	.28
	7	.32

Figure 3:11a Age trends and sex differences on the INTELLECTUAL PROCESS SCALE for the younger children's version of the battery (YC).
Age: F 2,23=4.35*; 5-7 years (boys) t=5.89*. Sex: F 1,47=6.01*; t=14.22*. * $p < .05$.



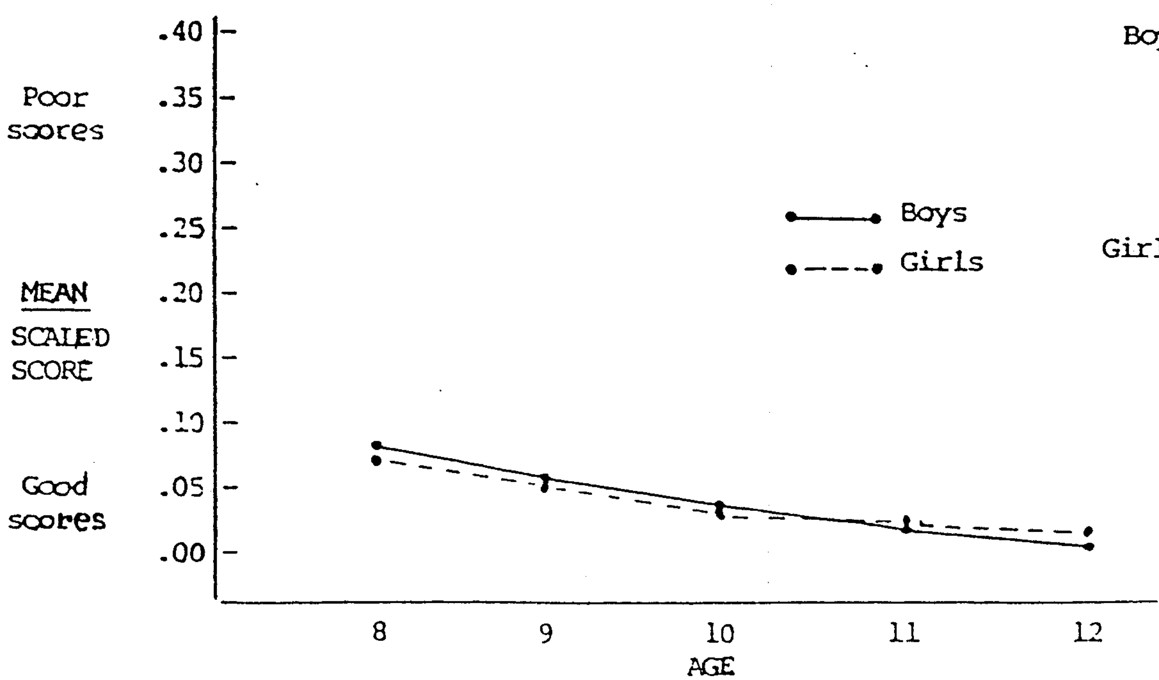
	Age	SD
Boys:	8	.22
	9	.23
	10	.15
	11	.08
	12	.12
Girls:	8	.28
	9	.31
	10	.16
	11	.14
	12	.15

Figure 3:11b. Age trends and sex differences on the INTELLECTUAL PROCESS SCALE for the older children's version of the battery (OC).



Boys	Age	SD
	5	.50
	6	.45
	7	.33
Girls	5	.45
	6	.35
	7	.31

Figure 3:12a. Age trends and sex differences averaged over all MAJOR SCALES for the younger children's version of the battery (YC). Age: $F_{2,47}=4.98$*; 5-7 years $t=7.23$*. Sex: $F_{1,47}=3.93$*; $t=11.2$*. * $p<.05$.



Boys	Age	SD
	8	.29
	9	.24
	10	.16
	11	.15
	12	.13
Girls	8	.21
	9	.23
	10	.18
	11	.13
	12	.14

Figure 3:12b. Age trends and sex differences averaged over all MAJOR SCALES for the older children's version of the battery (OC).

Generally, the analyses of variance showed significant ($p < .05$) age effects for all the major scales of the MLNNB-YC but not for the MLNNB-OC. Inspections of the graphs and the t-tests suggest that, where found, the significant differences for boys between 6 and 7 years were on the following scales: Motor, Tactile, Visual, Expressive Speech, Rhythm, Arithmetic, Intellectual Process, and on Major Scales combined.

The following scales were significant for boys between 5 and 6 years: Expressive Speech, Receptive Speech, Writing, Reading, Memory, and Arithmetic.

The following scales were significant for girls between 6 and 7 years: Expressive Speech, Receptive Speech, and the Major Scales combined. The following scales were significant for girls between 5 and 6 years: Visual, Writing, and Reading. These age differences were more pronounced for boys than for girls.

Inspection of the graphs and t-tests suggest that significant sex differences occurred most often between 5 and 6 years. The most pronounced sex differences were observed on the Motor, Tactile, and Rhythm Scales. The performance of boys and girls appears to be quite similar after the age of 7 years. In conclusion, these results show significant age and sex differences for the MLNNB-YC scales, but not for the -OC scales. This finding necessitates accurate age and sex norms for the MLNNB-YC. Although the age trends for the MLNNB-OC failed to reach statistical significance, there were sufficient Scale Score variations among the age groups to warrant separate age norms for the OC children. The results also suggest that among normal children individual differences (as indicated by standard deviations) become less pronounced with increasing age. On the basis of these findings it was decided to use separate T-tables (Appendix C) for boys and girls aged 5 to 7, and use boys-and-girls—combined T-tables for children 8-12 years.

3:2 Comparison of Diagnostic Groups

The next analyses compared the results of the brain-damaged (BD) and learning-disabled (LD) children with those of the normal-control (NC) group. The test scores of individual children from the three groups were converted into the appropriate T-Scores (see procedure described in 2.3.2). All comparisons in this section were based on these (age-corrected) T-Scores. Four different procedures were used to compare the normal and the clinical groups: (1) by drawing bar graphs depicting the proportion of children of each group performing 2 and 3 standard deviations worse than the mean of normal children; (2) by counting the number of scales on which the children of each group exceeded the impairment criterion of T-Score=80; (3) by plotting the frequency distributions of the Impairment Ratios; and (4) by comparing the individual-performance profiles of (age-and-sex) matched BD, LD, and NC children.

3.2.1 Proportions of children exceeding impairment criteria

In the first comparison the "Impairment Rates", that is the proportions of children of each of group with T-Scores higher than 70 (i.e., two standard deviations worse than the mean of normal children of the same age) and with T-scores higher than 80 (i.e., three standard deviations worse than the mean) were calculated for each MLNNB scale. Scores exceeding the cut-off scores of T = 70 and T = 80 ("Impairment Criteria") were taken as indicative of neurological impairment. One of the purposes of this analysis was to explore which of the two criteria for T values (T = 70 or T = 80) constitutes a more appropriate impairment criterion. Bar graphs comparing the three groups on each scale are shown in figures 3:13 - 3:24. The first number (percent) within the lined graph refers to 3 standard deviations and the second numbered value within the white field refers to 2 standard deviations worse than the normal mean.

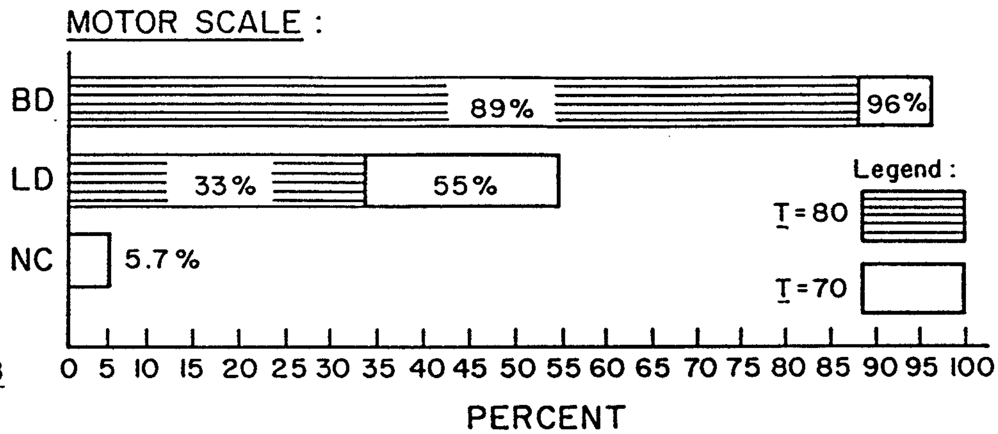


Figure 3:13

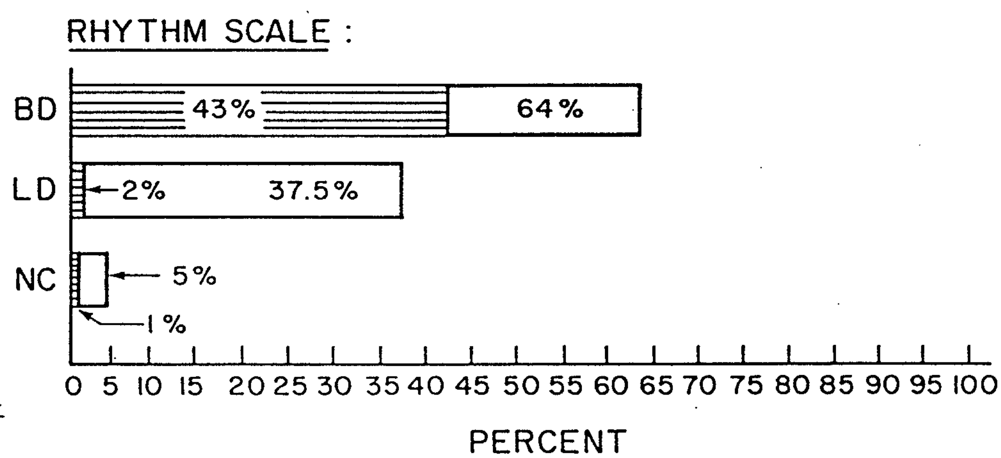


Figure 3:14

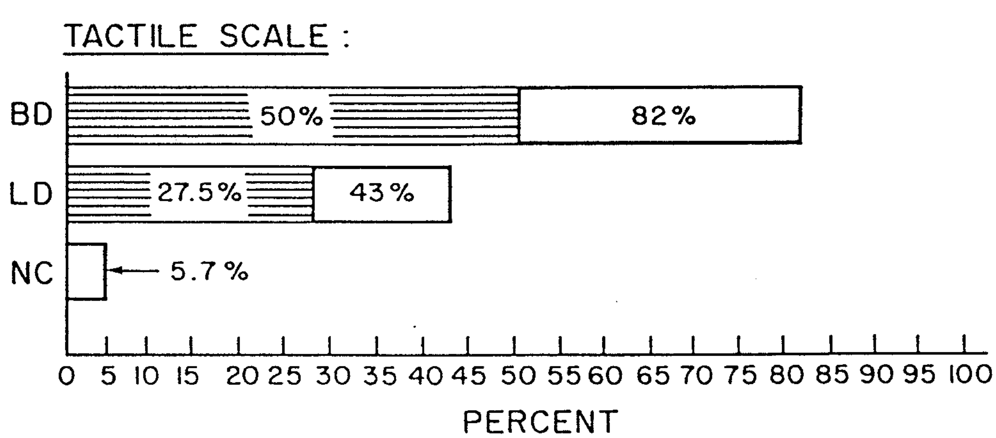


Figure 3:15

Proportion of brain-damaged, learning-disabled, and normal children who scored two and three standard deviations ($\underline{T}$ = 70 and $\underline{T}$ = 80 respectively) worse than the normal mean on the Motor, Rhythm, and Tactile scales.

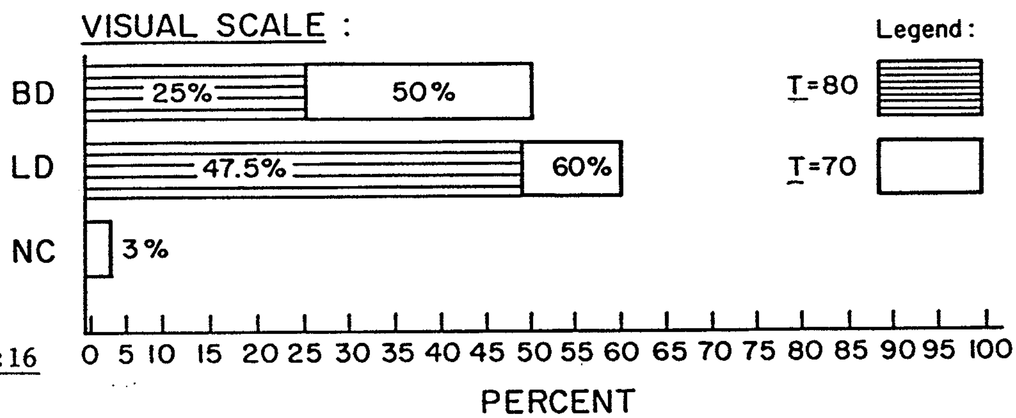


Figure 3:16

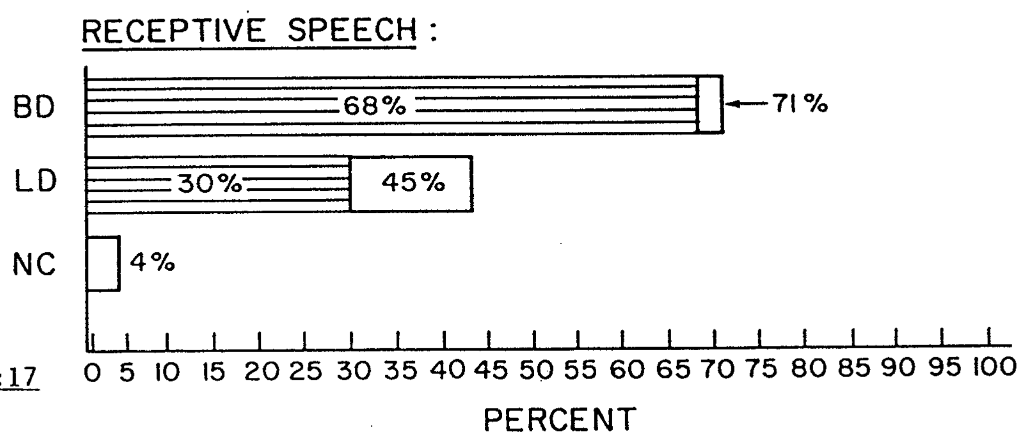


Figure 3:17

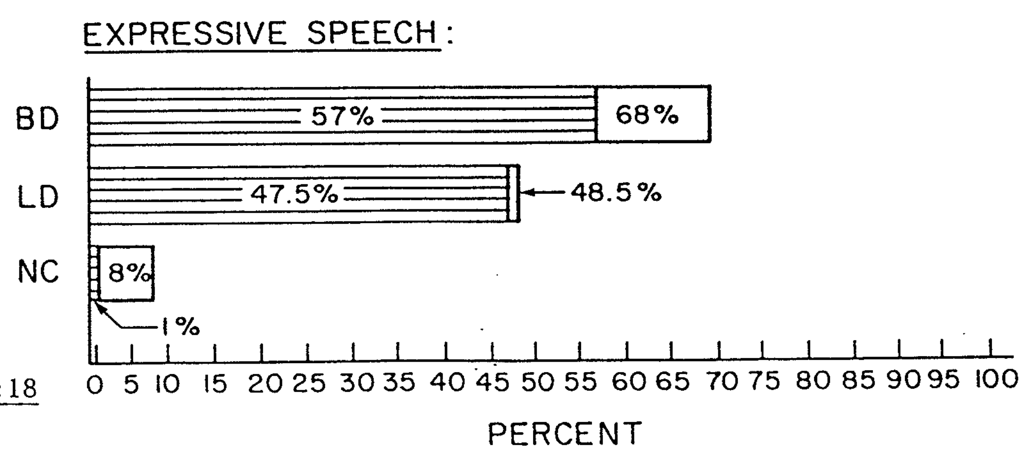


Figure 3:18

Proportion of brain-damaged, learning-disabled, and normal children who scored two and three standard deviations($\underline{T}$ = 70 and $\underline{T}$ = 80 respectively) worse than the normal mean on the Visual, Receptive Speech, and Expressive Speech scales.

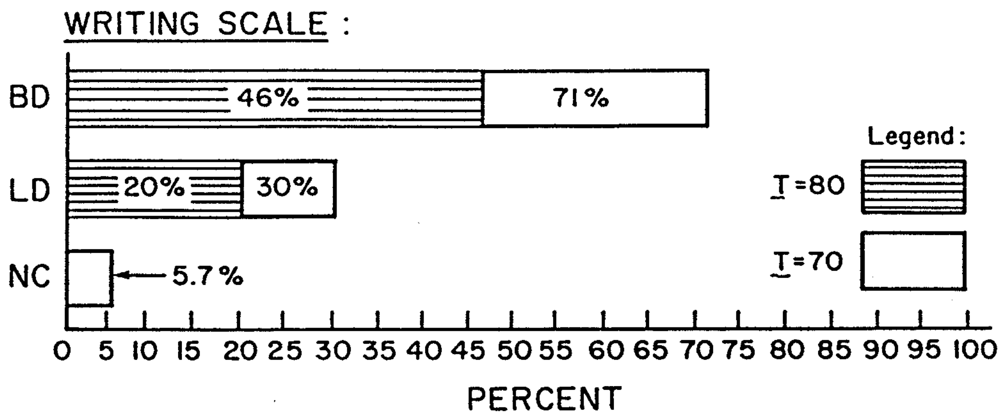


Figure 3:19

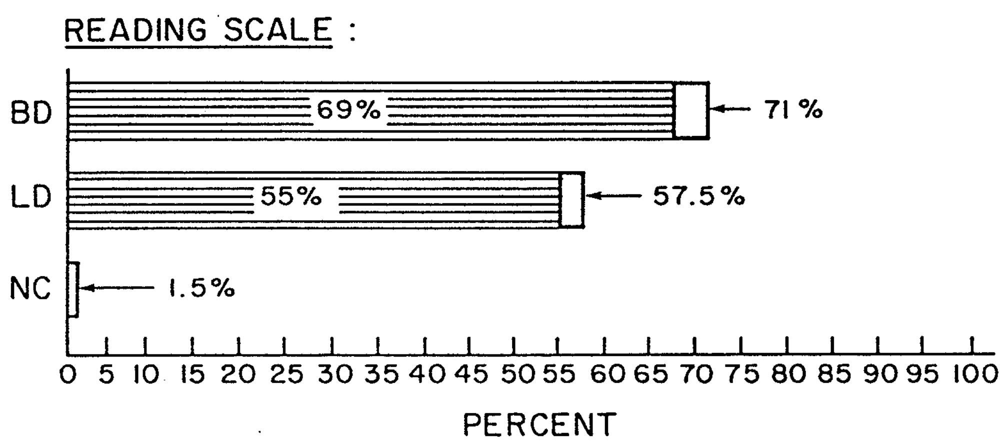


Figure 3:20

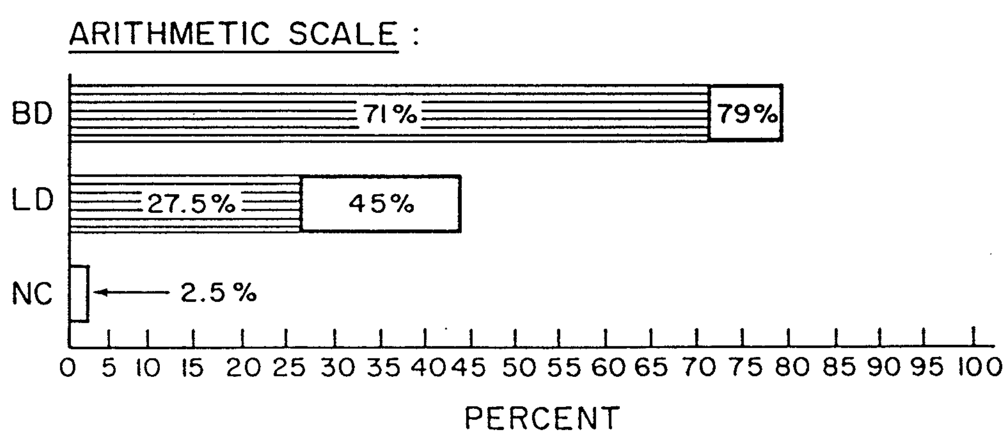


Figure 3:21

Proportion of brain-damaged, learning-disabled, and normal children who scored two and three standard deviations (T = 70 and T = 80 respectively) worse than the normal mean on the Writing, Reading, and, Arithmetic scales.

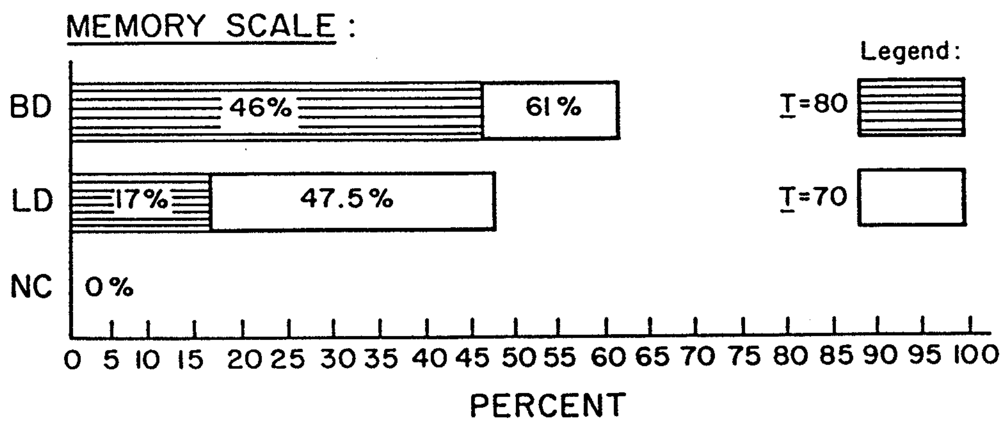


Figure 3:22

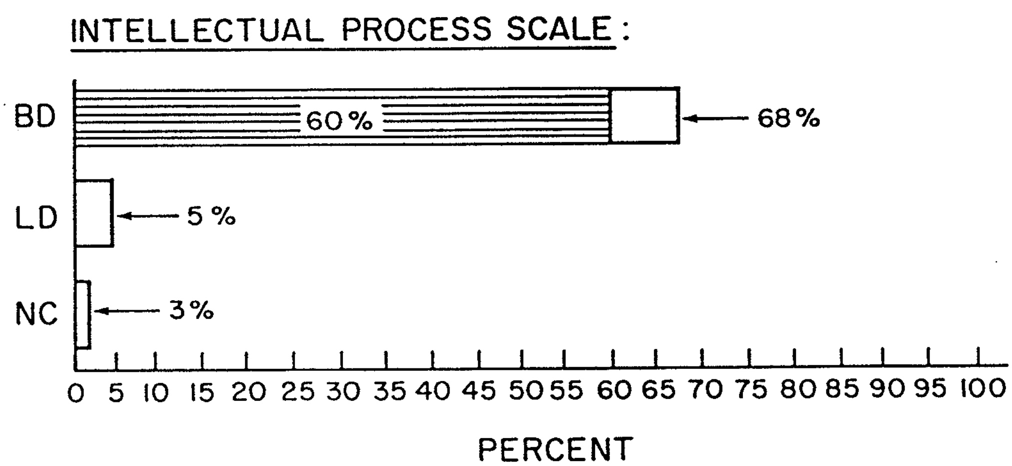


Figure 3:23

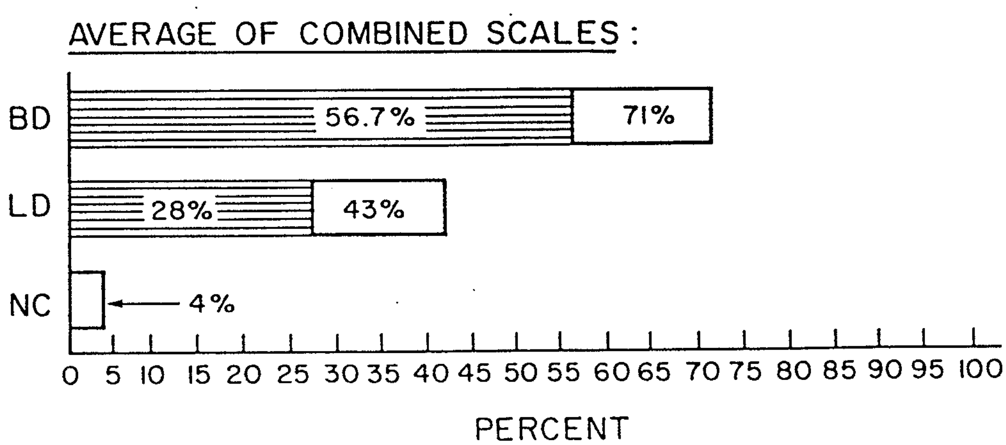


Figure 3:24

Proportion of brain-damaged, learning-disabled, and normal children who scored two and three standard deviations (*T*= 70 and *T* = 80 respectively) worse than the normal mean on the Memory, Intellectual, and Combined scales.

The bar graphs show that on most scales (except the Visual scale) the BD group had higher Impairment Rates, that is proportions of children exceeding the cut-off impairment criteria of T = 70 and T =80, than did the LD and the NC groups. On most scales (except the Intellectual Process scale) a substantial minority of LD children exceeded the corresponding impairment criteria. However, very few normal children exceeded these criteria. Observation of the bar graphs suggests that an impairment criterion of T = 80 differentiates the diagnostic groups better than does a criterion score of T = 70. Therefore, a cut-off score of T = 80 was taken as the appropriate criterion suggesting neurological impairment. Only one of the 193 NC children exceeded T = 80, and that on a single scale. On the other hand, depending on the scale, between 43% (Rhythm) and 89% (Motor) of the BD children exceeded T = 80. The impairment rates at T = 80 of the LD children tended to be intermediate between those of the BD and NC children, ranging from 2% (Rhythm) to 55% (Reading). Only on the Visual scale did the Impairment Rate of LD children (47.5%) exceed that of the BD children (25%). The Intellectual Process scale showed the largest difference in Impairment Rates between BD (68% at T =70 and 60% at T =80) and LD (5% at T =70 and 0% at T =80) children. The above analysis suggests that, with an appropriate scoring system and impairment criterion, both the MLNNB-YC and -OC can indeed differentiate between normal and impaired children.

3.2.2 Number of scales on which children exceeded T-80

This analysis involved counting for each child the number of scales exceeding the impairment criterion, that is the number of T Scores higher than 80 (number of "failed scales"). Figures 3:25 and 3:26 show the frequency distribution of the number of failed scales for the LD and BD children respectively. There is no graph for the NC children, because these children had hardly any failed scales.

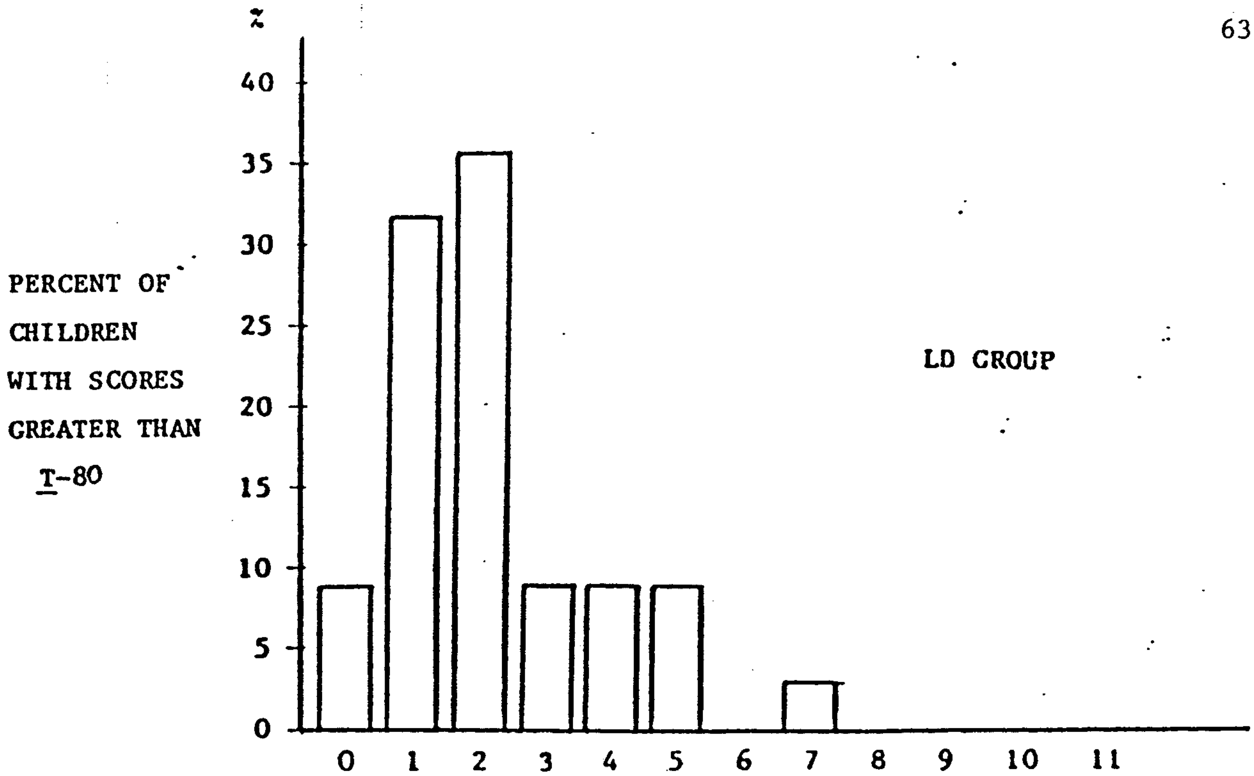


Figure 3:25 NUMBER OF SCALES ON WHICH SUBJECTS EXCEEDED T-80

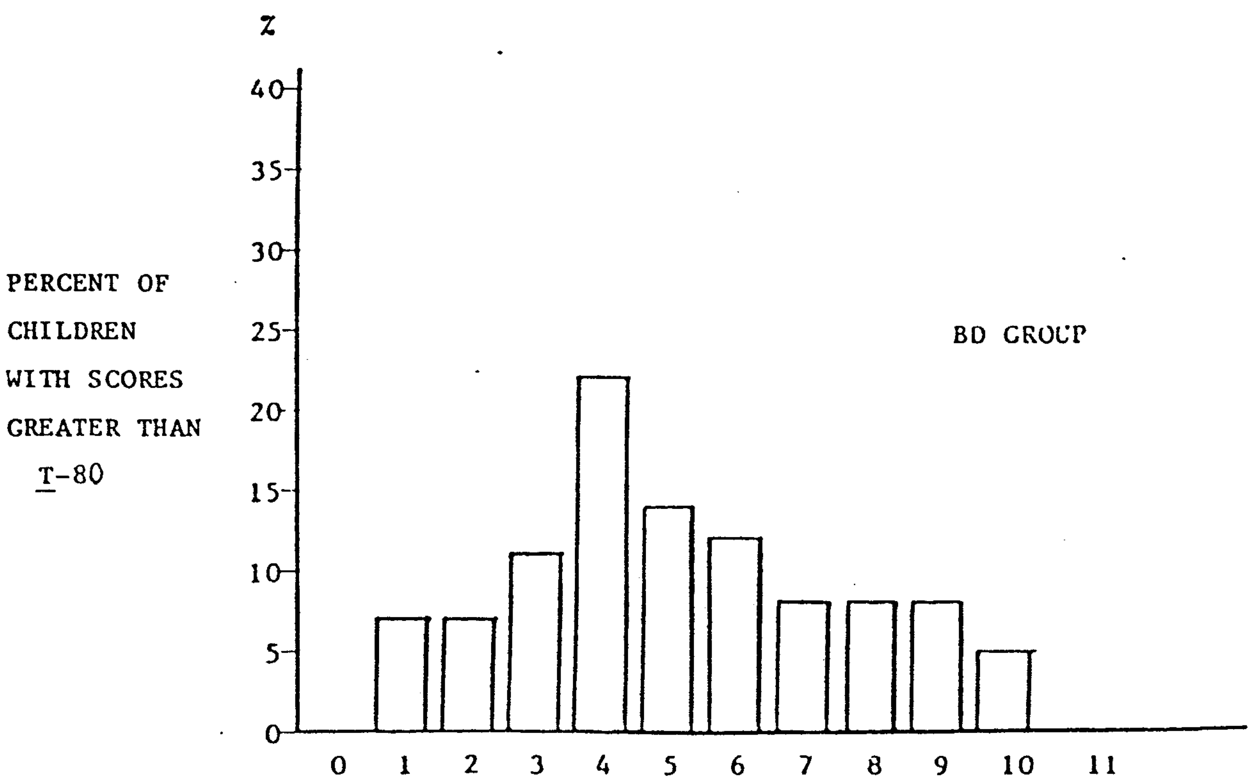


Figure 3:26 NUMBER OF SCALES ON WHICH SUBJECTS EXCEEDED T-80

Comparisons of the graphs shows that more than 60% of the LD children "failed" (i.e., $\underline{T} > 80$) only one or two scales. In contrast, almost 70% of the BD children failed 4 or more scales. The contrasting graphs suggest different deficit patterns for LD and BD children. LD children seem to show normal functioning on most scales with a few highly specific deficits. On the other hand, the deficits of BD children seem to be more generalized, i.e., involving impairment of several abilities.

3.2.3 <u>The Impairment Ratio</u>

This analysis involved the calculation of Impairment Ratios (i.e., for each individual child the proportion of scales with "impaired" performance at $\underline{T} > 80$, see 2.3.2). Corresponding Impairment Ratios were calculated for the HRNTB-C: (a) Knights' (1980) norms were used to identify for each test and for each age group the corresponding impairment criteria indicating performance 3 standard deviations worse than the mean of normal children. (b) For each child the number of tests exceeding the impairment criterion ("failed tests") was counted. (c) For each child the number of failed tests was then divided by the total number of tests in the battery (i.e., 11).

Figures 3:27 shows the frequency distribution of Impairment Ratios of the BD and LD children on the MLNNB. The results from normal children could not be shown on this graph, because these all had Impairment Ratios of 0.0. Figure 3:28 shows the corresponding frequency distributions of BD and LD children when they were tested on the HRNTB-C.

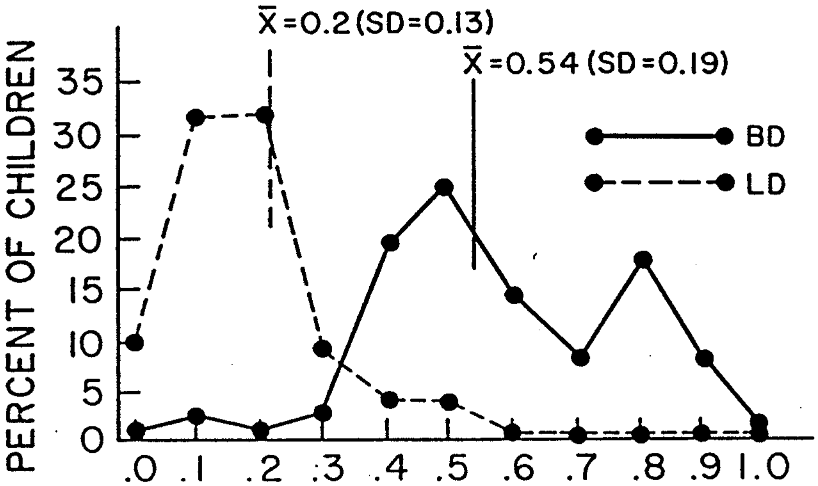


Figure 3:27. Impairment Ratio for MLNNB-YC, -OC (identical for both versions of the battery), a comparison between BD (N = 28) and LD (N = 50) children.

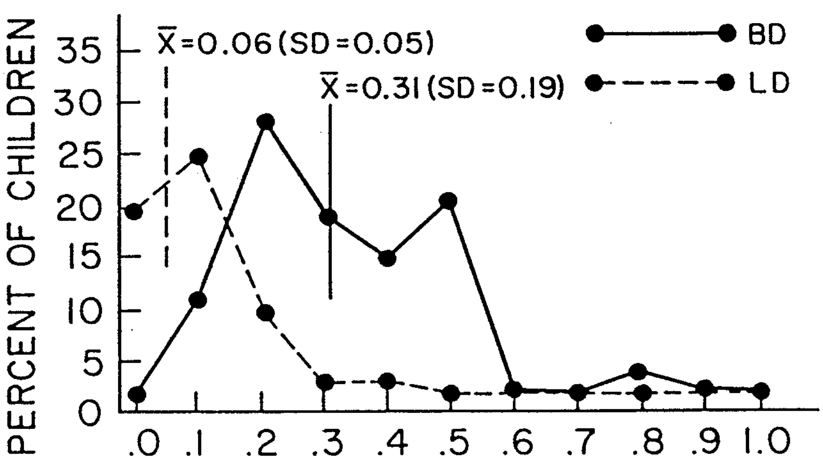


Figure 3:28. Impairment Ratio for the RINTB-C and HRNTB-C, a comparison between BD (N =28) and LD (N = 28) children.

Inspection of Figure 3:27 shows that on the MLNNB most LD children have Impairment Ratios of .1 and .2, while most BD children have Impairment Ratios of .4 or greater. An Impairment Ratio of .3 seems to be a cut-off point separating the LD and BD children into two distinct groups. These results are in agreement with the results of the analyses reported in 3.2.2. Figure 3:28 showing the results obtained with the HRNTB-C shows a similar trend, but also shows more overlap between the LD and BD groups. Comparison of the two graphs suggests that the LNNB may be more sensitive than the HRNTB-C in identifying LD children as a distinct diagnostic group.

3.2.4 Individual comparisons of matched NC, LD, and BD children.

This analysis started with the 28 BD children. A triplet was formed by randomly selecting for each BD child a LD and a NC child of the same age and sex. For each triplet a graph with the following characteristics was drawn: a) The top of the graph showed the performance on the MLNNB and the bottom of the graph showed performance on the HRNTB-C. b) Performance on the MLNNB was scaled in terms of *T* scores, while performance on the HRNTB-C was scaled in terms of standard-deviation units, so that performance on the MLNNB and the HRNTB-C were in comparable units (i.e., 10 *T* Score units on the MLNNB corresponds to 1 standard deviation on the HRNTB-C). c) The performance profiles of the three children of each triplet was plotted on the same graph. d) The performance of NC children was plotted for the MLNNB, but not for the HRNTB-C. e) Diagnostic information on the BD and LD children derived from medical records and school files respectively was reported on the bottom of each graph.

Appendix D shows the graphs of the 28 triplets. Inspection of these graphs suggests that the trends indicated by individual comparisons agree with the results of the analyses reported in 3.2.1 to 3.2.3. Thus the typical LD child showed "impaired" performance on one or two MLNNB scales only, while the typical BD child showed impaired performance on more scales. Comparison of the performance of individual LD children suggests that LD children may differ as to the nature of the specific impairment (e.g., visual-spatial deficit, auditory-verbal deficit). Normal children did not show any impaired performance. Where there was clear medical evidence about brain lesions confined to one hemisphere, the MLNNB localization indices (i.e., left- versus right-hemisphere scales) generally agreed with the medical data. Children who had impaired scores on the MLNNB also tended to have impaired scores on HRNTB-C. However, the differences in performance profiles of the BD and LD children tend to be less distinct on the HRNTB-C than on the MLNNB. This observation is consonant with the finding reported in 3.2.3.

3.3 Relative Diagnostic Importance of the LNNB-YC,-OC Scales:

In this analysis a *T* Score of 80 was taken as a cut-off score indicating impaired performance on MLNNB scales. Utilizing the results from the analyses reported in 3.2.1 (i.e., percentages of LD and BD children exceeding *T* = 80), individual MLNNB scales were rank-ordered according their "impairment rates" (i.e., the proportion of children with scores exceeding *T* =80) in LD and BD children. The results are reported in table 3.1.

TABLE 3:1

Rank order of scales in terms of impairment rates for BD and LD children.

Scale	Rank B.D.	Rank L.D.
Motor	1	4
Rhythm	10	9
Tactile	7	7
Visual	11	2
Receptive Speech	4	5
Expressive Speech	6	3
Writing	8	8
Reading	3	1
Arithmetic	2	6
Memory	9	10
Intellectual Process	5	11

The Rank-order correlation coefficient (rho) between the two rank orders was .28

Visual inspection of this table suggests that some scales may differ greatly in their relative sensitivity to BD and LD. For instance, the Visual scale is relatively sensitive to LD (rank 2), but the least sensitive scale (rank 11) to BD. However, some scales show similar relative sensitivities to both BD and LD, that is, they were either very sensitive (e.g., Reading) or very insensitive (e.g., Rhythm) to both conditions. A rank order correlation coefficient of .28 between these two rank orders suggests that BD and LD children may have quite distinct patterns of impairments. Scales sensitive in detecting impairments in BD children need not be sensitive in detecting impairments in LD children. The three most sensitive scales in detecting impairments in BD children were Motor, Arithmetic, and Reading, while the three most sensitive scales in LD children were Reading, Visual, and Expressive Speech. On the other hand, the three least sensitive scales in detecting impairments in BD children were Visual, Rhythm, and Memory, while the three least sensitive scales in detecting impairments in LD children were Intellectual Process, Memory, and Rhythm.

3:4 Reliability Estimates for the MLNNB-OC,YC

The scorer reliability was estimated in the following way: (1) The raw scores of all items were taken from 42 NC, 21 LD, and 8 BD children selected at random. (2) Three independent scorers were then asked to convert the Raw Scores into the corresponding 0-1-2 Scores. (3) The scorings of all items, for all children, by any two scorers were intercorrelated by the Spearman Rho formula. (4) These scorer-reliability coefficients were calculated for all items, and for the subset of graphic items which require some subjective judgment. (5) Kendall's coefficients of agreement were also determined.

Average interrater correlations for total scores and for graphic items were $r = .92$ and $r = .86$ respectively. These figures yielded Spearman-Rho multiple interrater reliability coefficients of $R = .97$ and $R = .96$ respectively. No statistically significant differences were found between rater judgments. Kendall coefficients of agreement (W) were $W = .92$

($p < .001$) and $\underline{W} = .87$ ($p < .001$) for all items and the graphic items respectively. The interrater reliabilities for single items were generally consistent with coefficients obtained using all item scores.

Test-retest reliabilities were estimated by the following procedure: (1) Thirty children were retested on the LNNB-YC or -OC three months after the initial testing. (2) For each of the 149 0-1-2 Items Scores test-retest correlations were calculated. (3) The mean test-retest correlation was calculated to obtain an over-all index of test-retest reliability. This average test-retest reliability coefficient (average $\underline{r}$) was .92.

Another method which had been used to establish the reliability of the MLNNB, that is an odd-even split-half correlation Golden, Fross & Graber (1981) seemed inappropriate for the MLNNB-YC and -OC in this study. The inappropriateness of this method was pointed out earlier in the review of the literature (see 1.6).

3:5 Factor Analysis

As has been pointed out earlier (see 1.6) the application of factor analysis to the MLNNB items of this study involves some problems and limitations: The number of items (149) is very large relative to the sample size. The items are scored not as continuous variables, but as pathognomic indicators (i.e., 0-1-2 system indicating pass/fail see 2.3.2). With pathognomic indicators most normal children pass the test items and there is little variability in scores among normal children of a given age. However, because of the "absolute" (i.e., not age-corrected) 0-1-2 scoring system a few younger normal children fail some items. Thus one may expect low correlations between item scores for normal children. On the other hand, for BD children the score variabilities and interitem correlations tend to be much higher than those found in NC children. Thus one may expect the factor structure associated with BD children to be more definite than the factor structure associated with normal children. Despite the acknowledgement of these limitations factor analyses were performed on the data obtained from this study. In this study the number of normal children (193) was much greater than the number of BD children (28). Therefore, the factor analysis reported in Appendix E is merely exploratory and the resulting factor structures must be regarded as being highly tentative. The factor analysis should be replicated in future studies with samples of several hundred BD children with a wide variety of neurological impairments. In spite of these acknowledged problems factor analyses were used to explore the characteristics of the MLNNB.

For readers who might want to pursue the factor analytic method with more homogenous samples and larger N's for each type of group the factor analytic results are summarized in Appendix E.

CHAPTER 4

DISCUSSION AND CONCLUSIONS

It is now helpful to summarize this study's major conclusions in relation to the original research goals. In the present study a systematic attempt was made to revise, to improve, and to evaluate the children's version of the Luria Nebraska Neuropsychological Battery or LNNB-C. As has been pointed out in the review of the background literature, several neuropsychologists have expressed serious doubts about the methodological soundness of the LNNB (see 1.5). Since less methodological information is available on the children's version than on the adult version of this test battery, critics of the LNNB have had even more reservations about the children's version than about the adult version. This study was planned to come to terms with some of these frequently valid criticisms.

Golden's original version of the LNNB-C is not suitable for children under the age of 8 years, because it presupposes the mastery of simple educational skills (e.g., writing, reading, and arithmetic). Yet school authorities frequently face the practical need for neuropsychological assessment of school children aged 5 to 7 years in order to make appropriate educational decisions about them. The MLNNB-YC (suitable for children aged 5 to 7 years) represents a downward extension of the education-related LNNB-C items in order to meet this practical need. The MLNNB-OC (suitable for children 8 to 12 years) contains a few modifications of Golden's original LNNB-C. For instance, there were minor changes in the instructional language in order to make the instructions easier to understand for young children and for children with language disorders. Because of these modifications it was necessary to conduct fresh standardization and validation studies on both the

-YC and -OC versions of the instrument. Both versions of the battery were prefixed by the inclusion of the "Preliminary Examination", part of which was based on Christensen's (1975) work. This "Preliminary Examination" provides some clinical background information which can facilitate the interpretation of test scores.

It was one of the premises of this study, that the diagnostic validity and power of the LNNB-C can be improved by a thorough standardization of the -YC and -OC on a carefully selected sample of normal children (aged 5 to 12 years, average school performance) and by using this normal sample to develop revised scoring system. This new scoring system was then applied to two clinical groups. Comparison of the MLNNB-YC and -OC scores of normal, learning disabled and brain-damaged children provided some indications about the power of the battery to distinguish between diagnostic groups. Finally, the MLNNB-YC, -OC were compared with another neuropsychological battery frequently used with children, namely the HRNTB-C. Generally, the results suggested that the major indices of the MLNNB-YC, -OC, (age-corrected T-Scores) can be used to differentiate between the normal and clinical groups. These indices can also reveal the distinctive impairment patterns characterizing learning-disabled and brain-damaged children.

4:1 The Revisions of the Tests and Scoring Systems: Rationale and Justification

The revision leading to the -YC and -OC versions of the MLNNB followed the overall plan of Golden's original instrument as much as possible with respect to instructions, the names and numbers of scales, the grouping of items into scales, the number of items per scale etc. The methodological results (e.g., factor structure, diagnostic power of *T*-Scores) of this study suggests that this plan is basically sound and does not require any major revisions. Future factor-analytic studies may lead to some refinement of scales and the corresponding *T*-Scores. For seven of the eleven scales identical items were appropriate for both younger and older children. In some instances it was therefore possible to pool data from the younger and older children for the same statistical analysis.

The major revisions in this study occurred with respect to test scoring rather than with respect to test items. It is helpful to discuss now the rationale for the revised scoring system. The great heterogeneity of the LNNB test items presented the basic scoring problem. How can one relate in a quantitative way time taken to complete a given task, performance within a time limit, number of errors, comprehension, the quality of drawings etc. to each other? How should a child's age affect the scores he/she obtains? Since Golden's original scoring system of the LNNB-C did not address these issues in any consistent way, a new scoring system had to be worked out. Decisions about this new scoring system involved both practical and psychometric objectives. The scoring system should be reliable and consistent, so that the tester could easily acquire testing skills. Scores for different kinds of test items (e.g., time scores, errors, quality of drawings) should become comparable. The neuropsychological assessment was conceptualized in pathognomic terms, thus the scoring system was designed to focus on the detection of neurological impairment rather than on sensitivity to variations in normal functioning. The scoring system should also take into consideration developmental changes during the primary-school years. It should also be based on appropriate norms.

As far as possible, Raw Item Scores were determined according to the original instructions of Golden's LNNB-C. The first step in scoring, that is to convert Raw Scores into 0-1-2 Scores involved several decisions. Firstly, the objective was pathognomic in the sense that the focus was on the detection of inadequate performance rather than on measuring variations in adequate performance. Secondly, the 0-1-2 system was "absolute" in the sense that a child's score depended on performance only, regardless of the child's age. It is much easier to train a test administrator to convert Raw Scores into 0-1-2 Scores according to an absolute system than according to any kind of age-corrected system. An absolute standard is especially helpful with items requiring some amount of subjective judgment (like the evaluation of children's drawings).

The 0-1-2 scoring system allows the integration of different kinds of Raw Scores into meaningful averaged Scale Scores. The adding of the 0-1-2 Item Scores of a given scale into Scale Totals and by dividing this Scale Total by the number of items in the scale yielded averaged Scale Scores which were comparable across scales. Such averaged Scale Scores can then be used to investigate age trends and sex differences in neuropsychological functioning. They can also be used to establish age norms for the calculations of T-Scores. Two considerations determined the choice of T-Scores as appropriate indices. Firstly, by basing them on normative data (mean averaged Scale Score) of each age group such scores could be regarded as age-corrected indices of the adequacy of neuropsychological functioning. Secondly, T-Scores could be used to develop an impairment criterion which is comparable over the wide age range of the children studied. A relatively severe impairment criterion was decided upon, because the purpose of neuropsychological assessment with the MLNNB is the detection of significant impairment (pathognomic) rather than the measurement of normal functioning. The results of this study suggest that with the new scoring system the MLNNB-YC, -OC is very effective in differentiating between the normal and clinical samples over a wide age range. The results also suggest the desirability of choosing a scoring system which is both age-corrected and pathognomic. They also provide some indirect justification for the decisions about the nature of the new scoring system.

4:2 Developmental Trends and Sex Differences.

This study suggests that there are significant developmental trends for many neuropsychological functions. Such developmental trends are especially pronounced among the younger children assessed with the MLNNB-YC. This finding suggests the need to base the scoring of the MLNNB-YC, -OC on year-by-year age norms, rather than on broader age categories. Furthermore, for normal children the individual differences in test scores (as indicated by standard deviations) were found to become progressively more narrow with increasing age. Such an age-related decline in individual differences has also been reported for other tests for children such as the WPPSI and the WISC-R (Wechsler, 1967 and Wechsler 1974 respectively). Some of this decline may be attributed to increasing reliability of test-taking-performance with increasing age; some may be attributed to progressive changes (slowing, stabilizing) in the rate of neuropsychological development. In this study, normative information about age trends in both mean scores and standard deviations constituted the basis for the calculation of *T*-Scores.

This study suggested that younger girls tended to out-perform younger boys on the MLNNB-YC. On the other hand, sex differences were found to decline with increasing age. This early superiority of girls over boys is usually attributed to an earlier maturation of girls. Such an interpretation has some support in the research literature (see eg. Cramer, 1981; Epstein, 1979, 1980, 1981; Sylvester, 1981; and Toepfer, 1979).

4:3 <u>The BD Group</u>

The study showed that with an appropriate scoring system the MLNNB-YC, -OC could easily differentiate between normal and BD children. The performance of BD children was clearly outside of the normal range (i.e., 3 standard deviations worse than the mean of normal children) on several MLNNB scales. The Impairment Ratios of the BD children were considerably higher than the ratios of the LD children, with only a minor overlap. Because of the limited number of BD children, the MLNNB's ability to differentiate between various kinds of brain damage could not be assessed in this study.

The MLNNB's sensitivity to brain damge tends to be at least as high as that of the much-used HRNTB-C. The finding that the Impairment Ratios of the MLNNB-YC, -OC were somewhat higher than those of the HRNTB-C might possibly be interpreted by the LNNB's assessment of a broader spectrum of skills which are impaired by brain damage. It should be noted that the MLNNB requires much less testing time than the HRNTB-C. Moreover, the MLNNB has the added advantage over the HRNTB-C in being portable. Tests of HRNTB-C tend to be more "inclusive", in the sense that deficits in any one of several functions (e.g., perception, motor control, memory) may result in impaired scores on a given test (e.g., the Tactual Performance Test). In contrast, the MLNNB items tends to be more "specific", in the sense that a given item is meant to assess the adequacy of only a single function. Even though it is not quite clear, as to how these differences between the MLNNB and the HRNTB-C in inclusiveness/specificity determine their relative effectiveness for the differential diagnosis of brain damage. The lack of certainty in this area does not detract from the usefulness of the MLNNB-YC, -OC., as a diagnostic tool. Further, the fact that the revised Luria instruments point to more specific problem areas than the HRNTB-C tends to support its utility in an educational setting and as a basis for educational remediation strategies. Further, the findings of this study tend to lend support to Luria's model as described in his discussion on functional systems.

There are several issues which remain to be worked out in future research: (1) Are the MLNNB-YC, -OC capable of differentiating between different kinds of brain damage? (2) How do the MLNNB-YC, -OC and the HRNTB-C compare in their capacity to diagnose different kind of brain damage? (3) Are there certain kinds of neurological deficits which can be more readily detected by one of the two neuropsychological batteries? (4) Which of the two batteries provides better guidance for the remedial education of BD children? The answers to these questions requires a systematic research effort where a large number of children with a wide variety of neurological deficits are assessed on both batteries.

4:4 The LD Group

The performance profile of LD children could be easily distinguished from that of normal children. Typically, LD children performed in the normal range on most scales, but were clearly deficient (i.e., 3 standard deviations worse than the means of normal children of the same age) on one or two scales. None of the normal children showed such a performance profile. In contrast to LD children, the BD children tended to show much more widely distributed deficits. These findings suggest that the MLNNB-YC, -OC is capable of identifying LD children and of specifying their particular deficits.

The test profiles of LD children often show impaired performance on the Reading, Visual, and Expressive Speech scales. However, LD children may differ greatly as to which particular scales show impaired performance. This finding agrees with other research which suggests that there may be distinct subtypes of LD children. Rourke et al.,(1978) who tested LD children on the WISC and HRNTB-C found two subtypes of LD children whom they labelled as "visual-spatial" and "auditory verbal" types (pp. 460-461). It is interesting to note, that distinct subtypes of LD children were observed more clearly in the test profiles of WISC-R subtests than of that of the HRNTB-C. In an earlier study Rourke and Bakker (1976) showed that extremely poor readers exhibited either poor visual imaging or poor immediate memory of auditory non-redundant information. A subsequent cross-check of the WISC-R scores of the LD children (records of the Child Guidance Clinic) revealed the familiar ACID pattern (i.e., outstandingly poor performance on the Arithmetic, Coding, Information, and Digit-span subtests). About 60% of the LD children who exhibited the ACID pattern on the WISC-R also showed high impairment scores on the Visual scale of the MLNNB-YC, -OC, while 40% had scores indicative of impairment on auditory and memory measures (e.g., Receptive Speech and Memory scales). The sample size of the LD group in this study was not sufficiently large to determine the number of distinct subtypes of LD children and to estimate their relative prevalence. However, the results of this study suggest that the MLNNB-YC, -OC can be used in future research with large samples of LD children to work out a typology of learning disabilities.

It could be argued that the selection criteria for the LD children might account for the above findings. Clearly deficient performance in at least one school subject suggested initially the possibility of "learning disability" and led to systematic assessment which then did or did not confirm the diagnosis of "learning disability". The special emphasis on reading in the early school years can be expected to make poor readers very conspicuous and, therefore, to get them more readily included in samples of LD children than is the case of children with other education-related deficits. The high proportion of LD children with impaired performance on the Reading scale could be attributed to such a selective bias. On the other hand, one can argue that the results of this study support the contention that the Reading scale is indeed sensitive to reading deficits and is therefore a valid scale.

4:5 Literature Critique

It was one of the research goals of this study to come to terms with some of the concerns voiced by reviewers about the LNNB (e.g., Adams, 1980, a,b; Crosson and Warren, 1982; Oelis and Kaplan, 1982; Spiers, 1981, 1982). Golden et al. (1978, 1979, 1980, 1981) conducted several methodological studies to vindicate the LNNB against such criticism. Even though most of the debate referred to the adult battery, it is also applicable to the LNNB-C. It is now helpful to relate briefly the results of this study to the results of earlier methodological studies of the LNNB.

On the whole, the results of this study agreed with the results obtained by Golden and his coworkers. For example, the interscorer reliability of this study ($\underline{r}$ =.92) was similar to that obtained by Hammeke (1978, 1980). The estimated test-retest reliability ($\underline{r}$ =.92) was found to be somewhat higher than that obtained by Golden, Berg and Graber (1980) for the parent battery. The factor analyses of this study generally supported Golden's grouping of items into scales. However, every scale had some items which were factorially independent of the scale factor(s). One should also remember the earlier-mentioned problem that it is difficult to meaningfully express dichotomous and trichotomous variables in a factor analytic model (Kim and Mueller, 1978; see also 3.6). The results of the factor analysis are therefore viewed as somewhat tentative.

The results of this study contribute to the above debate about the LNNB by providing evidence that (with the appropriate scoring system) the MLNNB-YC, -OC can indeed differentiate clearly between normal, LD, and BD children with very low rates of misclassification. Comparisons of the MLNNB-YC, -OC and the HRNTB-C batteries with respect to groups and to individuals suggest that the two batteries tend to provide similar information and thereby may provide some evidence for the construct validity of the MLNNB-YC, -OC. The agreement between the two batteries tends to be closer with respect to BD children than with repect to LD children.

4:6 Conclusions about Research Goals.

It is now appropriate to relate the results of this study explicitly to the original research goals.

(1) The study succeeded in developing a version of the battery which was suitable for assessing LD and BD in younger children.

(2) The study succeeded in improving and working out the methodological

properties of the MLNNB-YC, -OC. This was accomplished primarily by revising the scoring system.

(3) The study produced good age norms which were the basis of a new scoring system. These year-by-year age norms represent an advance over those previously available for the LNNB-C.

(4) The study documented for normal children age trends and sex difference in different abilities. Age differences were found to be more pronounced than sex differences.

(5) The study succeeded in delineating the score profile characteristic of LD children. LD had substantial deficits on only a few abilities and there was evidence for subtypes in the deficit pattern of LD children.

(6) The study showed that the MLNNB-YC, -OC were similar to the HRNTB-C in their ability to identify brain lesions in children. This finding provides some supporting validity for the MLNNB-YC, -OC.

(7) The study provided some support for the view that LD children perform normally on most functions but have significant impairments on one or two functions. These results obtained with the MLNNB-YC, -OC agree with conclusions based on other batteries.

The present form of the MLNNB-YC, -OC., clearly demonstrates the validity of this diagnostic tool in significantly differentiating between a) NC vs clinical groups and b) LD children vs BD children. To this extent, the MLNNB-YC, -OC can claim further support for its validity in terms of the goals set fourth in this research.

4:7 <u>The Significance of the Findings</u>.

1) The results obtained using the MLNNB-YC has demonstrated this instrument's usefulness as a tool for early identification of learning

problems in the primary school years. This is important for remediation programs of LD children.

2) The findings on age trends and sex differences clearly suggest that failure to consider age changes in neuropsychological functioning could lead to erroneous diagnostic decisions.

3) The validity of Luria's model has been demonstrated by extending the model to include the younger age groups (YC) and finding that this extension has the diagnostic power to differentiate between clinically distinct groups.

4) Variability obtained in performance patterns on the MLNNB-YC, -OC among the LD children suggest the usefulness in pursuing additional research in this area with a specific focus on detecting LD patterns.

5) The relatively short administrations time of the MLNNB-YC, -OC has two advantages, a) the effects of fatigue and boredom on neuropsychological test performance are minimal. Luria (1975) noted that score variability increases with testing time and felt that this was undesirable. (b) The MLNNB-YC, -OC are at least as sensitive to brain damage as the RINTB and HRNTB-C while administration time is about half that of the HRNTB-C.

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APPENDIX A

THE MANITOBA REVISION OF

THE LURIA-NEBRASKA NEUROPSYCHOLOGICAL BATTERY

Including YC items (for ages 5 to 7 years) and OC items (for ages 8 to 12 years) on the Writing, Reading, and Arithmetic scales

Rune S. Lundin
University of Manitoba
1984

CONTENTS

THE REVISED LURIA-NEBRASKA

NEUROPSYCHOLOGICAL BATTERY FOR CHILDREN

AGED 5 TO 12 YEARS.

A.1.1 Preliminary Interview: Recording section

Detailed notes should be made of the following; (if possible use a tape recorder to obtain a voice trace, note voice irregularities such as hoarseness, tenseness etc.)

a) Speech, appearance, cooperation, posture, general attitude, characteristic mannerisms, motor behavior, the child's appearance, including conditions of clothing and hair, facial expressions, peculiarities, rapport with environment; and his conduct including activity gestures and changeability. Speech and stream of thought with special attention to spontaneity, relevance and coherence. Distractibility, flight of ideas, blocking, punning, rhyming, neologizing and stereotypy are noted, and verbatim examples are recorded.

b) Mood: Anxiety, depression, apathy, suspicion, fear, aggression, elation, irritability excitation etc.

c) The Romberg Test: The subject is asked to stand with his heels together and eyes closed, (increased swaying commonly occur in subjects with dysfunctions of the cerebellar or vestibular mechanisms, and if the subject falls over during testing, there is some suspicion that he may have contracted a disease or sustained injury to the posterior columns of the spinal chord). The test is performed to rule out the possibility of spinal injuries which would render some of the test items questionable (e.g. Motor functions).

A.1.2 The Preliminary Conversation:

State of consciousness:

a) Orientation (ask the following questions and record the answers verbatim)

1) What is your name?
2) Where were you born?, ie. in what city, town etc.
3) What is the first name of your mother?
4) What day of the week is today?
5) What time is it now? (show watch)
6) What did you eat today?, yesterday?
7) What date is Christmas day?
8) Where do you live?
9) Do you have any sisters or brothers?
10) Name one of your friends.

b) Premorbid level (and recollection of same)

1) What was the name of your first teacher?
2) What do you usually do on weekends and in the evenings?
3) What did you do last summer?
4) What do you like to do best of all?

c) Attitudes toward environment and life situations

1) How do you feel?
2) Where are you now and when did you come here?
3) What is the name of your grandmother?
4) Who am I - have you met me before?
5) Can you loose your temper (or get angry)?
6) Can you do schoolwork as well now as you did before - do you have any difficulties doing things you used to do?
7) What about at home - can you play as usual and do you get along with your parents and friends as usual?
8) Do friends and parents treat you differently now than what they used to before?

d) Principal complaints (spontaneous subjective complaints)

1) Tell me how you feel.
2) Do you have any complaints - or do you feel that there is something wrong with you? Try to explain.
3) If you have pains, where are they located? Show me.
4) Do you sometimes feel as if something bad is going to happen, although you don't know what it is or why it should happen?
5) Do you sleep well - as usual, or much more than usual?
6) Do you feel more hungry or thirsty now than you used to?
7) Have you noticed any strange smells lately? and do they bother you?

e) Generalized complaints:

1) Do you have headaches - if so, can you describe what kind of headache - where it is located (in the front of the head, back of the head, or side(s)?
2) Is that the only ache you have?
3) Can you see everything you look at?, if not, when did you eye problem begin?
4) Do you have difficulty hearing? if so, when did it start? Is that your only problem?
5) Do you find it hard to get going when you are going to do something?
6) Can you remember well or have you difficulties remembering (ie. do you forget what you read - what happened yesterday - an hour ago?)
7) Do you feel more tired than usual?
8) Is it difficult for you to find the right words to explain something?
9) Do you find writing more difficult now than before?
10) Do you forget what it was you were going to do?

f) Complaints of Specific Episodic Symptoms:

1) Do you sometimes have body movements you can't control/-can you describe how it feels when this happens?
2) Have you ever felt that you were seeing things and if so, what were they like?
3) When you look at things do they seem to sometimes look bigger and sometimes smaller or change shape?
4) When you look at some object eg., a table, is it always in the same place or does it seem to move from side to side, or up and down?
5) Have you ever felt that you were hearing things when no one was around/ if so, what were the sounds like?
6) Can melodies change into noise?

A.2.1 HISTORY TAKING:
For a more accurate interpretation of the neuropsychological test results and for the purpose of providing a pre-trauma functional level estimate, the history taking procedure must be executed with utmost care and information should be cross-checked whenever possible.

<u>Birth and Diseases</u>:

1) Premature birth ______
2) Instrumental or operative birth ______
3) Malformations (cleft palate, spina bifida etc.) ______
4) Birth injuries ______
5) Congenital mental deficiency ______
6) Allergic diseases (asthma, eczema, urticaria) ______
7) Nervous diseases (myopathies, poliomyelitis, Little's disease) ______
8) Head injury ______
9) Loss of consciousness (fainting, coma) ______
10) Convulsions ______
11) Accidents ______

<u>Neuropathic Traits</u>:

1) Minor neuropathic traits (nail-biting, thumb-sucking) ______
2) Nervous breakdown (depression, states of excitement) ______
3) Persistent fears ______
4) Persistent nightmares ______
5) Persistent obsessions ______
6) Persistent compulsions ______
7) Tics, stammering, stuttering ______
8) Behavior problems (truancy, fights, disciplinary problems) ______
9) Antisocial behavior ______
10) Enuresis or encopresis beyond 3 years ______
11) Emotional overreactions, sudden outbursts (temper tantrums) ______

Constant or gradually progressing Symptoms:

1) Do you sometimes feel smells or tastes for no good reason?
2) Have you felt that your body changes - like sometimes your hands or arms get bigger or smaller, or other parts of your body?

Complaints of Disturbances in Complex Functions:

1) Do you have difficulty in finding your way around?
2) Do you have problems with dressing or undressing (taking your clothes on or off)?
3) Do you have problems with writing or reading that you did not have before? and can you tell me more about this? (ask for specifics).
4) Do you find it more difficult to understand what people say to you? - is it difficult to follow what is said in a conversation? (talking or listening to people).
5) Do you "stumble" over words when you speak or sometimes find it difficult to pronounce the words?
6) Do you have trouble with calculations or arithmetic - of what kind are they?

The Revised Luria-Nebraska Neuropsychological Battery for Children

INSTRUCTIONS for scoring of test items see Appendix B.

A.3.1 MOTOR FUNCTIONS

Simple Movement - Hands:

1. Hold out your right hand with the palm up, as if you were asking me to give you something, then touch each one of your fingers with your thumb as quickly as you can while I count how many times you can do it in ten seconds (demonstrate and let the child practice a few times before timing).

   Timing: Allow 10″ #/10″

   Right hand #/10″= _____

   *(Note that incomplete maturation in children 5 1/2 years of age often leads to movements of the fingers of the contralateral or untested hand. Should overflow movements occur beyond this age the child receives a score of 1).

2. Left hand #/10″= _____

3. Both hands simultaneous #/10″= _____

Additional scoring considerations for finger movements:

a) Reverse finger touching (ie. going from the little finger to the index finger) occurs quite often in children under 6 years of age. If this occurs in older children, and persists after additional instruction, give an additional score of 1.

b) Random body movements accompanying the choice of appropriate finger is given a score of 2 if the child is older than six.

a) _____

b) _____

Kinesthetic Movement-Hands:

Right Hand

4. Close your eyes, (use occluded goggles if necessary). I am going to put your fingers in a certain position. I want you to try and remember exactly how they are. (place right thumb against the fifth finger, forming a circle, hold for 2 seconds). Hold your hand out and stretch your fingers then show me how your hand was.

   Scoring: Correct response = 0   Incorrect response = 2

4. _____

5. Left Hand (Repeat as in 4)

5. _____

6. With your eyes closed put your other hand the same way I put this one. (Left thumb and middle finger pressed together for 2 seconds).

6. _____

7. With your eyes closed put your other hand the same way I put this one. (Right thumb and middle finger pressed together for 2 seconds).

7. _____

Optic-Spatial Organization - Hands:

8. Do as I do (pinch a pencil between thumb and index finger, palm up, and hold the pencil parallel to table top). Scoring is based on angle of deviation from horizontal.

Angle of dev. = _____°

9. (Pencil at right angle to table).

Angle of dev. = _____

10. (Pencil at 45 degree angle to table top)

Angle of dev. = _____°

11. <u>Do as I do</u>: (Right hand points to left eye). If the child uses the wrong hand but otherwise correctly completes the item tell the child "<u>No that is not the correct hand</u>. <u>Use the same hand I do</u>".

Correct/Incorrect

11. ______

12. (Left hand points to right eye). Correct as above if necessary.

12. ______

13. <u>Point to your left eye with your right hand</u>. For children under 7 years of age: <u>Point to your foot and touch your nose</u>.

13. ______

14. <u>Touch your right ear with your left hand</u>. For children under 7 years reverse hand/foot and touch nose with the other hand.

14. ______

<u>Dynamic Organization - Hands</u>

15. <u>Put your hands on the table just like mine</u> (One flat palm down and one closed fist). <u>Now reverse them like this</u> (palm fist, palm fist etc.) <u>Keep changing them</u>. <u>Do it as quickly and smoothly as you can until I tell you to stop</u>. (Demonstrate and allow the child to practice before timing). Allow <u>10</u> seconds.

#/10 seconds = ______

16. I want you to tap your right hand two times and your left once, (demonstrate). Keep doing that as smoothly as you can until I tell you to stop. (Allow the child to practice a few times before starting timing). Allow 10 seconds.

#/10 seconds = ______

17. (Same as 16 but reverse order of hands).

#/10 seconds = ______

18. <u>Draw this pattern</u> (card D1) <u>without lifting the pencil from the paper</u>. (Allow 40 seconds).

18. ______

<u>Simple Movement - Oral</u>:

19. <u>Puff out your cheeks</u> (if necessary, demonstrate)

19. ______

20. <u>Stick out your tongue at me until I tell you to stop</u>. The child must hold tongue out for 3 seconds.

20. ______

<u>Selectivity of the Motor Act</u>:

21. <u>Without lifting your pencil from the paper, I want you to draw the best circle you can</u>. (Permit second attempt if pencil is lifted before completion of drawing). Allow 30 seconds.

21. ______

22. Time taken to draw circle:

22. ______

23. <u>Without lifting your pencil from the paper, I want you to draw the best square you can</u>. (Age 5-6 may need demonstration but should draw independently). Allow 30 seconds. (See manual for scoring quality of square).

23. ______

24. Time taken to complete drawing

(seconds) ______

24. ______

25. <u>Without lifting your pencil from the paper, I want you to draw the best triangle you can, and try to make each side equally long</u>. (Allow 30 seconds). (Scoring at end of Appencix B triangle for quality).

25. ______

26. Time taken to complete drawing

(seconds) _____

26. _____

27. <u>Copy this figure as best you can without lifting your pencil from the paper</u>. (Same for 29, 30, 31 and 32) (Card D2). (See manual)

27. _____

28. Time taken to complete drawing

(seconds) _____

28. _____

29. (Card D3) (square, quality): (see Appendix B for scoring).

29. _____

30. Time taken to complete drawing

(seconds) _____

30. _____

31. (Show card D4) (Triangle, quality): (see Appendix B for scoring)

31. _____

32. Time taken

(seconds) _____

32. _____

<u>Speech Regulation of the Motor Acts</u>:

33. (Have the child take your hand and say:) <u>If I say "red" squeeze my hand, and if I say "green", do nothing</u>. (Say: <u>Red</u>, <u>green</u>, <u>green</u>, <u>red</u>).

(R) _____, (G) _____, (G) _____, (R) _____

33. _____

34. Say: If I knock once raise your right hand. If I knock twice raise your left hand. (If the child cannot tell R and L tell him this is your right hand and this is your left hand, show). (Knock: once, twice, once, twice).

34. _____

MOTOR SCALE TOTAL: _________

A.3.2 ACOUSTICO-MOTOR ORGANIZATION (RHYTHM)

Perception of Pitch Relationships:

35. Now you are going to hear two tones on the tape. I want you to tell me if the tones are the same or different? (Play tape) (Circle errors)

(Tones are: S, D, S, S, D).

35. _____

Reproduction of pitch Relationships and Musical Melodies:

36. Listen to these tones and hum them. (Play tape) (Before third series say: "Now there will be three tones".) (Circle errors).

Series: Low-high, High-low, Low-high-low, High-low-high.

36. _____

37. Listen to this song and sing it. (Play tape, "My Bonnie lies over the ocean").

Scoring:	0	2
	Correct	Incorrect

37. _____

38. Please sing "Happy Birthday".

Scoring:	0	2
	Correct	Incorrect

38. _____

Perception and Evaluation of Acoustic Signals:

39. How may beeps do you hear now? (Play tape).

Series: (2) ___, (3) ___, (2) ___, (3) ___
(Record responses).

39. _____

40. How many beeps do you hear now altogether? Keep counting until I tell you all the beeps have ended. (For children under 8 yrs. play only the first series (8 beeps).

Series: 1st.=8 2nd.=12

Record number of errors _____ 40. _____

Motor Performance of Rhythmic Groups:

41. You will now hear a rhythm on the tape. When it is finished, I want you to tap the same rhythm with your hand on the table (The examiner may have to demonstrate to children under 6 yrs.) (Play tape). Record the number of errors.

Series: a) (" " " ") _____
b) (" ' " ' " ' " ') _____
c) (" " ") _____

Number of errors _____ 41. _____

42. I want you to make a group of .... taps, do the taps more than once. (For children under 7 yrs. the examiner may have to demonstrate).

Series: a. Two taps _____
b. Three taps _____
c. Two strong & three weak _____

Number of errors _____ 42. _____

RHYTHM SCALE TOTAL: _____

A.3.3 HIGHER CUTANEOUS AND KINESTHETIC FUNCTIONS (TACTILE)

Cutaneous Sensation:

(For all the tests in this section the child should be blindfolded).
Materials needed: Pencil with eraser, cloth-pin, compass for two point discrimination, a coin (Quarter), a key, an eraser, a paper clip.
(Have the child sitting in front of you with his hands on the table, palms up.)
Say: Tell me where I am touching you. (Touch the child with the eraser end of a pencil, alternating between right and left fingers, (numbered: P (palms), F (forearm), S (shoulder, and fingers from 1-5). If uncertain of intended locus in verbal report, have the child point to locus and touch with opposite hand. If will help to have the child tell you what he calls each finger prior to placing the blindfold. (Circle errors).

43. Series: Right hand: 1, F, 3, 5, P, 2, S, 4
Left hand : P, 2, 3, S, 5, 4, F, 1

(Right Hand) 43. _____

44. (Left Hand) 44. _____

45. Am I touching you with the point or the head of a pin? (Touch the back of the appropriate hand with either the point or head of a pin. Hold touch for one second, alternate between hands. Circle errors).

Series: Right Hand: P - H - P - P - H.
Left Hand : H - P - P - H - H.

(Right Hand): Number of errors 45. _____

46. (Left Hand): Number of errors 46. _____

47. With the head of a pin on the back of the S's wrist, depress the skin approximately 3 mm. Say, "This is strong", then depress the skin approximately 1 mm. and say, "This is weak". Ask S if there is a difference felt. If not, demonstrate once more. Say, "now the touch you feel, is it strong or weak"? (Alternate between hands, circle errors)..

Series: Right Hand: W - S - S - W
Left Hand : S - W - S - W

(Right Hand): Number of errors 47. _____

48. (Left Hand): Number of errors 48. _____

49. <u>How many points do you feel</u>? (Using the compass begin with a single point, then gradually increment the separation by 5 mm on the middle finger until the threshold of two-point discrimination is reached. On middle finger, spread points parallel to arms. Alternate between right and left. Recheck each 2-point discrimination by following it with a one-point check and then another 2-point check at the same distance. Hold each check for a period of <u>two seconds</u> and allow at least <u>five seconds</u> (refractory period) between any point check on the same location. If both these are discerned accurately, consider the two-point discrimination valid. If not, proceed to the next higher magnitude. Discontinue after 25 mm spread between point)..

(Right Hand): 49. _____ mm

50. (Left Hand): 50. _____ mm_

51. <u>In what direction am I touching you, up or down your arm</u>? (Move screw on the compass 150 mm up or down the outside lateral surface of the S's arm. Alternate between right and left arms). (Circle errors).

Series: (Right Arm): <u>U</u> <u>D</u>
(Left Arm): <u>D</u> <u>U</u>

(Right Arm) Correct/Incorrect 51. _____

52. (Left Arm) Correct/Incorrect 52. _____

53. <u>I am going to trace either a cross, triangle, or a circle on your wrist</u>, (with children under six it may be necessary to demonstrate the shapes while saying, "This is a cross, this is a circle, etc.") <u>Tell me what I am tracing now</u>. (Alternate between right and left wrist (back) making the figures approximately 30 mm. in diameter. Indicate missed figures. (Child may be reminded of the three forms only after the first error).

Series: Right: ___; Left: ___; Right: ___;
Left: ___; Right: ___; Left: ___.

(Right wrist) Number of errors 53. _____

54. (Left wrist) Number of errors 54. _____

55. (On back of wrist) <u>What number is this</u>? (For children 5-6 yrs. trace <u>1</u> for children over 6 yrs. trace <u>3</u>). Alternate between right and left wrist.

(Right): 0 - Correct 2 - Incorrect 55. ______

56. (Left): Correct Incorrect 56. ______

<u>Stereognosis</u>

57. (Instruct S to hold right palm up and place first object on fingers. Alternate between hands). Say, "<u>Feel this object and tell me exactly what it is</u>". (Allow twenty seconds per item). (If the child says "coin" for quarter or "clip" for paper clip, say, "be more specific".)

Series:	Right Hand		Left Hand	
1.	Quarter	______	Eraser	______
2.	Key	______	Paper Clip	______
3.	Eraser	______	Key	______
4.	Paper Clip	______	Quarter	______

(Right Hand): Number of errors 57. ______

58. (Left Hand) Number of errors 58. ______

TACTILE SCALE TOTAL: ______

A.3.4 <u>VISUAL FUNCTIONS</u>

<u>Visual Perception - Objects and Pictures</u>:

59. <u>What do you call this</u>? (Present the following objects to the child, one at a time: Pencil, eraser, rubber band, quarter). (Allow twenty seconds per item).

Series: Pencil ______
Eraser ______
Rubber Band ______
Quarter ______

59. ______

60. What is this called? (Present pictures to S one at a time (Christensen cards G1, G2, G3, G6). (Allow twenty seconds per card).

G1: ______ (Watch)
G2: ______ (Scissors)
G3: ______ (Hand bag, purse, pocket-book)
G6: ______ (Camera and lenses)

Number of errors 60. ______

61. What is the picture supposed to be? (Present Christensen cards: G8a, G8b, G9a, G9b, G9c, G10 (Allow twenty seconds per card).

G8a: ______ (Book, any book)
G8b: ______ (Book)
G9a: ______ (Sunglasses, glasses, spectacles)
G9b: ______ (Sunglasses, glasses, spectacles)
G9c: ______ (Sunglasses)
G10: ______ (Telephone)

*Number of errors: 61. ______

62. What objects can you see in this picture? (Show Christensen cards G13 and G14). (Allow 30 seconds).

(G13)

Pail, bucket ______
Paintbrush, brush, baster ______
Rake ______
Scissors, shears ______
Hatchet, axe ______

(G14) (Allow 30 seconds)

Coffee pot, tea pot, tea kettle ______
Fork ______
Bottle ______
Glass, wire basket ______
Bowl, dish, saucer, basin ______

Total Errors: 62. ______

Spatial Orientation:

63. Look at this pair. How are they alike and how are they different? (Card G22) (See scoring criteria Appendix B).

A. BB Score (0) for Correct and
(1) for Incorrect
B. 44 Score (0) for Correct and
(1) for Incorrect
C. IV VI Score (0) for Correct and
(1) for Incorrect

Total Score: 63. _____

64. I am going to show you a card for about ten seconds. Be sure to look at it carefully because I shall take it away and ask you to draw from memory what you have seen. (See scoring criteria). (Show card G23 and G24).

G23: _____ Score (0) for correct and
(1) for Incorrect
G24 _____ Score (0) for correct and
(1) for Incorrect

Total Score: 64. _____

65. At the left of this paper (point to stimulus figure in sample 1) there is a square with a small circle in one corner. Notice the heavy dark line on one side of the square (point). The dark line is called the baseline. Now look at these squares (point to the four samples), and notice that each square has a small circle in one corner and the bottom of each has a heavy or thicker line, the baseline. One of the four squares is just like the sample square (point to sample again). When the baseline is not at the bottom the square must have turned itself but by looking at the baseline and the small circle you can tell which one of the squares is the same as the sample but has been turned.

You see some letters under each square and I want you to draw a circle around the letter under the square that is just like the sample. Square A is the correct square because the circle is in this corner next to the baseline, just as in the sample.

Now look at sample 2. This is the same type of problem, but the baseline is on the left side of the square (trace with a pencil). To solve the problem you have to turn the sample square in your head so that the baseline is on the bottom like it is here under the correct square. Square B is the correct square because if you

<u>turn the sample figure so that the baseline is at the bottom, the circle will be in the upper right corner, just as it is in this square</u> (point), (circle).

<u>Now, I want you to do the rest of these</u> (motion 3 through 10) <u>circling the letter under the correct square as we did with the others</u>. <u>Do them as quickly as you can, but try not to make any mistakes</u>. <u>If you are having trouble with one problem, skip it and come back to it later</u>. (Allow 180 seconds to complete the task).

Answer:	1.	A	6.	B
	2.	B	7.	C
	3.	D	8.	C
	4.	C	9.	D
	5.	A	10.	A

Maximum errors = 8 (do not count 1 & 2)

Total errors: __________

65. _____

TOTAL VISUAL SCALE: __________

stimulus figure

A.3.5 RECEPTIVE SPEECH

Phonemic Hearing - Repetition and Writing:

Now I will say some sounds. What I want you to do is first say out loud exactly the sound you hear and then write down the letter of the alphabet which goes with that sound. For example, if you hear "ta" first say "ta" and then write down the letter "t". Remember, first say the sound you hear out loud, then write the letter which goes with the sounds. (Note that most children under 6 years of age have not learned the letters. For children who do not know the letters and their sounds the repetition of the sound instructions can be followed by a request for a word that starts with the same sound, eg., - Tell me a word that starts with the sound you just made, if you cannot think of a real word just make one up).

66. Oral: Say, Buh; (___); Puh; (___); Muh; (___)

Total # of errors: _____ 66. _____

67. Written or word production:
Now write the letter you hear (or say a word that starts with the same sound).

Say: Buh ___, Puh ___, Muh ___

Total # of errors: _____ 67. _____

68. Now I am going to say two sounds. After I say them I want you to repeat them after me.

1. muh-puh (___/___)
2. puh-suh (___/___)
3. buh-puh (___/___)
4. duh-tuh (___/___)
5. kuh-guh (___/___)
6. ruh-luh (___/___)

\# errors: _____
(of 12 poss.) 68. _____

69. Written: __ __ __ __ __ __ __ __ __ __ __ __
m - p p - s b - p d - t k - g r - l

Scoring: same as above. 69. _____

70. Now I will say three sounds. After I complete them, repeat them after me.
Say: bi-ba-bo (___/___/___)

\# errors _____ (6 poss.) 70. _____

71. Now I am going to say two letter sounds. Tell me if they are the same or different:
"b - p" (Pronounced at same pitch) _____.
"b - p" (at different pitch) _____.

Total # of errors: _____ 71. _____

Word Comprehension - Definitions:

72. Will you please point at your:
"eye" ___, "nose" ___, "ear" ___, "elbow" ___, "knee" ___

Total # of errors: _____ 72. _____

Word Comprehension - Effect of Repetition:

73. Now I want you to point at the place I tell you, in the same order I say them. (Allow one repetition of the series before permitting a scoreable performance).
Say: "eye-nose-ear-eye-nose"

73. _____

Word Comprehension - Identification:

74. (Place Christensen cards #H 7-10 and H 14 on the table from the child's left to right). Say, Show me:
"the orange" (H8) ___, "the candle (H14) ___
"the bottle" (H7) ___, "the shoe" (H10) ___

74. _____

75. What does (word) mean?
Cat _____
Bat _____
Pat _____

75. _____

Simple Sentences - Phrases:

76. (Place Christensen cards #H 17-22 in front of the child from the child's left to right). Say, Point to the picture that shows:
typewriting ___; mealtime ___, summer___.

76. _____

77. a. Put your hand on your head.
Score (0) correct (1) incorrect

b. Whose watch is this? (examiner's)
Score (0) correct (1) incorrect

c. Whose is this? (Examiner's ring, etc.)
Score (0) correct (1) incorrect

d. (Place Christensen cards H 23-25, left to right in front of S). Which one is used to light a fire?

Score (0) correct (1) incorrect

Errors _____ 77. _____

Simple Sentences - Conflicting Instructions:

78. (Materials: Christensen cards #H 26-27)
a) Say, Here are two cards, one is gray and one is black (place the cards in front of child).

Say: If it is night now, point to the gray card and if it is day now, point to the black card. __________

Errors: _____ 78. _____

Logical Grammatical Structures:

79. (Place a pencil, key, and comb clockwise in a triangle before the Subject.

	Correct	Incorrect
Say: a) Point at the pencil	___	___
b) Point at the key	___	___
c) Point with the key toward the pencil	___	___
d) Point with the pencil toward the key	___	___
e) Point to the pencil with the key	___	___
f) Now to the comb with the pencil	___	___

# of Errors: _____ 79. _____

80. Say: Draw a cross beneath a circle.
Correct ___ Incorrect ___

Draw a circle to the right of a cross.
Correct ___ Incorrect ___

# of Errors: _____ 80. _____

Logical Grammatical Structures - Attributive:

81. (Present Christensen card #H 28). Say: Show me, by pointing, who is the daughter's mother (allow 20 seconds).

81. _____

Logical Grammatical Structures - Comparative:

82. Which statement is correct: "A fly is bigger than an elephant" or "an elephant is bigger than a fly"? (Allow 20 seconds per response).

Correct ___ Incorrect ___

(Present Christensen cards #H 26-27 (20" per response).

Say: Look at these two cards, which of the two is lighter? (26)

Correct ___ Incorrect ___

Which of the two is less light? (27)

Correct ___ Incorrect ___

Which of the two is darker? (27)

Correct ___ Incorrect ___

Which of the two is less dark? (26)

Correct ___ Incorrect ___

82. _____

Logical Grammatical Structures - Inverted Grammatical Constructions:

83. If I say:
   a) "Peter struck John", Which of the boys was hurt? _____(John) (Allow 20").

83. _____

RECEPTIVE SPEECH TOTAL SCORE: _____

A.3.6 EXPRESSIVE SPEECH

Articulation of Speech Sounds:

84. Repeat after me: (Give each stimulus sound in normal speaking voice, do not repeat).
a (as in late) ___
i (as in light) ___
m (as in milk) ___
b (as in baby) ___
sh (as in shine) ___

84. _____

85. Repeat after me:
sp (spot) ___
th (thaw) ___
pl (plate) ___
str (string) ___
awk (awkward) ___

85. _____

86. Repeat after me:
see-seen ___
tree-trick ___

86. _____

87. Repeat after me:
house ___
table ___
apple ___
hairbrush ___
screwdriver ___
laborious ___

87. _____

88. Repeat after me:
cat-hat-bat ___
hat-sun-bell ___
hat-bell-sun ___
house-ball-chair ___
ball-chair-house ___

88. _____

<u>Articulation of Speech Sounds</u>:

89. For children who have not yet learned the sounds of the letters of the alphabet or below 6 years of age (depending on educational exposure) show items in the Christensen cards that begin with the sounds listed below and ask the child to say these sounds, (eg., apple for a, ball for b, etc.) For children who know the letter sounds, say: <u>Say the sounds that go with these letters</u> (Show Christensen cards #J 1):

a ___
i ___
m ___
b ___
sh ___

89. _____

90. (Show Christensen card #J 2). <u>Say the sounds that go with these letters</u>:

sp ___
th ___
pl ___
str ___
awk ___

# of errors: ___ 90. _____

91. (For children under 8 years of age the examiner should read the words and have the child repeat them). For children 8 yrs.+ say: <u>Read these words</u>: (J 3).

see-seen ___
tree-trick ___

Total # errors: ___ 91. _____

92.

(J4)		(J5)		(J6)		(J8)
cat	___	house	___	hairbrush	___	cat-hat-bat
dog	___	table	___	screwdriver	___	
man	___	apple	___	laborious	___	

Total # errors: ___ 92. _____

Reflective speech - Sentences:

93. Repeat after me (May not be repeated. Circle missed words and score a 1 for each sub-item):

A. The weather is fine today. ___
B. The apple trees grew in the garden behind a high fence. ___
C. In the edge of the forest the hunter killed the wolf. ___
D. The house is on fire, the moon is shining, the broom is sweeping. ___

Total # errors: ___ 93. _____

Nominative Function of Speech - Naming from Description:

(Allow 20 seconds per item).

94. What do you call the object with which you fix your hair each morning? (Comb, hairbrush, or brush) ___

What do you call the object that shows what time it is? (Watch, clock, etc.) ___

What do you call the object that protects you from the rain? (Umbrella, raincoat) ___

Total # of errors: ___ 94. _____

Narrative Speech - Fluency and Automatization of Speech:

95. Count from 1 to 20 out loud. (For children under 6 years, count from 1-10) (Discontinue after one error or 30 seconds).

Correct/Incorrect 95. _____

96. Count backwards from 20 to 1, like this, 20, 19, 18, all the way back to 1. (For children under 6 years, count backwards from 10. Discontinue after one error or 30 seconds).

96. _____

97. Say aloud the days of the week. (Discontinue after 1 error or 30 seconds).

97. _____

98. Say the days of the week backwards starting with Sunday. (Discontinue after one error or 30 seconds).

98. _____

Predictive Speech - Reproductive Forms:

99. (Show Christensen card #J 29) - Tell me what is happening in this picture. (Start timing after completing the instruction, allow 30 seconds but count the number of words uttered during the first 10 seconds. Items involving rate of speech are best taped and played back for recording of response).

Response time: ___ sec. 99. _____

100. Scoring: (Word rate)
Words/10 sec.___ 100. _____

101. (Hand the child Christensen card #J 30 and say): I am going to read this short story out loud. Please listen carefully because when I am finished I am going to take the card away and then you will have to tell me the story back in your own words. (After taking the card away, say "go ahead" and start timing immediately. Allow 30". "Yesterday Peter who was seven years old went down to the river to fish. He took his dog Prince with him. The river had overflowed its banks after the rainy weather. Peter slipped and fell into the deep water. He would have drowned if the dog had not dived in and helped him to reach the shore".

Response time: ___ 101. _____

102. Scoring: (Word rate)
Words/10 sec. ___ 102. _____

Narrative Speech - Predictive Forms:

103. Could you make a short speech about the weather? (If the child replies "I don't know anything about it" or "I can't", say: Just say what you thing is right). (Start timing immediately after instruction and allow 30 seconds).

Response time: ___ 103. _____

(Time)

104. (Words)
Words/sec. ___ 104. _____

The following three scales (Writing, Reading and Arithmetic) will have different items for children aged 5 to 7 years (YC items) and for children aged 8 to 12 years (OC items). For each of the three scales the YC items are presented first followed by the OC items. Make certain that the items used are appropriate for the age child being tested.

WRITING READINESS (-YC, children 5 to 7 years)

Phonetic Analysis

105. Point to all the things that start with the same sound as (show and say stimulus).

Correct/Incorrect

Visual Matching

106. Point to the picture that looks the same as this one (point to stimulus figures).

Correct/Incorrect

107. This is the word cat. (Point to stimulus). It has three letters
(c) (a) (t) (count 1 - 2 - 3).
How many letters does this word have? (A), (B), (C), (D).

Number of errors _____

108. Copying and writing - Simple

Please write your first and last name: (Allow 30 minutes). (5 year old first name only).

Correct/Incorrect

Line Recognition and Copying (Visual)

109. How are these lines (a) different from these lines (b)?
Copy all the lines (A - B - C - D).

Number of errors _____

Complete Copying

Item number

110. Copy these figures:

Number of errors _____

111. These are letters. Each one of them has some part missing. I want you to complete them. Draw them finished.

Correct/Incorrect

Total Writing ________

A.3.7.s WRITING (OC, children aged 8 to 12 years)

Phonetic Analysis:

105. How many letters are there in: (Allow 20″ per item).
Cat ___(3), Trap ___(4), Banana ___(6),
Hedge ___(5)

# of Errors: ___ 105. _____

106. (Allow 20″ per item).
SAY: What is the 2nd letter in cat? ___(a)
What is the 1st letter in match? ___(m)
What is the 3rd letter in hedge? ___(d)
Which letter in "stop" comes after "o"? ___(p)
Which letter in "bridge" comes before "g"? ___(d)

# of Errors: ___ 106. _____

Copying and Writing -- Simple:

107. Copy these letters in your own handwriting (K1): (Allow 40″).

___(B), ___(L), ___(L), ___(D), ___(B)

Copy these in your own handwriting (K2): (Allow 60″).

___(pa), ___(an), ___(pro), ___(pre), ___(sti)

# of Errors: ___ 107. _____

108. Please write your first and last name: (Allow 30″).

Correct Incorrect 108. _____

Copying and Writing -- Complex Forms:

109. Write the letters that I say: F___, T___, H___, L___.

# of Errors: ___ 109. _____

110. Now write these sounds. (Dictate): ba___, da___, back___, pack___

# of Errors: ___ 110. _____

111. Now words and phrases (Dictate): (Circle words containing an error. Allow 20" per item).

1. hat-sun-dog ___(3)
2. all of a sudden ___(4)

# of Errors: ___ 111. _____

READING READINESS (YC, children aged 5 to 7 years)
Semantic Association

112. Show reading work sheet "A" to child and SAY: "Here are some boxes with pictures in them (point). I am going to ask you a question about one of the pictures but first, point to the picture of the DOG. Now, look at the picture that shows the dog **behind** the dog-house (repeat **behind**). For 112b SAY: "The cat **on** the tree". For 112c SAY: "In **front** of the ball". For 112d SAY: "The star on **top** of the tree". For 112e SAY: "The truck **inside** the garage".

Number of errors _____

Shape Constancy - Letter Recognition (Reversals)

Item number

113. a) Show worksheet "B" to child.
- Look at the letter I point at (point at M to the left).
- Now, point at the letter that looks the same among these letters (point at the row a, b, c, d, e).

b) Point to the house that looks exactly the same as this one (point to house at left).

c) Point to the letter that looks exactly the same as this one (point to b at left).

d) This is the letter G. Find the letter G among these letters (point to row a, b, c, d, e).

Number of errors _____

Directionality (left-right discrimination) (Reading worksheet "B")

114. a) This arrow points to the left (show stimulus figure "A"). Point to the arrow that points to the left. Here (point to A B C D).
b) Point to the arrow that points to the right.

Number of errors _____

115. a) Point to the **FIRST** apple. b) Point to the **NEXT** apple.
c) Point to the **LAST** apple.

Number of errors _____

Auditory Sequencing (Reading Worksheet "C")

Item number

116. Here are some pictures (show 116a). The first one shows a cup, the second shows a glass and the third shows a fork. Let's say them together (rehearse). There are 3 more pictures. Look at them. Now, close your eyes tightly and listen carefully. I am going to say the name of each picture in order. SAY: "Find the picture that has a **fish**, a **bird**, and a **flower**. (Say only once). Open your eyes and point to the picture I told you about.

Correct/Incorrect

Reading Classificated Words

117. Read word list "a" to the child and explain why the word "shoe" does not belong in the sequence. SAY: "I am going to read some more words, tell me which one does not belong, or which object is different from the others:

Number of errors _____ 117 _____

Oral Context Sequence

118. I am going to begin a short story. I will not finish the story, so when I stop the story, I want you to finish saying the story words:

SAY: "Peter's favorite TV show is ______________".
"When it rains the ground gets ______________".
"If you throw a stone in the river it will ______________".
"If you go shopping to a grocery store you buy ______________".
"One day Lisa climbed up in a tree because she wanted ______________".
(Finish the story).

Number of errors _____ 118. _____

A.3.8.2 READING (OC, children aged 8 to 12 years)

Phonetic Synthesis:

112. What sound is made by the letters: (Allow 20″ per item).

g-r-o ___, p-l-y ___, s-t-o-n-e ___

# of Errors: ___ 112. _____

Reading -- Letters and Words:

113. Tell me what you see here (K4). (Circle errors). (Allow 20″).

K S W R T

# of Errors: ___ 113. _____

114. Which of the letters, B, J, or S, stands for John? _____(J) (Allow 20″).

Correct Incorrect 114. _____

Reading -- Syllables and Words:

115. Read these sounds (K5): (Allow 20″ per item).

po___, cor___, cra___, spro___, prot___.

# of Errors: ___ 115. _____

116. Read these words: (Allow 20″ per item).

1. (K6): juice___
2. (K7): bread___
3. (K8): bonfire___
4. (K9): cloakroom___
5. (K10): fertilizer___

# of Errors: ___ 116. _____

Reading -- Phrases and Whole Texts:

117. Read these sentences: (Allow 20" per item).
   1. (K18): The man went out for a walk. ___
   2. (K20): There are flowers in the garden. ___
   3. (K21): The sun rises in the west. ___
   4. (K22): The boy went to bed because he was ill. ___

   # of Errors: ___ 117. _____

118. Read this out loud (K23): (Circle missed words). (Discontinue at 120" or 10 errors).

   "John was a boy who liked apples -- especially if they were stolen. One dark night he went into an orchard, plucked what he took to be an apple and set his teeth in it. It was, however, a very unripe pear and his loose front tooth stuck in the fruit. Now he only steals apples in the daytime.

   # of Errors: ___ 118. _____

READING SCALE SCORE _____

A.3.9.1 ARITHMETICAL READINESS SKILLS (YC, children aged 5 to 7 years)
Size Constancy

119. (Worksheet "A"). Place worksheet in front of the child and point to the stimulus figure in the left margin (circle). SAY: "This is a ball and these are some other balls. (Point to row 1 2 3 4 at right). You can see that some balls are small and some are bigger. I want you to find the ball that is the same size as the one I am pointing at (point to stimulus). When you think you have found the ball with the same size here (point to row 1 2 3 4), point with your finger to the ball".

   Correct/Incorrect

Shape Constancy

120. Here is a cheese (point to stimulus). If I take a knife and cut this cheese into pieces what would those pieces look like? Look at the pieces here, (show by pointing to row 1 2 3 4). Which one of these would make the cheese whole again if you put them together. Remember that the pieces you put together should make a nice round cheese just like this one (point to stimulus).

   Correct/Incorrect

Counting

121. a) Look at these squares. I want you to count them and count out loud and tell me how many squares you see.

a) ________________

b) Point to the stimulus at left and SAY: "Look at these Christmas trees. Now, I want you to find the picture here (point to 1, 2, 3, 4) that has the same number of Christmas trees".

b) ________________

c) Point to stimulus figure and SAY: "These are some houses, and here are pictures of buttons (point to 1, 2, 3, 4). Now show me the picture that has as many buttons as there are houses".

c) ________________

Number of errors _____

Arithmetical operations Sequential Subtraction

122. This is a whole apple pie (point to stimulus). These pictures (point to 1, 2, 3) show what happens when you cut pieces of the pie. First is the whole pie (point to 1), then we cut one pice of pie (point to 2), then another (point to 3). (Hand child pencil). I want you to draw a picture of what is left if you cut one more piece of pie.

Correct/Incorrect

Number Recognition

123. Here are some birds (point to stimulus) count them. Point to the number here (point to 1, 2, 3, 4) which is the same as the number of birds.

Correct/Incorrect

Comprehension of Number Structure

124. Here are some counting numbers (point to stimulus) but one of them is missing. Find the missing number among these numbers, (point to 1, 2, 3, 4).

Correct/Incorrect

Arithmetical Operations

125. Here are some more numbers (show stimulus). If we count like this, what number comes next here? (Point to space provided).

Correct/Incorrect

Numberical Matching

126. Here are some playing cards. They have numbers in the corners (point). I want you to find the card that has the same number of hearts as the number in the corner.

Correct/Incorrect

127. Here are two apples (point) and if you add two more apples (point) how many apples will you have.

Correct/Incorrect

A.3.9.2 ARITHMETICAL SKILLS (OC, children aged 8 to 12 years)

Number Comprehension

119. Write down the numbers I say. (Circle errors).
a. 7-9-3; 3-5-7 (10″ per number group)
b. 17 and 71; 69 and 96 (10″ per number pair)
c. 27, 34, 158, 396, 9845 (10″ per number)

\# of Errors: ___ 119. _____

120. Read these numbers.
a. (L1) 7-9-3-; 3-5-7 (10″ per number group)
b. (L3) 17 and 71; 69 and 96 (10″ per number pair)
c. (L3.5) 27, 34, 158, 396, 9845 (10″ per number)

\# of Errors: ___ 119. _____

121. There are three numbers on this card (L4) arranged from top to bottom. Read each number as a whole number. (Point to each column individually. If, on 158, the child says "1-5-8", say "I want you to read this as if it were just one number". (Allow 20″ per item).

158___; 396___; 1023___.

\# of Errors: ___ 121. _____

Comprehension of Number Structure -- Numerical Differences:

122. Tell me which number is larger: (Circle answer; Allow 10″ per item).

17 or 68; 23 or 56; 189 or 201

\# of Errors: ___ 122. _____

123. Look at this card (L5) and show me, by pointing, which of the top two numbers is the larger? Which of the bottom two? (Allow 10″ per item. Circle answer).

189 - 201; 1967 - 3002

\# of Errors: ___ 123. _____

Arithmetical Operations -- Simple:

124. Now I will ask you to solve some problems and you may write them down if you like. How much is: (Allow 20″ per item, including writing).

1. 3 x 3 = ___(9)
2. 5 x 4 = ___(20)
3. 7 x 8 = ___(56)

\# of Errors: ___ 124. _____

125. How much is:
3 + 4 = ___(7) (20″)
6 + 7 = ___(13) (20″)
27 + 8 = ___(35) (20″)

\# of Errors: ___ 125. _____

126. How much is:
7 - 4 = ___(3) (20″)
8 - 5 = ___(3) (20″)
44 - 14 = ___(30) (40″)
31 - 7 = ___(24) (40″)

\# of Errors: ___ 126. _____

127. I want you to count backwards from fifty by 3's, like this, 50, 47, 44, and so on. Start from 50 and subtract 3 each time. (If the child makes an error say, "No, it is not ___, what is (give previous correct response) minus 3). (Allow 60″).

50, ___, ___, ___, ___, ___, ___.
47 44 41 38 35 32

127. _____

A.10.1

MEMORY

(No stimulus repetitions are allowed for any item in this section).

The Learning Process -- Series of Unrelated Words:

128. I am going to say 7 words. After I finish saying them, I want you to repeat as many of them back to me as you can remember. (Present at a rate of 1 word/second).

house-forest-cat-night-table-needle-pie

(Have the child recall as many of the words as possible. Go on to next trial if the child is unable to recall another word after a pause of 5 seconds since the last word given). (Say) "You remembered ___ words out of the 7 on that trial. I am going to say the same seven words again and I want you to try to recall as many as you are able to when I finish. However, before I begin, I want you to tell me, how many words to you think you'll remember this next time. Remember you got ___ words out of 7 on this last trial. (Do this for each trial until either the child reaches the criterion of two perfect trials in a row or five trials).

Scoring: (total errors over all trials):

128. _____

Retention and Retrieval -- Immediate Sensory Trace Recall

129. I am going to show you a card with some pictures on it. You will have 10 seconds to examine it, and then I will remove it and ask you to draw what you saw (M5).

correct: ___

129. _____

130. I am going to put my hands in three positions. I want you to remember what positions my hand made because I will then ask you to make the same positions. (Use same hand for each and hold each position for 2" before going on to the next position. The child may use either hand).

Position 1 ___ Position 2 ___ Position 3 ___

# of Errors: ___

130. _____

131. Now I am going to show you a card. You will have 5 seconds to examine it, and then I will remove it. I want you to repeat the words written on the card after I remove it. (Show M6; circle errors).

house, moon, street, boy, water

# of Errors: ___ 131. _____

132. I want you to remember some words that I am going to say: house, tree, cat. Repeat them. Now look at this picture. What do you see? (Present M7 and have S describe picture for 15 seconds). Now can you tell me, what were the words I asked to remember?

house: (___); tree: (___); cat: (___)

132. _____

133. Now I am going to say some words and I want you to try and remember them: man, hat, door. Now please repeat those words to me. (If incorrect, say once before preceding: "Remember, the words are man, hat, door"). Now try to remember these words: light, stove, cake. Please repeat these words. Tell me, what were the three words I said first?

man: (___); hat: (___); door (___).

What were the three words I said second?

light: (___); stove: (___); cake: (___)

Number of errors on all memory trials combined. _____

133. _____

134. Now I am going to read you a short story. I want you to listen carefully because when I am finished I want you to repeat to me all that you can remember about the story. (Read the following (also on M9), then ask the child to tell story). Score for number of major points of story the child remembers.

The Crow and the Doves:

A crow heard/that doves had plenty to eat./He colored himself white/and flew to the dove cote./The doves thought/he was one of them/and took him in./However, he could not help cawing/like a crow./The doves then realized that he was a crow/and threw him out./He went back to rejoin the crows,/but they did not recognize him/and would not accept him./

134. _____

Logical Memorizing -- Recalling by Visual Aid:

135. Now I am going to show you some pictures (M10-15). With each picture I am going to say a word. When I finish, I will show you the pictures, and I want you to say the word. For example, I will show you this picture and say "energy". When I show you this picture later what would you say? (Prompt if necessary). You will have 5" to look at each picture. (Allow 5" per picture for both administration and recall).

(M10)	energy	___
(M12)	party	___
(M13)	happy	___
(M14)	family	___
(M15)	project	___

# of Errors: ___ 135. _____

A.11.1 INTELLECTUAL PROCESSES

Understanding of Thematic Pictures:

136. Look carefully at this picture (N1) and tell me what is happening in this picture?

(N1): ____

____

(See manual for scoring) 136. _____

I am going to show you some pictures. They are in the wrong order. I want you to put them in the right order so that they make sense. Please try to put them in the right order as quickly as you can and tell me when you are finished. (Present N14 - N18 cards from S's left to right in 1-5 sequence. Time after placement of last card. Allow 60 seconds). Score for order and time.

Card Order (ABCDE):
(___) (___) (___) (___) (___)

137. Order of cards scored 137. _____

138. Scoring: (Time-Seconds): ___ 138. _____

139. What's funny (foolish) about these pictures? (See scoring criteria).
A. dog _____
B. Winter _____
C. Fire _____

139. _____

Understanding of Thematic Texts:

140. Listen carefully to the story I tell you (Give S M8 to read along); when I have finished I am going to ask some questions about it. (Allow the child to keep card). "The Hen and the Golden Eggs: A man had a hen which laid golden eggs. Wishing to obtain more gold without having to wait for it, he killed the hen. But there was no gold inside the hen, for it was just as any other hen.
What did the man do? ______________________________
Did he do right? ________________________________
What is the moral of the story? ____
____

(See Appendix B for scoring) 140. _____

Concept Formation -- Definition: (141-143 score total for both subitems in item)

141. Now I will say some words which I want you to define. What does the word "   " mean?

"table": _____ Score: 0 1 2 (see manual)

(If the child defines table as a type of chart or graph, or as to put something aside for later consideration, say "What else does table mean")?

"island": _____ Score: 0 1 2 (see manual)

141. _____

Concept Formation -- Comparison and Differentiation:

142. In what way are "table" and "sofa" alike?
_______________ Score: 0 1 2 (see Appendix B)

In what way are "axe" and "saw" alike?
_______________ Score: 0 1 2 (see Appenidx B)

142. _____

143. What is the difference between:

"a fox and a dog": _____
Score: 0 1 2 (see Appenidx B)

"a stone and an egg": _____
Score: 0 1 2 (see Appendix B)

143. _____

Concept Formation -- Logical Relationships:

(144-145 score total errors).

144-YC. If a banana is a kind of fruit and a Teddy Bear is a kind of toy. Then a "rose is a kind of __________ (flower) and a "cat is a kind of __________ (animal).

Scaled score: _____

144-OC. The word "table" belongs to the group of objects called "furniture". What group does "   " belong to?

"rose": _____ (flower, plant)
"shark": _____ (fish)

Number of errors _____

145-YC. Horses and dogs belong to animals and hamburger and hot dogs belong to food. Can you tell me something that belongs to:
a) Library   b) Zoo

Number of errors _____

145-OC. If we start with the group "animals", then a "horse" will be a member of the group. Give me examples of a member of the group "   ".

"vehicles": _____ (any vehicle, e.g., car, tractor, bike)
"tool": _____ (any tool found in a tool box or workshop)

Number of errors _____

146. If we consider a table as a whole, then the legs will be part of the whole; can you tell me what are the parts of the whole "knife"?
_______________ (blade, and/or handle)

Scoring: (0) Correct (2) Incorrect   146. _____

Discursive Reasoning -- Elementary Arithmetical Problems:

147 - 149 Hand card to the child to follow along while each problem is read to the child. Begin timing after reading of the problem is completed. Allow 20" for each problem).

147.(N30) Peter had 2 apples and John had 6 apples. How many did they have together? _____(8)

Scoring: (errors): (0) Correct (2) Incorrect

147. _____

148.-YC <u>What do you need if it is</u>: 1) <u>raining outside</u>; 2) <u>snowing and cold</u>; 3) <u>hot and sunny</u>?

Number of errors _____

148-OC.(N31) <u>Jane had 7 apples and gave 3 away</u>. <u>How many did she have left</u>? _____(4)

Correct/Incorrect

148. _____

149.-YC <u>If a bird gets from one place to another by flying and a fish gets from one place to another by swimming, how does a frog get from one place to another</u>.

Correct/Incorrect

149.-OC(M32) <u>Mary had 4 apples and Betty had 2 apples more than Mary</u>. <u>How many apples did they have together</u>? _____(10)

149. _____

DATA SHEET FOR THE CHILDREN'S VERSION OF

THE MANITOBA REVISION OF THE LURIA-NEBRASKA NEUROPSYCHOLOGICAL BATTERY

A.4.1

<u>MOTOR FUNCTIONS</u>	T-Score ____________
Simple movements - hands	____________
Kinesthetic movements - hands	____________
Optic-Spatial organization - hands	____________
Dynamic organization - hands	____________
Simple movement - oral	____________
Selectivity of the motor acts	____________
Speech regulation of the motor acts	____________
<u>ACOUSTICO-MOTOR ORGANIZATION (RHYTHM)T</u>	T-Score ____________
Perception of pitch relationships	____________
Perception of pitch relations and melodies	____________
Perception and evaluation of acoustic signals	____________
Motor performance of rhythmic groups	____________
<u>HIGHER CUTANEOUS AND KINESTHETIC FUNCTIONS (TACTILE)</u>	T-Score ____________
Cutaneous sensation	____________
Stereognosis	____________
<u>VISUAL FUNCTIONS</u>	T-Score ____________
Visual perception - objects and pictures	____________
Visuo-spatial orientation	____________
<u>RECEPTIVE SPEECH FUNCTIONS</u>	T-Score ____________
Phonemic hearing - repetition and writing	____________
Phonemic hearing - pitch change	____________
Word comprehension - definitions	____________

Word comprehension - effect of repetition		________
Word comprehension - identification		________
Simple sentences - phrases		________
Simple sentences - conflicting instructions		________
Logical grammatical structures		________
Logical grammatical structures - attributive		________
Logical grammatical structures - comparative		________
Inverted grammatical constructions		________
<u>EXPRESSIVE SPEECH</u>	T-Score	________
Articulation of speech sounds		________
Reflective speech		________
Normative functions of speech - naming from description		________
Narrative speech - fluency and automatization		________
Predictive speech - reproductive forms		________
Narrative speech - predictive forms		________
<u>WRITING</u>	T-Score	________
Phonetic analysis		________
Copying and writing - simple forms		________
Copying and writing - complex forms		________
<u>READING</u>	T-Score	________
Phonetic synthesis		________
Reading - letters and words		________
Reading - syllables and words		________
Reading - phrases and texts		________

<u>ARITHMETIC</u>	T-Score	______
Number comprehension		______
Comprehension of number structure and numerical differences		______
Arithmetic computations - simple		______
Arithmetic operations - complex		______
<u>MNESTIC PROCESS (MEMORY)</u>	T-Score	______
The learning process		______
Retention and retrieval - immediate trace recall		______
Logical memorizing - recall by visual aids		______
<u>INTELLECTUAL PROCESS</u>	T-Score	______
Concept formation - comparisons and differences		______
Concept formation - definitions		______
Understanding of thematic pictures		______
Understanding of thematic texts		______
Concept formation - logical relationships		______
Discursive reasoning (arithmetical problems)		______

<u>PATHOGNOMIC SCALE</u> T-Score ______

<u>LEFT HEMISPHERE SCALE</u> T-Score ______

<u>RIGHT HEMISPHERE SCALE</u> T-Score ______

APPENDIX B

B.1.1 CONVERSION OF RAW SCORES INTO 0-1-2 SCORES-YC (5 TO 7 YEARS)

Best Performance Norms (7-year-old children)

M = mean, SD =standard deviations, Columns X=0,X=1,X=2 give Raw Scores which are equivalent to 0-1-2 Scores of 0,1,and 2 respectively

			Equivalent for 0-1-2 Scores		
Item #	M	SD.	X=0	X=1	X=2
MOTOR					
1	22.8	1.56	20 +	14-19	0-13
2	21.2	2.40	19 +	14-18	0-13
3	18.36	2.89	17 +	12-16	0-11
4	--	--	Correct	--	Incorrect
5	--	--	Correct	--	Incorrect
6	--	--	Correct	--	Incorrect
7	--	--	Correct	--	Incorrect
8	--	--	0-5	6-10	11+
9	--	--	0-5	6-10	11+
10	--	--	0-5	6-10	11+
11	--	--	Correct	--	Incorrect
12	--	--	Correct	--	Incorrect
13	--	--	Correct	--	Incorrect

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
14	--	--	Correct	--	Incorrect
15	12.3	1.69	14	8-13	0-7
16	9.97	1.36	11	7-10	0-6
17	8.7	1.53	10	7-9	0-6
18	--	--	Correct	--	Incorrect
19	--	--	Correct	--	Incorrect
20	--	--	Correct	--	Incorrect
21	--	--	0	1	2+
	See Figure: B1 for point violations				
22	6.36	2.08	0-7 sec.	8-10	11+
23	--	--	0	1	2+
	See Figure: B2 for point violations				
24	6.8	2.6	0-8 sec.	9-11	12+
25	--	--	0	1	2+
	See Figure: B3 for point violations				
26	5.8	1.12	0-7 sec.	8-10	11+
27	--	--	0	1	2+
	See Figure: B1 for point violations				
28	5.75	2.49	0-7 sec.	8-10	11+
29	--	--	0	1	2+
	See Figure: B2 for point violations				

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
30	9.37	2.44	0-11 sec.	12-14	15+
31	--	--	0	1	2+
	See Figure: B3 for point violations				
32	8.82	2.40	0-11 sec.	12-14	15+
33	--	--	0 # of errors	1	2+
34	--	--	0 # of errors	1	2+
RHYTHM					
35	--	--	0 # of errors	1	2+
36	--	--	0 # of errors	1	2+
37	--	--	Correct	--	Incorrect
38	--	--	Correct	--	Incorrect
39	--	--	0 # of errors	--	1+
40	--	--	0 # of errors	1	2+
41	--	--	0 # of errors	1	2+
42	--	--	0 # of errors	1	2+
TACTILE					
43	--	--	0 # of errors	1	2+

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
44	--	--	0 # of errors	1	2+
45	--	--	0 # of errors	1	2+
46	--	--	0 # of errors	1	2+
47	--	--	0 # of errors	1	2+
48	--	--	0 # of errors	1	2+
49	--	--	5 mm 2-prong separation	10 mm	15+ mm
50	--	--	5 mm 2-prong separation	10 mm	15+ mm
51	--	--	0 # of errors	--	1-2
52	--	--	0 # of errors	--	1-2
53	--	--	0 # of errors	1	2+
54	--	--	0 # of errors	1	2+
55	--	--	Correct	--	Incorrect
56	--	--	Correct	--	Incorrect
57	--	--	0 # of errors	1	2+
58	--	--	0 # of errors	1	2+

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
VISUAL					
59	--	--	0 # of errors	--	1+
60	--	--	0 # of errors	--	1+
61	--	--	0-2 # of errors	3	4+
62	--	--	0-2 # of errors	3	4+
63	--	--	0 # of errors	1	2+
64	--	--	0 # of errors	1	2+
65	--	--	1 # of errors	2	3+
RECEPTIVE SPEECH					
66	--	--	0 # of errors	--	1+
67	--	--	0 # of errors	--	1+
68	--	--	0 # of errors	1	2+
69	--	--	0 # of errors	1	2+
70	--	--	0 # of errors	1	2+
71	--	--	0 # of errors	1	2+
72	--	--	0 # of errors	--	1+
73	--	--	Correct	--	Incorrect

			Equivalent for 0-1-2 Scores		
Item #	M	SD.	X=0	X=1	X=2
74	--	--	0 # of errors	--	1+
75	--	--	0 # of errors	--	1+
76	--	--	0 # of errors	--	1+
77	--	--	0 # of errors	1	2+
78	--	--	0 # of errors	1	2+
79	--	--	0 # of errors	1	2+
80	--	--	0 # of errors	1	2+
81	--	--	Correct	--	Incorrect
82	--	--	0 # of errors	1	2+
83	--	--	0 # of errors	1	2+
EXPRESSIVE SPEECH					
84	--	--	0 # of errors	--	1+
85	--	--	0 # of errors	--	1+
86	--	--	0 # of errors	--	1+
87	--	--	0 # of errors	1	2-6
88	--	--	0 # of errors	1	2-5

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
89	--	--	0	1	2-5
			# of errors		
90	--	--	0	1	2-5
			# of errors		
91	--	--	0	--	1+
			# of errors		
92	--	--	0	1	2+
			# of errors		
93	--	--	0	1	2+
			# of errors		
94	--	--	0	--	1+
			# of errors		
95	--	--	Correct	--	Incorrect
96	--	--	Correct	--	Incorrect
97	--	--	Correct	--	Incorrect
98	--	--	Correct	--	Incorrect
99	3.39"	1.07"	3"	4-5	6+
			Response time/sec.		
100	12.5	3.68	10	8-9	0-7
			# of words/10"		
101	3.62	1.36	3	4	5+
			Response time/sec.		
102	19.92	2.43	17	14-16	0-13
			# of words/10"		
103	4.0	1.60	0-6	7-8	9+
			Response time/sec.		
104	17.4	4.62	13	8-12	0-7
			# of words/10"		

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
WRITING					
105	--	--	0 # of errors	1	2+
106	--	--	Correct	--	Incorrect
107	--	--	0 # of errors	1	2+
108	--	--	0 # of errors	1	2+
109	--	--	0 # of errors	1	2+
110	--	--	0 # of errors	1	2+
111	--	--	Correct	--	Incorrect
READING					
112	--	--	0 # of errors	1	2+
113	--	--	0 # of errors	1	2+
114	--	--	0 # of errors	1	2+
115	--	--	0 # of errors	--	1+
116	--	--	Correct	--	Incorrect
117	--	--	0 # of errors	1	2+
118	--	--	0 # of errors	1	2+

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
ARITHMETIC					
119	--	--	Correct	--	Incorrect
120	--	--	Correct	--	Incorrect
121	--	--	0 # of errors	1	2+
122	--	--	Correct	--	Incorrect
123	--	--	Correct	--	Incorrect
124	--	--	Correct	--	Incorrect
125	--	--	0 # of errors	1	2+
126	--	--	Correct	--	Incorrect
127	--	--	Correct	--	Incorrect
MEMORY					
128	2.39	.78	3 # of repetitions	4	5
129	--	--	0 # of errors	1	2+
130	--	--	0 # of errors	1	2+
131	--	--	0 # of errors	1	2+
132	--	--	0-1 # of errors	2	3+
133	--	--	0-2 # of errors	3-4	5+
134	--	--	7-14 # Units remembered/14	4-6	0-3

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
135	--	--	0	1	2+
			# of errors		
INTELLECTUAL PROCESSES					
136	--	--	Correct	--	Incorrect
137	--	--	Correct	--	Incorrect
138	18.2	8.86	0-26	27-36	37+
			Time/sec.		
139	--	--	0	1	2+
			# of errors		

140 WHAT DID THE MAN DO? Give points to answers.
0 points = "He killed the hen"
1 point = Any other response, including a recounting of the story that includes the right response unless it is specifically mentioned as the desired response by the child.

DID HE DO RIGHT? 0 points = NO
1 point = Any other response

WHAT IS THE MORAL OF THE STORY?
0 points = An accurate abstract generalization such as "you should not be greedy" or "be happy wit what you have".
1 point = A concrete or functional generalization such as "when something is making money for you, you shouldn't ruin it" or Don't kill the cow that gives you milk".
2 points = An erroneous generalization from the story, e.g., "don't kill the hen"
Sum the point scores of the three above 3 questions to obtain a point total. Convert the point total into 0-1-2 Scores as follows:

			0 = 0-2pts	1 = 3pt	2 = 4pts
141	--	--	0	1	2+
			# of errors		
142	--	--	0-1	2-3	4+
			# of errors		
143	--	--	0-1	2-3	4+
			# of errors		

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
144	--	--	0 # of errors	1	2+
145	--	--	0 # of errors	1	2+
146	--	--	Correct	--	Incorrect
147	--	--	Correct	--	Incorrect
148	--	--	0 # of errors	1	2+
149	--	--	Correct	--	Incorrect

END OF TABLE FOR -YC

B.2 CONVERSION OF RAW SCORES INTO 0-1-2 SCORES, -OC (8 TO 12 YEARS)

Best Performance Norms (12-year-old children)

M = mean, SD =standard deviations, Columns X=0,X=1,X=2 give Raw Scores which are equivalent to 0-1-2 Scores of 0,1,and 2 respectively

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
MOTOR					
1	25.1	2.78	22 +	16-21	0-15
2	25.1	2.04	23 +	18-22	0-17
3	21.3	2.31	19 +	13-18	0-12
4	--	--	Correct	--	Incorrect
5	--	--	Correct	--	Incorrect
6	--	--	Correct	--	Incorrect
7	--	--	Correct	--	Incorrect
8	--	--	0-5	6-10	11+
9	--	--	0-5	6-10	11+
10	--	--	0-5	6-10	11+
11	--	--	Correct	--	Incorrect
12	--	--	Correct	--	Incorrect
13	--	--	Correct	--	Incorrect
14	--	--	Correct	--	Incorrect

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
15	12.3	1.69	14	8-13	0-7
16	9.97	1.36	11	7-10	0-6
17	8.7	1.53	10	7-9	0-6
18	--	--	Correct	--	Incorrect
19	--	--	Correct	--	Incorrect
20	--	--	Correct	--	Incorrect
21	--	--	0	1	2+
	See Figure: B1 for point violations				
22	6.36	2.08	0-7 sec.	8-10	11+
23	--	--	0	1	2+
	See Figure: B2 for point violations				
24	6.8	2.6	0-8 sec.	9-11	12+
25	--	--	0	1	2+
	See Figure: B3 for point violations				
26	5.8	1.12	0-7 sec.	8-10	11+
27	--	--	0	1	2+
	See Figure: B1 for point violations				
28	5.75	2.49	0-7 sec.	8-10	11+
29	--	--	0	1	2+
	See Figure: B2 for point violations				
30	9.37	2.44	0-11 sec.	12-14	15+

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
31	--	--	0	1	2+
	See Figure: B3 for point violations				
32	8.82	2.40	0-11 sec.	12-14	15+
33	--	--	0 # of errors	1	2+
34	--	--	0 # of errors	1	2+
RHYTHM					
35	--	--	0 # of errors	1	2+
36	--	--	0 # of errors	1	2+
37	--	--	Correct	--	Incorrect
38	--	--	Correct	--	Incorrect
39	--	--	0 # of errors	--	1+
40	--	--	0 # of errors	1	2+
41	--	--	0 # of errors	1	2+
42	--	--	0 # of errors	1	2+
TACTILE					
43	--	--	0 # of errors	1	2+
44	--	--	0 # of errors	1	2+

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
45	--	--	0	1	2+
			# of errors		
46	--	--	0	1	2+
			# of errors		
47	--	--	0	1	2+
			# of errors		
48	--	--	0	1	2+
			# of errors		
49	--	--	5 mm	10 mm	15+ mm
			2-prong separation		
50	--	--	5 mm	10 mm	15+ mm
			2-prong separation		
51	--	--	0	--	1-2
			# of errors		
52	--	--	0	--	1-2
			# of errors		
53	--	--	0	1	2+
			# of errors		
54	--	--	0	1	2+
			# of errors		
55	--	--	Correct	--	Incorrect
56	--	--	Correct	--	Incorrect
57	--	--	0	1	2+
			# of errors		
58	--	--	0	1	2+
			# of errors		
VISUAL					
59	--	--	0	--	1+
			# of errors		

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
60	--	--	0 # of errors	--	1+
61	--	--	0-2 # of errors	3	4+
62	--	--	0-2 # of errors	3	4+
63	--	--	0 # of errors	1	2+
64	--	--	0 # of errors	1	2+
65	--	--	1 # of errors	2	3+
RECEPTIVE SPEECH					
66	--	--	0 # of errors	--	1+
67	--	--	0 # of errors	--	1+
68	--	--	0 # of errors	1	2+
69	--	--	0 # of errors	1	2+
70	--	--	0 # of errors	1	2+
71	--	--	0 # of errors	1	2+
72	--	--	0 # of errors	--	1+
73	--	--	Correct	--	Incorrect
74	--	--	0 # of errors	--	1+

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
75	--	--	0 # of errors	--	1+
76	--	--	0 # of errors	--	1+
77	--	--	0 # of errors	1	2+
78	--	--	0 # of errors	1	2+
79	--	--	0 # of errors	1	2+
80	--	--	0 # of errors	1	2+
81	--	--	Correct	--	Incorrect
82	--	--	0 # of errors	1	2+
83	--	--	0 # of errors	1	2+
EXPRESSIVE SPEECH					
84	--	--	0 # of errors	--	1+
85	--	--	0 # of errors	--	1+
86	--	--	0 # of errors	--	1+
87	--	--	0 # of errors	1	2-6
88	--	--	0 # of errors	1	2-5
89	--	--	0 # of errors	1	2-5

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
90	--	--	0	1	2-5
			# of errors		
91	--	--	0	--	1+
			# of errors		
92	--	--	0	1	2+
			# of errors		
93	--	--	0	1	2+
			# of errors		
94	--	--	0	--	1+
			# of errors		
95	--	--	Correct	--	Incorrect
96	--	--	Correct	--	Incorrect
97	--	--	Correct	--	Incorrect
98	--	--	Correct	--	Incorrect
99	3.39″	1.07″	3″	4-5	6+
			Response time/sec.		
100	12.5	3.68	10	8-9	0-7
			# of words/10″		
101	3.62	1.36	3	4	5+
			Response time/sec.		
102	19.92	2.43	17	14-16	0-13
			# of words/10″		
103	4.0	1.60	0-6	7-8	9+
			Response time/sec.		
104	17.4	4.62	13	8-12	0-7
			# of words/10″		

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
WRITING					
105	--	--	0 # of errors	1	2+
106	--	--	Correct	--	Incorrect
107	--	--	0 # of errors	1	2+
108	--	--	0 # of errors	1	2+
109	--	--	0 # of errors	1	2+
110	--	--	0 # of errors	1	2+
111	--	--	Correct	--	Incorrect
READING					
112	--	--	0 # of errors	1	2+
113	--	--	0 # of errors	1	2+
114	--	--	0 # of errors	1	2+
115	--	--	0 # of errors	--	1+
116	--	--	Correct	--	Incorrect
117	--	--	0 # of errors	1	2+
118	--	--	0 # of errors	1	2+

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
ARITHMETIC					
119	--	--	Correct	--	Incorrect
120	--	--	Correct	--	Incorrect
121	--	--	0 # of errors	1	2+
122	--	--	Correct	--	Incorrect
123	--	--	Correct	--	Incorrect
124	--	--	Correct	--	Incorrect
125	--	--	0 # of errors	1	2+
126	--	--	Correct	--	Incorrect
127	--	--	Correct	--	Incorrect
MEMORY					
128	2.39	.78	3 # of repetitions	4	5
129	--	--	0 # of errors	1	2+
130	--	--	0 # of errors	1	2+
131	--	--	0 # of errors	1	2+
132	--	--	0-1 # of errors	2	3+
133	--	--	0-2 # of errors	3-4	5+

Item #	M	SD.	Equivalent for 0-1-2 Scores X=0	X=1	X=2
134	--	--	7-14	4-6	0-3
			# Units remembered/14		
135	--	--	0	1	2+
			# of errors		
INTELLECTUAL PROCESSES					
136	--	--	Correct	--	Incorrect
137	--	--	Correct	--	Incorrect
138	18.2	8.86	0-26	27-36	37+
			Time/sec.		
139	--	--	0	1	2+
			# of errors		

140 WHAT DID THE MAN DO? Give points to answers.
0 points = "He killed the hen"
1 point = Any other response, including a recounting of the story that includes the right response unless it is specifically mentioned as the desired response by the child.

DID HE DO RIGHT? 0 points = NO
1 point = Any other response

WHAT IS THE MORAL OF THE STORY?
0 points = An accurate abstract generalization such as "you should not be greedy" or "be happy wit what you have".
1 point = A concrete or functional generalization such as "when something is making money for you, you shouldn't ruin it" or Don't kill the cow that gives you milk".
2 points = An erroneous generalization from the story, e.g., "don't kill the hen"
Sum the point scores of the three above 3 questions to obtain a point total. Convert the point total into 0-1-2 Scores as follows:

			0 = 0-2pts	1 = 3pt	2 = 4pts
141	--	--	0	1	2+
			# of errors		
142	--	--	0-1	2-3	4+
			# of errors		

143	--	--	0-1 # of errors	2-3	4+
144	--	--	0 # of errors	1	2+
145	--	--	0 # of errors	1	2+
146	--	--	Correct	--	Incorrect
147	--	--	Correct	--	Incorrect
148	--	--	0 # of errors	1	2+
149	--	--	Correct	--	Incorrect

*Best performance Norms

END OF OC TABLE

Scoring Criteria: Items 21 and 27 (circles) (squares) (triangles)

The abilities to produce free-hand drawings and copying simple geometric figures, such as a circle, a square, or a triangle has been well studied and documented by Terman (1937), Gesell's Stanford-Binet norms (1940) and Beery's Developmental Test of Visual-Motor Integration (1967) and many others. The current scoring system is based on the presence of 1 or 2-point violations. These violations are identified by letters (see figure 1).

A score of zero (0) is indicated when the responses do not violate lettered criteria.

A one-point score (1) is given whenever one or two of the following violations occur:

a) lack of closure in the figure by 2 to 6 millimeters (mm)

b) tracing overlaps from 2 to 6 mm.

c) evidence of hand tremor in at least half of the figure without distortion of the overall gestalt

d) the length of one dimension is 1 1/2 to 2 times greater than that of the other dimension

e) one or more of the corners are rounded (no clear angle evident)

f) any angle (computed by drawing lines through figure corners) that is greater than or equal to 70^{o} but less than 80^{o}; or greater than 100^{o} but less than or equal to 110^{o} (two angles within this range count as one violation; three angles within this range count as two violations.

g) angle within normal range (between 80^{o} and 100^{o}) but contains a "dog ear".

A two point score is if any of the following occur:

h) three or more 1-point violations (each violation of a single criterion is counted separately)

i) lack of closure is greater than 6mm.

j) tracing overlap is greater than 6mm.

k) overall gestalt of the figure is obviously distorted by gross tremor or extraneous figures (ie., a "hump")

l) the figure takes longer than 15 seconds to complete

m) subject fails to keep pencil from lifting during the second attempt

n) the length of one dimension is greater than two times that of the other dimension

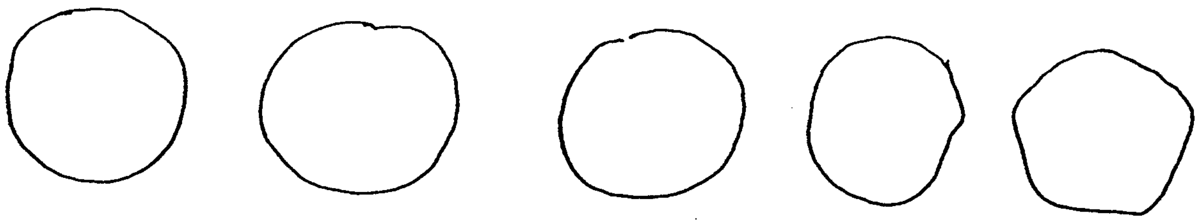
o) four angles greater than or equal to 70^{o} but less than 80^{o}; or greater than 100^{o} but less than 110^{o}

p) one or more angles greater than 110^{o} or less than 70^{o}

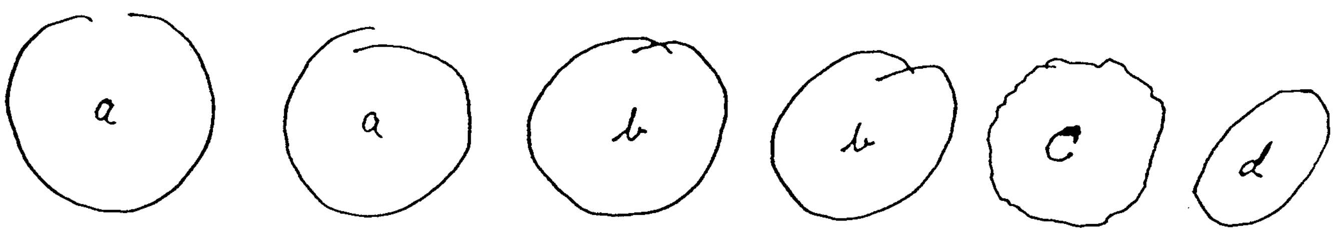
q) for the triangle, the longest side is 1 1/2 to 2 times greater than the shortest side.

ITEMS 21 AND 27 (CIRCLE)

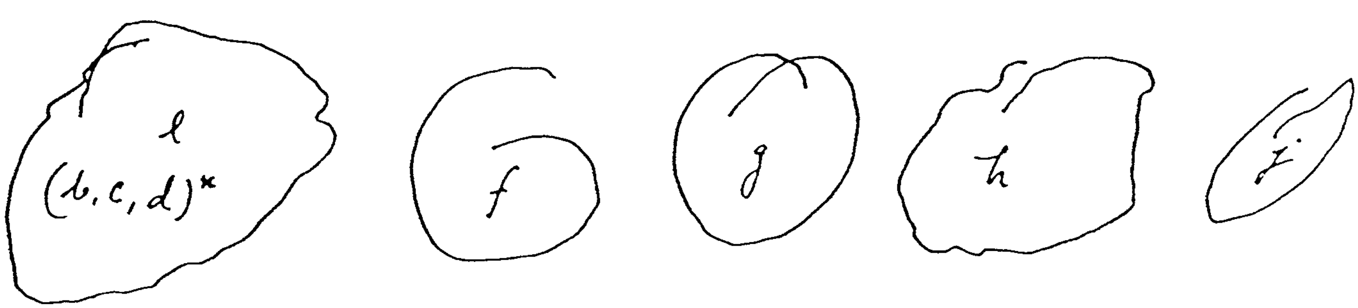
score = 0



score = I

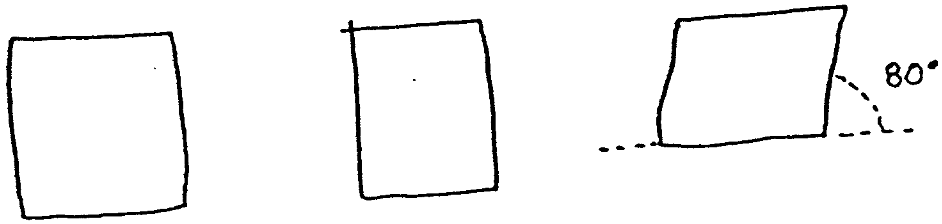


score = 2

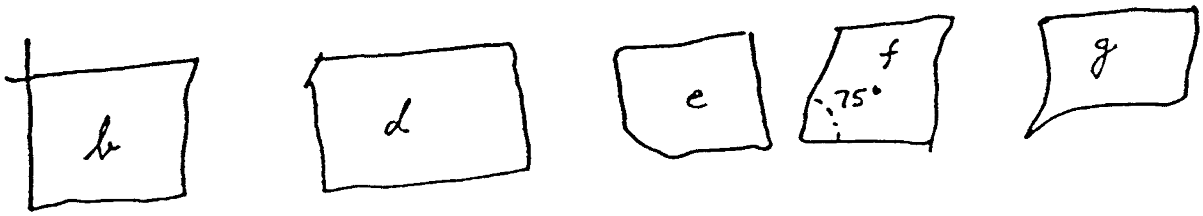


* Letters in parenthesis refer to I point violations.

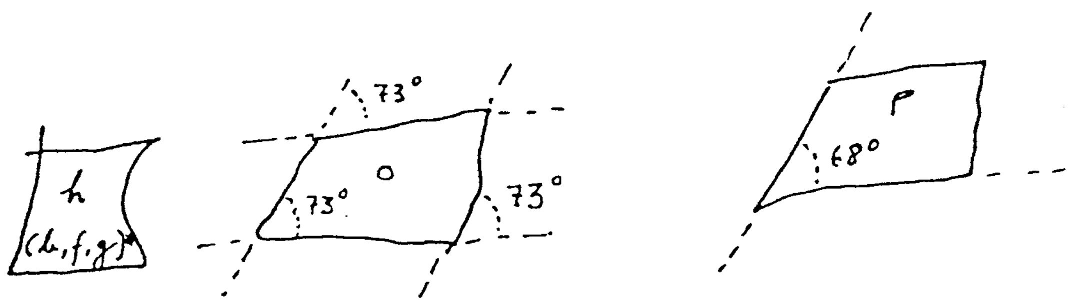
score = 0



score = I



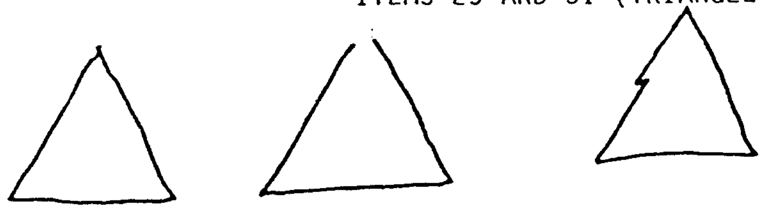
score = 2



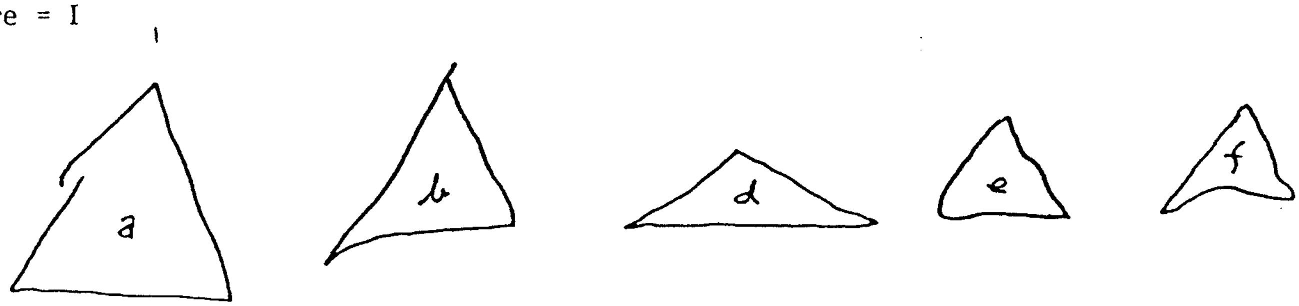
* Letters in parenthesis refer to I point violations.

ITEMS 25 AND 3I (TRIANGLE)

score = 0



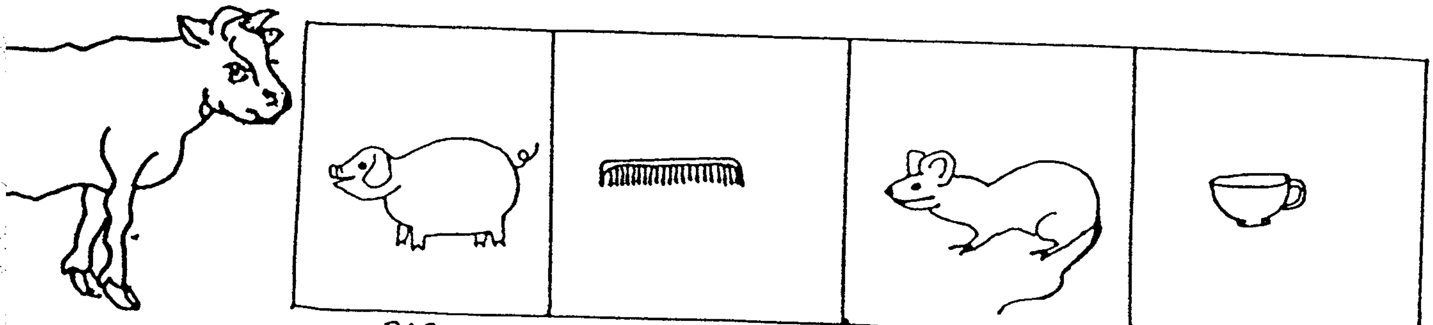
score = I



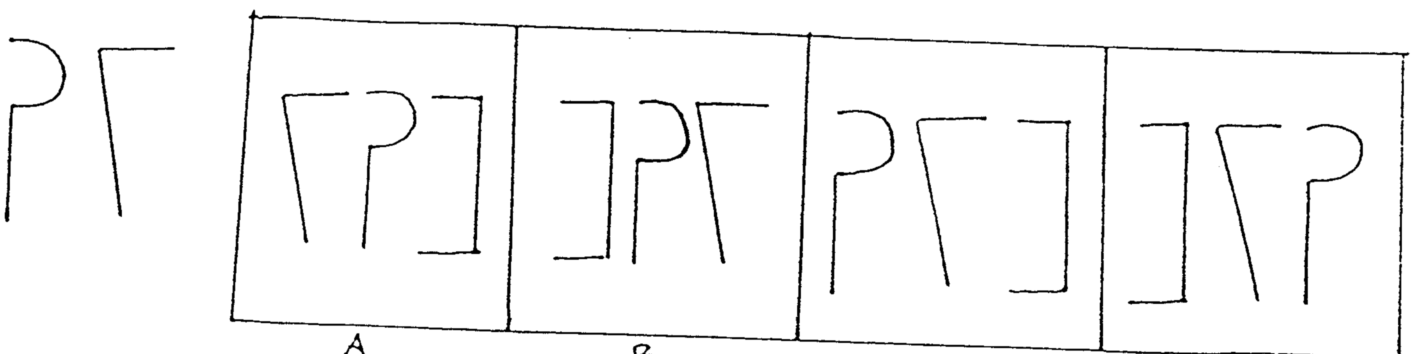
score = 2

* Letters in parenthesis refer to I point violations.

WRITING READINESS WORKSHEET A.



PIG COMB MOUSE CUP



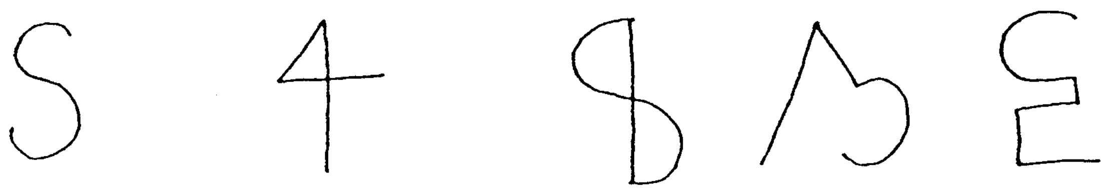
A B C D

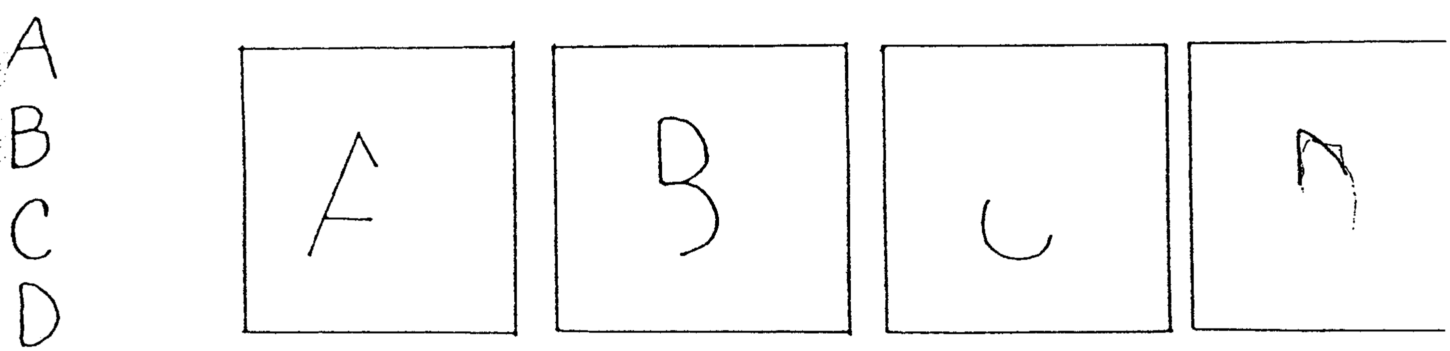
T

BAT	TRAP	HORSE	HAT
A	B	C	D

WRITING READINESS WORKSHEET B.

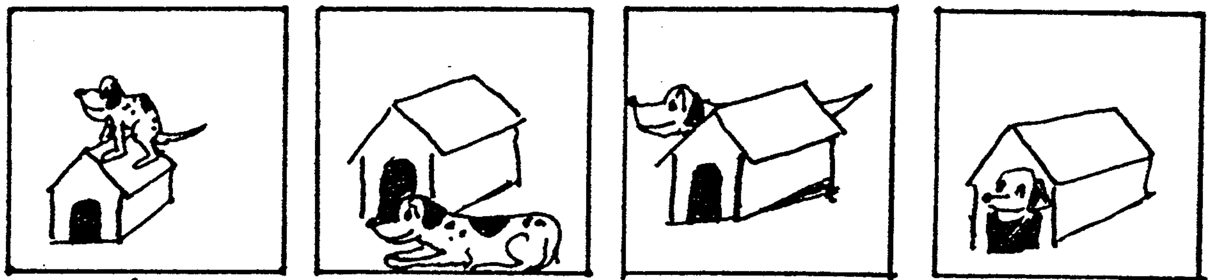
A B C D





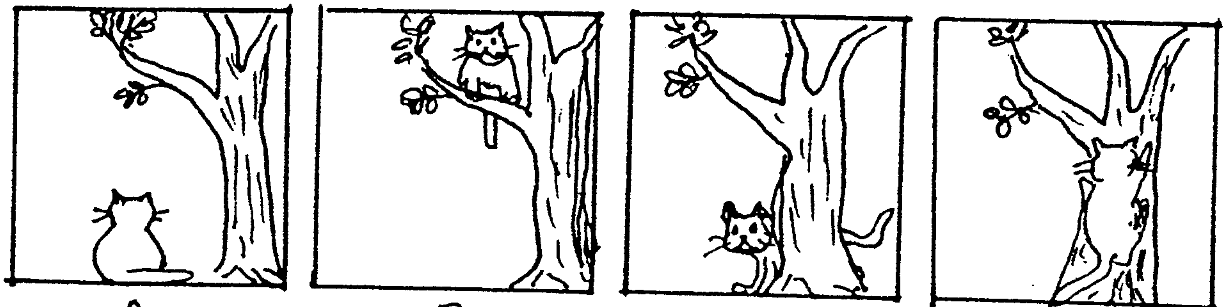
READING READINESS WORKSHEET A.

12 a



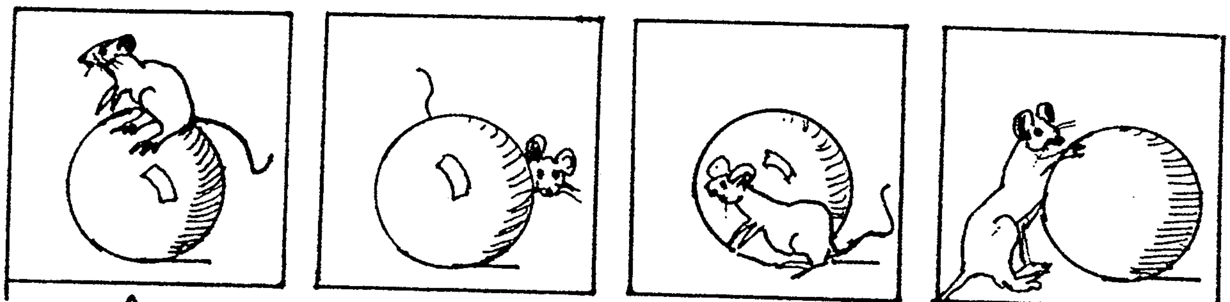
A B C D

12 b



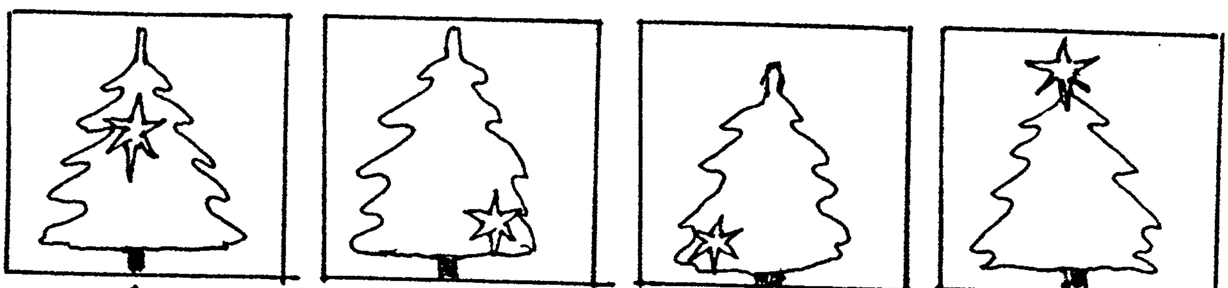
A B C D

12 c



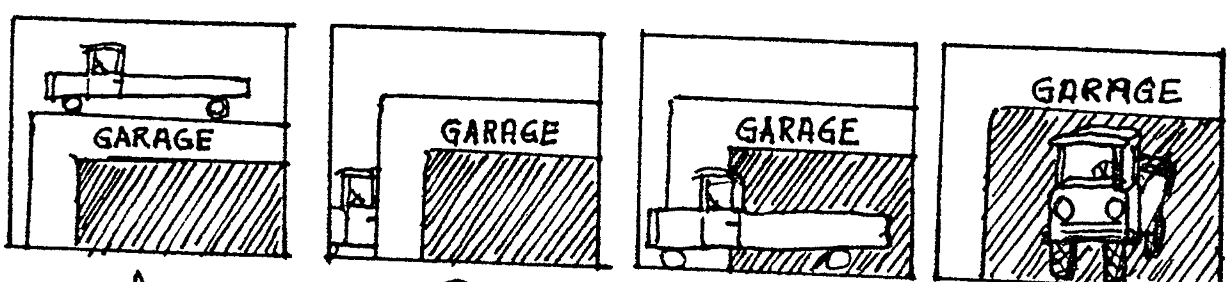
A B C D

112 d



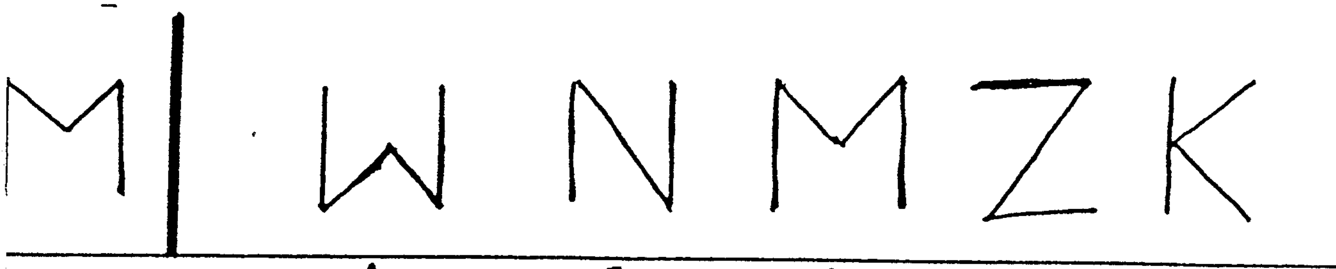
A B C D

12 e

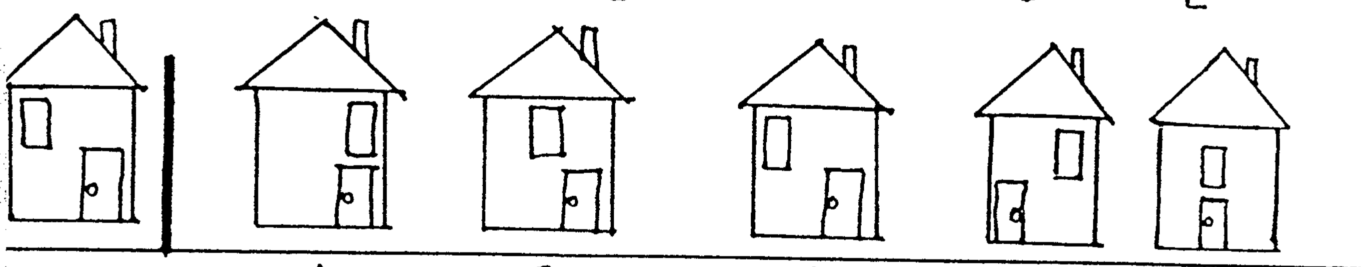


A B C D

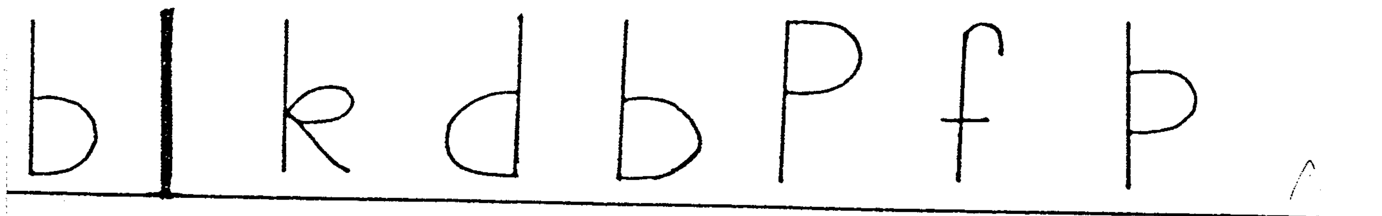
READING WORKSHEET B.



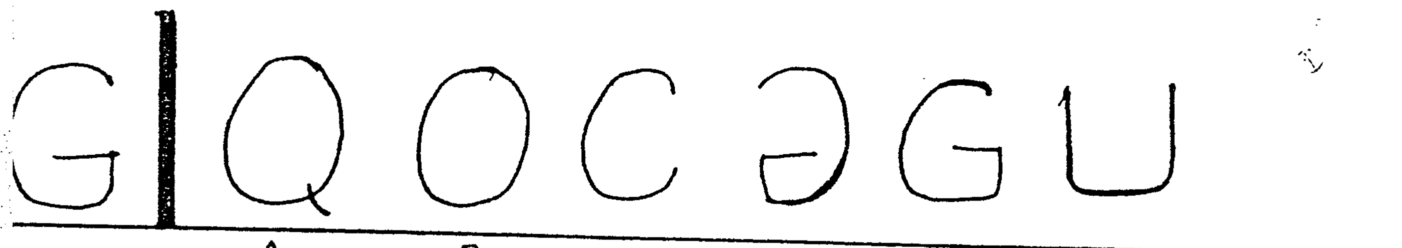
A B C D E



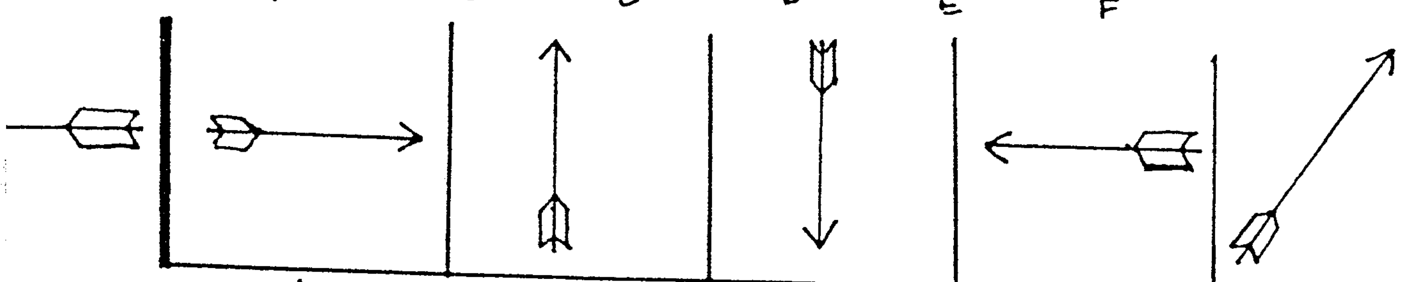
A B C D



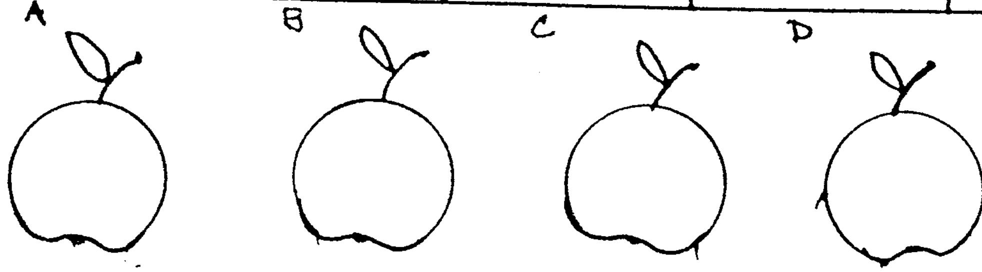
A B C D E F



A B C D E F



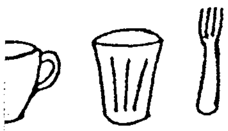
A B C D E

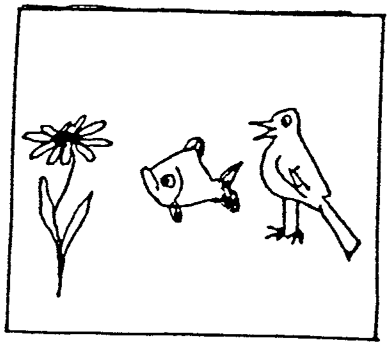


A B C D

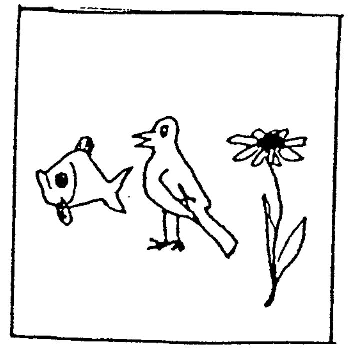
READING READINESS WORKSHEET C.

>

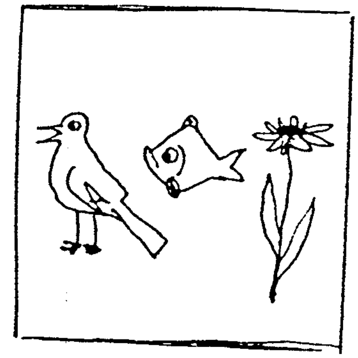




A



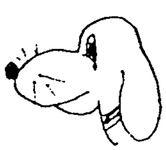
B



C

A.

CAT



DOG

MOUSE

HORSE

SHOE

B.

SOCKS
HAT
COAT
PANTS
FISH

C.

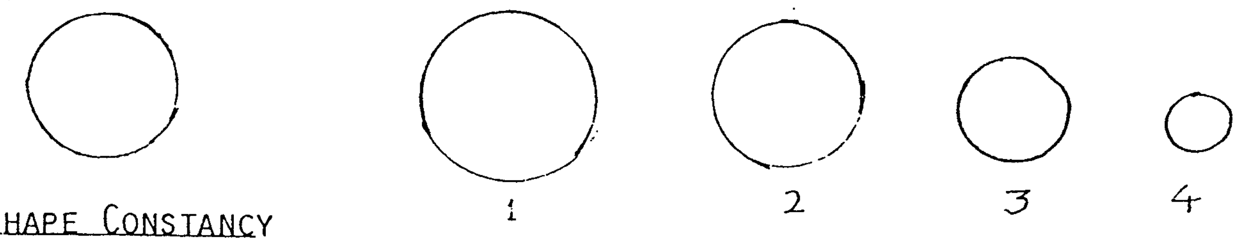
CAR
AIRPLANE
BUS
FLOWER
BICYCLE

D.

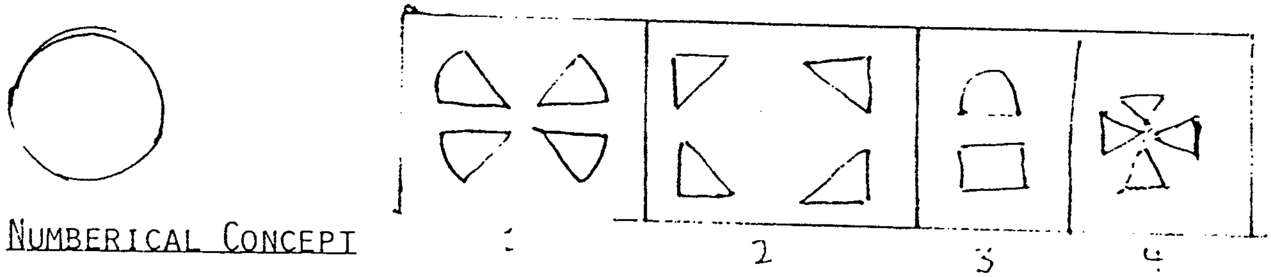
APPLE
BANANA
PEAR
BUBBLEGUM
ORANGE

ARITHMETIC WORKSHEET A.

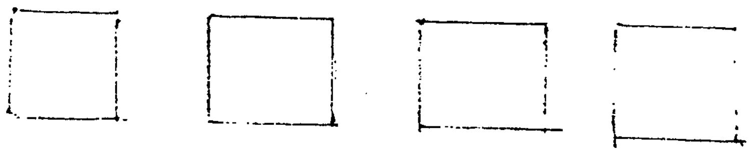
. SIZE CONSTANCY



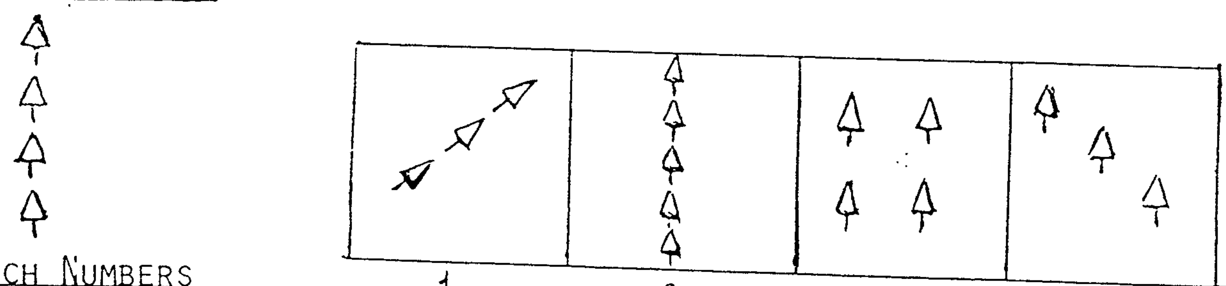
. SHAPE CONSTANCY



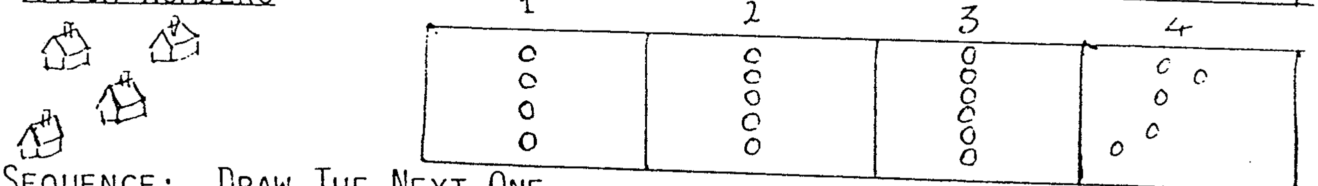
A. NUMBERICAL CONCEPT



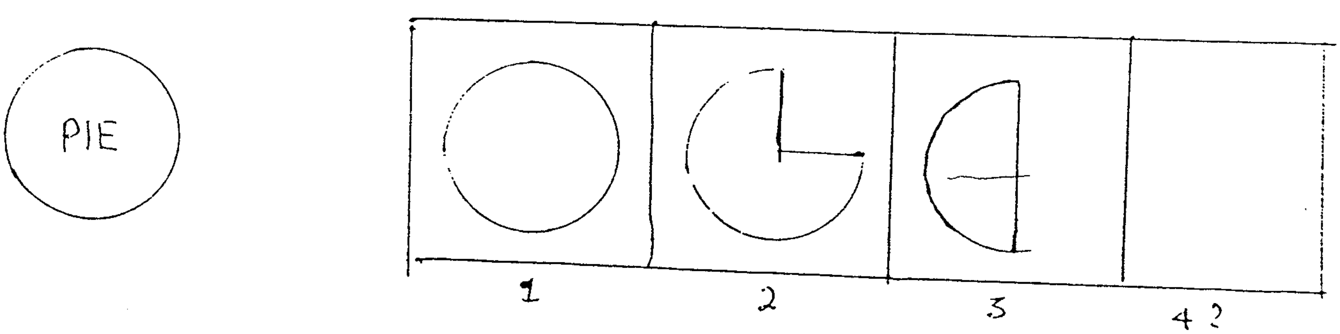
B. MATCH NUMBERS



C. MATCH NUMBERS

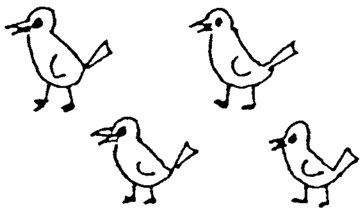


SEQUENCE: DRAW THE NEXT ONE



ARITHMETIC WORKSHEET " B "

3 Number Recognitions



5	3	4	6
1	2	3	4

Find Missing Number

-2-3-4 __ 6-7.

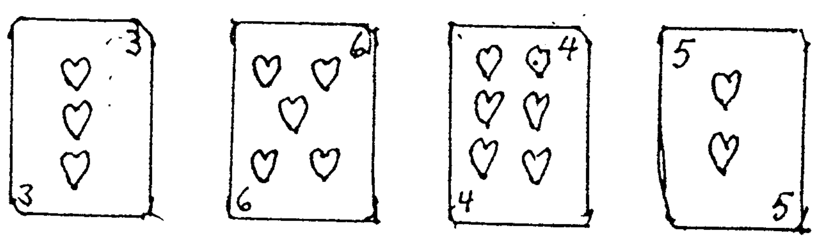
8	9	5	3
1	2	3	4

Complete Sequence

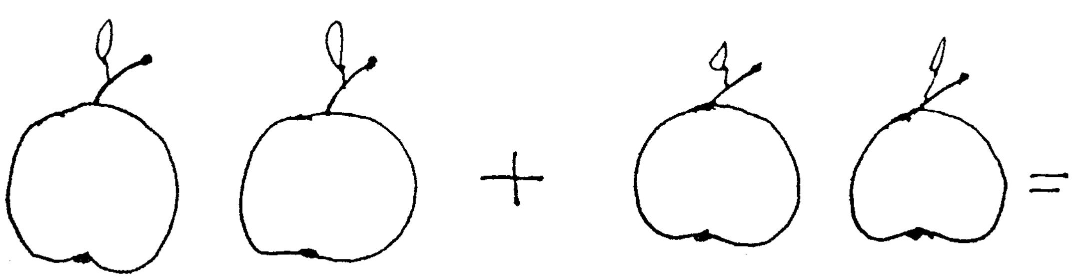
1, 3, 5, ____, ?

2, 4, 6, ____, ?

Numerical Matching



Addition



APPENDIX C

CALCULATION OF T-SCORES FROM 0-1-2 SCORES

C.1 PART ONE: OBTAINING AVERAGED SCALE SCORES

The 0-1-2 Item Scores of the items of a given scale are added up to form the Scale Total. This Scale Total is then divided by the number of items in the scale to form the (average) Scale Score. The tables in Part One were developed to read off the average Scale Score from the Scale Total. Use this average Scale Score to read off the corresponding *T*-Score from the age-appropriate table in Part Two.

Motor Scale (-YC,-OC)

Total	Scale Score	Total	Scale Score
1	0.029	35	1.029
2	0.059	36	1.058
3	0.088	37	1.088
4	0.117	38	1.117
5	0.147	39	1.147
6	0.176	40	1.176
7	0.206	41	1.205
8	0.235	42	1.235
9	0.265	43	1.264
10	0.294	44	1.294
11	0.323	45	1.323
12	0.353	46	1.353
13	0.382	47	1.382
14	0.412	48	1.411
15	0.441	49	1.441
16	0.470	50	1.470
17	0.500	51	1.500
18	0.529	52	1.529
19	0.558	53	1.558
20	0.588	54	1.588
21	0.617	55	1.617
22	0.647	56	1.647
23	0.676	57	1.676
24	0.705	58	1.706
25	0.735	59	1.735
26	0.765	60	1.765
27	0.794	61	1.794
28	0.823	62	1.823
29	0.853	63	1.853
30	0.882	64	1.882
31	0.912	65	1.912
32	0.941	66	1.741
33	0.970	67	1.970
34	1.000	68	2.000

Rhythm Scale

Total	Scale Score
1	0.125
2	0.250
3	0.375
4	0.500
5	0.625
6	0.750
7	0.875
8	1.000
9	1.125
10	1.250
11	1.375
12	1.500
13	1.625
14	1.750
15	1.875
16	2.000

Visual Scale

Total	Scale Score
1	0.143
2	0.285
3	0.428
4	0.571
5	0.714
6	0.857
7	1.000
8	1.143
9	1.285
10	1.428
11	1.571
12	1.714
13	1.857
14	2.000

Tactile Score

Total	Scale Score	Total	Scale Score
1	0.062	17	1.062
2	0.125	18	1.125
3	0.187	19	1.187
4	0.250	20	1.250
5	0.312	21	1.312
6	0.375	22	1.375
7	0.437	23	1.437
8	0.500	24	1.500
9	0.562	25	1.562
10	0.625	26	1.625
11	0.687	27	1.687
12	0.750	28	1.750
13	0.812	29	1.812
14	0.875	30	1.875
15	0.937	31	1.937
16	1.000	32	2.000

Receptive Speech Scale

Total	Scale Score	Total	Scale Score
1	0.055	19	1.055
2	0.111	20	1.111
3	0.166	21	1.166
4	0.222	22	1.222
5	0.277	23	1.277
6	0.333	24	1.333
7	0.388	25	1.388
8	0.444	26	1.444
9	0.500	27	1.500
10	0.555	28	1.555
11	0.611	29	1.611
12	0.666	30	1.666
13	0.722	31	1.722
14	0.777	32	1.777
15	0.833	33	1.833
16	0.888	34	1.888
17	0.944	35	1.944
18	1.000	36	2.000

Expressive Speech Scale

Total	Scale Score	Total	Scale Score
1	0.047	22	1.047
2	0.095	23	1.095
3	0.143	24	1.143
4	0.190	25	1.190
5	0.238	26	1.238
6	0.285	27	1.285
7	0.333	28	1.333
8	0.381	29	1.380
9	0.428	30	1.428
10	0.476	31	1.476
11	0.524	32	1.524
12	0.571	33	1.571
13	0.619	34	1.619
14	0.666	35	1.666
15	0.714	36	1.714
16	0.761	37	1.762
17	0.809	38	1.809
18	0.857	39	1.857
19	0.904	40	1.905
20	0.952	41	1.952
21	1.000	42	2.000

Writing Scale

Total	Scale Score
1	0.143
2	0.285
3	0.428
4	0.571
5	0.714
6	0.857
7	1.000
8	1.143
9	1.285
10	1.428
11	1.571
12	1.714
13	1.857
14	2.000

Reading Scale

Total	Scale Score
1	0.143
2	0.285
3	0.428
4	0.571
5	0.714
6	0.857
7	1.000
8	1.143
9	1.285
10	1.428
11	1.571
12	1.714
13	1.857
14	2.000

Arithmetical Scale

Total	Scale Score
1	0.111
2	0.222
3	0.333
4	0.444
5	0.555
6	0.666
7	0.777
8	0.888
9	1.000
10	1.111
11	1.222
12	1.333
13	1.444
14	1.555
15	1.666
16	1.777
17	1.888
18	2.000

Memory Scale

Total	Scale Score
1	0.125
2	0.250
3	0.375
4	0.500
5	0.625
6	0.750
7	0.875
8	1.000
9	1.125
10	1.250
11	1.375
12	1.500
13	1.625
14	1.750
15	1.875
16	2.000

Intellectual Process Scale

Total	Scale Score	Total	Scale Score
1	0.071	15	1.071
2	0.142	16	1.142
3	0.214	17	1.214
4	0.285	18	1.285
5	0.357	19	1.357
6	0.428	20	1.428
7	0.500	21	1.500
8	0.571	22	1.571
9	0.642	23	1.642
10	0.714	24	1.714
11	0.785	25	1.785
12	0.857	26	1.857
13	0.928	27	1.928
14	1.000	28	2.000

C.2 PART TWO: OBTAINING AGE-CORRECTED T-SCORES FROM SCALE SCORES

How to use the tables

Having obtained a Scale Score (see C.1) for each of the Major Scales in the battery for a particular child, these tables are used to read off the corresponding *T*-Score.

T-SCORE TABLE FOR 5-YEAR-OLD BOYS

TSCORE	MOTOR	RHYTHM	TACTILE	VISUAL	RECEP SPEECH	EXPR SPEECH	WRITING	READING	ARITH-METIC	MEMORY	INTEL-LECTUAL	LEFT	RIGHT	PATHOG-NOMIC	TSCORE
100	0.87	1.97	1.21	1.14	0.73	0.99	0.35	1.68	.	1.85	1.73	1.08	1.34	0.85	100
95	0.81	1.82	1.12	1.05	0.68	0.91	0.31	1.52	.	1.71	1.60	1.01	1.25	0.79	95
90	0.75	1.67	1.03	0.96	0.62	0.83	0.28	1.36	1.99	1.57	1.46	0.94	1.15	0.74	90
85	0.69	1.52	0.93	0.87	0.57	0.75	0.25	1.21	1.80	1.43	1.33	0.86	1.06	0.68	85
80	0.63	1.37	0.84	0.78	0.52	0.67	0.22	1.05	1.61	1.29	1.19	0.79	0.97	0.63	80
75	0.57	1.22	0.75	0.69	0.46	0.59	0.19	0.89	1.42	1.15	1.06	0.72	0.87	0.57	75
70	0.51	1.07	0.65	0.61	0.41	0.51	0.16	0.73	1.23	1.00	0.93	0.64	0.78	0.51	70
65	0.45	0.93	0.56	0.52	0.35	0.43	0.13	0.57	1.04	0.86	0.79	0.57	0.69	0.46	65
60	0.39	0.78	0.47	0.43	0.30	0.35	0.10	0.42	0.85	0.72	0.66	0.50	0.59	0.40	60
55	0.33	0.63	0.37	0.34	0.25	0.27	0.06	0.26	0.66	0.58	0.53	0.42	0.50	0.34	55
50	0.27	0.48	0.28	0.25	0.19	0.19	0.03	0.10	0.47	0.44	0.39	0.35	0.40	0.29	50
45	0.21	0.33	0.19	0.16	0.14	0.11	0.00	.	0.28	0.30	0.26	0.28	0.31	0.23	45
40	0.15	0.18	0.09	0.08	0.08	0.03	.	.	0.09	0.15	0.13	0.20	0.22	0.17	40
35	0.09	0.04	.	.	0.03	.	.	.	.	0.01	.	0.13	0.12	0.12	35
30	0.03	.	.	.	.	.	.	.	.	.	.	0.06	0.03	0.06	30
25	.	.	.	.	.	.	.	.	.	.	.	.	.	0.01	25
20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20
15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0

T-SCORE TABLE FOR 5-YEAR-OLD GIRLS

TSCORE	MOTOR	RHYTHM	TACTILE	VISUAL	RECEP SPEECH	EXPR SPEECH	WRITING	READING	ARITH-METIC	MEMORY	INTEL-LECTUAL	LEFT	RIGHT	PATHOG-NOMIC	TSCORE
100	0.38	0.69	0.41	0.79	0.42	0.87	1.28	1.84	.	1.50	0.71	1.15	0.85	0.62	100
95	0.36	0.66	0.39	0.75	0.40	0.81	1.17	1.68	.	1.38	0.66	1.06	0.80	0.58	95
90	0.34	0.62	0.37	0.71	0.39	0.74	1.06	1.51	1.97	1.25	0.60	0.97	0.75	0.54	90
85	0.31	0.59	0.36	0.67	0.37	0.68	0.95	1.35	1.83	1.13	0.55	0.88	0.70	0.50	85
80	0.29	0.55	0.34	0.63	0.36	0.62	0.85	1.18	1.69	1.00	0.49	0.79	0.65	0.46	80
75	0.27	0.51	0.32	0.59	0.34	0.55	0.74	1.02	1.55	0.88	0.44	0.70	0.59	0.42	75
70	0.25	0.48	0.30	0.55	0.32	0.49	0.63	0.85	1.41	0.75	0.38	0.61	0.54	0.39	70
65	0.22	0.44	0.28	0.50	0.31	0.43	0.52	0.69	1.27	0.63	0.33	0.52	0.49	0.35	65
60	0.20	0.41	0.27	0.46	0.29	0.36	0.41	0.52	1.13	0.50	0.28	0.43	0.44	0.31	60
55	0.18	0.37	0.25	0.42	0.28	0.30	0.30	0.36	0.99	0.38	0.22	0.34	0.39	0.27	55
50	0.16	0.33	0.23	0.38	0.26	0.24	0.19	0.19	0.85	0.25	0.17	0.25	0.33	0.23	50
45	0.13	0.30	0.21	0.34	0.24	0.18	0.08	0.03	0.71	0.13	0.11	0.16	0.28	0.20	45
40	0.11	0.26	0.19	0.30	0.23	0.11	.	.	0.57	0.00	0.06	0.07	0.23	0.16	40
35	0.09	0.23	0.18	0.26	0.21	0.05	.	.	0.43	.	0.00	.	0.18	0.12	35
30	0.07	0.19	0.16	0.22	0.20	.	.	.	0.29	.	.	.	0.13	0.08	30
25	0.04	0.15	0.14	0.17	0.18	.	.	.	0.15	.	.	.	0.07	0.04	25
20	0.02	0.12	0.12	0.13	0.16	.	.	.	0.01	.	.	.	0.02	0.00	20
15	.	0.08	0.10	0.09	0.15	.	.	.	.	.	.	.	.	.	15
10	.	0.04	0.08	0.05	0.13	.	.	.	.	.	.	.	.	.	10
5	.	0.01	0.07	0.01	0.11	.	.	.	.	.	.	.	.	.	5
0	.	.	0.05	.	0.10	.	.	.	.	.	.	.	.	.	0

<u>T</u>-SCORE TABLE FOR 6-YEAR-OLD BOYS

TSCORE	MOTOR	RHYTHM	TACTILE	VISUAL	RECEP SPEECH	EXPR SPEECH	WRITING	READING	ARITH-METIC	MEMORY	INTEL-LECTUAL	LEFT	RIGHT	PATHOG-NOMIC	TSCORE
100	0.74	1.40	0.79	1.12	1.02	0.83	1.01	1.17	1.40	1.80	1.52	1.03	1.00	0.69	100
95	0.69	1.31	0.75	1.04	0.96	0.78	0.93	1.07	1.28	1.66	1.40	0.96	0.94	0.64	95
90	0.64	1.21	0.70	0.97	0.89	0.73	0.84	0.97	1.16	1.52	1.28	0.89	0.88	0.58	90
85	0.59	1.12	0.65	0.89	0.82	0.68	0.76	0.87	1.04	1.39	1.16	0.82	0.83	0.53	85
80	0.54	1.03	0.61	0.82	0.75	0.63	0.68	0.77	0.92	1.25	1.04	0.75	0.77	0.47	80
75	0.49	0.93	0.56	0.74	0.69	0.58	0.59	0.67	0.80	1.12	0.92	0.68	0.71	0.42	75
70	0.44	0.84	0.51	0.66	0.62	0.53	0.51	0.58	0.68	0.98	0.80	0.60	0.66	0.37	70
65	0.39	0.75	0.47	0.59	0.55	0.48	0.43	0.48	0.56	0.84	0.68	0.53	0.60	0.31	65
60	0.34	0.65	0.42	0.51	0.48	0.43	0.34	0.38	0.44	0.71	0.56	0.46	0.54	0.26	60
55	0.29	0.56	0.37	0.43	0.41	0.38	0.26	0.28	0.32	0.57	0.44	0.39	0.49	0.20	55
50	0.24	0.47	0.33	0.36	0.35	0.33	0.18	0.18	0.20	0.43	0.32	0.32	0.43	0.15	50
45	0.19	0.38	0.28	0.28	0.28	0.28	0.10	0.08	0.08	0.30	0.20	0.25	0.37	0.10	45
40	0.14	0.28	0.24	0.20	0.21	0.23	0.01	.	.	0.16	0.08	0.18	0.32	0.04	40
35	0.09	0.19	0.19	0.13	0.14	0.18	.	.	.	0.02	.	0.11	0.26	.	35
30	0.04	0.10	0.14	0.05	0.08	0.13	.	.	.	.	.	0.04	0.20	.	30
25	.	0.00	0.10	.	0.01	0.08	.	.	.	.	.	.	0.15	.	25
20	.	.	0.05	.	.	0.03	.	.	.	.	.	.	0.09	.	20
15	.	.	0.00	.	.	.	.	.	.	.	.	.	0.04	.	15
10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0

T -SCORE TABLE FOR 6-YEAR-OLD GIRLS

TSCORE	MOTOR	RHYTHM	TACTILE	VISUAL	RECEP SPEECH	EXPR SPEECH	WRITING	READING	ARITH-METIC	MEMORY	INTEL-LECTUAL	LEFT	RIGHT	PATHOG-NOMIC	TSCORE
100	0.65	1.62	0.82	0.87	0.65	0.70	1.16	0.83	1.32	1.49	1.17	0.92	1.03	0.59	100
95	0.60	1.48	0.75	0.79	0.59	0.64	1.06	0.75	1.20	1.37	1.08	0.85	0.95	0.54	95
90	0.54	1.35	0.69	0.72	0.54	0.58	0.96	0.67	1.08	1.25	0.98	0.78	0.86	0.49	90
85	0.49	1.22	0.62	0.65	0.48	0.52	0.86	0.59	0.97	1.14	0.88	0.71	0.78	0.44	85
80	0.43	1.09	0.55	0.58	0.43	0.45	0.76	0.52	0.85	1.02	0.79	0.64	0.70	0.39	80
75	0.38	0.95	0.49	0.51	0.37	0.39	0.66	0.44	0.73	0.90	0.69	0.57	0.62	0.34	75
70	0.32	0.82	0.42	0.44	0.32	0.33	0.56	0.36	0.61	0.78	0.59	0.50	0.54	0.29	70
65	0.27	0.69	0.36	0.37	0.26	0.26	0.46	0.28	0.49	0.67	0.50	0.43	0.46	0.24	65
60	0.21	0.55	0.29	0.29	0.20	0.20	0.36	0.21	0.37	0.55	0.40	0.36	0.37	0.19	60
55	0.15	0.42	0.22	0.22	0.15	0.14	0.26	0.13	0.25	0.43	0.30	0.29	0.29	0.14	55
50	0.10	0.29	0.16	0.15	0.09	0.07	0.16	0.05	0.14	0.32	0.21	0.22	0.21	0.09	50
45	0.04	0.16	0.09	0.08	0.04	0.01	0.06	.	0.02	0.20	0.11	0.15	0.13	0.04	45
40	.	0.02	0.03	0.01	.	.	.	.	.	0.08	0.01	0.08	0.05	.	40
35	.	.	.	.	.	.	.	.	.	.	.	0.00	.	.	35
30	.	.	.	.	.	.	.	.	.	.	.	.	.	.	30
25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25
20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20
15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0

T-SCORE TABLE FOR 7-YEAR-OLD BOYS

TSCORE	MOTOR	RHYTHM	TACTILE	VISUAL	RECEP SPEECH	EXPR SPEECH	WRITING	READING	ARITH-METIC	MEMORY	INTEL-LECTUAL	LEFT	RIGHT	PATHOG-NOMIC	TSCORE
100	0.51	1.55	0.75	0.74	0.48	0.55	0.40	0.17	0.96	1.38	1.04	0.56	0.83	0.50	100
95	0.46	1.43	0.69	0.68	0.44	0.50	0.36	0.15	0.88	1.27	0.96	0.52	0.77	0.46	95
90	0.42	1.30	0.63	0.63	0.40	0.45	0.33	0.13	0.79	1.16	0.87	0.47	0.71	0.42	90
85	0.38	1.18	0.57	0.57	0.36	0.40	0.29	0.12	0.70	1.06	0.79	0.43	0.65	0.38	85
80	0.33	1.06	0.51	0.52	0.32	0.35	0.25	0.10	0.61	0.95	0.71	0.39	0.59	0.34	80
75	0.29	0.94	0.45	0.46	0.28	0.30	0.22	0.09	0.52	0.84	0.62	0.34	0.52	0.30	75
70	0.25	0.81	0.39	0.40	0.25	0.25	0.18	0.07	0.44	0.73	0.54	0.30	0.46	0.26	70
65	0.20	0.69	0.34	0.35	0.21	0.21	0.14	0.06	0.35	0.62	0.45	0.26	0.40	0.22	65
60	0.16	0.57	0.28	0.29	0.17	0.16	0.10	0.04	0.26	0.52	0.37	0.21	0.34	0.18	60
55	0.12	0.45	0.22	0.23	0.13	0.11	0.07	0.02	0.17	0.41	0.29	0.17	0.27	0.14	55
50	0.07	0.32	0.16	0.18	0.09	0.06	0.03	0.01	0.08	0.30	0.20	0.13	0.21	0.10	50
45	0.03	0.20	0.10	0.12	0.05	0.01	.	.	.	0.19	0.12	0.08	0.15	0.06	45
40	.	0.08	0.04	0.07	0.01	.	.	.	.	0.08	0.04	0.04	0.09	0.02	40
35	.	.	.	0.01	.	.	.	.	.	.	.	.	0.03	.	35
30	.	.	.	.	.	.	.	.	.	.	.	.	.	.	30
25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25
20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20
15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0

T-SCORE TABLE FOR 7-YEAR-OLD GIRLS

TSCORE	MOTOR	RHYTHM	TACTILE	VISUAL	RECEP SPEECH	EXPR SPEECH	WRITING	READING	ARITH-METIC	MEMORY	INTEL-LECTUAL	LEFT	RIGHT	PATHOG-NOMIC	TSCORE
100	0.56	1.85	0.79	0.80	0.32	0.63	0.24	0.00	1.06	1.12	1.15	0.61	0.98	0.50	100
95	0.52	1.70	0.73	0.74	0.30	0.57	0.22	0.00	0.96	1.04	1.05	0.56	0.90	0.46	95
90	0.47	1.55	0.67	0.68	0.27	0.51	0.19	0.00	0.87	0.96	0.96	0.51	0.83	0.42	90
85	0.42	1.41	0.61	0.62	0.25	0.46	0.17	0.00	0.77	0.87	0.86	0.47	0.76	0.38	85
80	0.37	1.26	0.54	0.56	0.22	0.40	0.15	0.00	0.67	0.79	0.77	0.42	0.69	0.34	80
75	0.32	1.11	0.48	0.50	0.19	0.34	0.13	0.00	0.58	0.71	0.67	0.37	0.61	0.30	75
70	0.28	0.96	0.42	0.44	0.17	0.28	0.10	0.00	0.48	0.62	0.58	0.32	0.54	0.26	70
65	0.23	0.82	0.36	0.38	0.14	0.23	0.08	0.00	0.38	0.54	0.48	0.28	0.47	0.22	65
60	0.18	0.67	0.29	0.32	0.12	0.17	0.06	0.00	0.28	0.45	0.39	0.23	0.40	0.18	60
55	0.13	0.52	0.23	0.26	0.09	0.11	0.04	0.00	0.19	0.37	0.29	0.18	0.32	0.14	55
50	0.09	0.38	0.17	0.20	0.07	0.05	0.01	0.00	0.09	0.29	0.20	0.13	0.25	0.10	50
45	0.04	0.23	0.11	0.14	0.04	.	.	0.00	.	0.20	0.11	0.09	0.18	0.07	45
40	.	0.08	0.04	0.08	0.02	.	.	0.00	.	0.12	0.01	0.04	0.10	0.03	40
35	.	.	.	0.02	.	.	.	0.00	.	0.04	.	.	0.03	.	35
30	.	.	.	.	.	.	.	0.00	.	.	.	.	.	.	30
25	.	.	.	.	.	.	.	0.00	.	.	.	.	.	.	25
20	.	.	.	.	.	.	.	0.00	.	.	.	.	.	.	20
15	.	.	.	.	.	.	.	0.00	.	.	.	.	.	.	15
10	.	.	.	.	.	.	.	0.00	.	.	.	.	.	.	10
5	.	.	.	.	.	.	.	0.00	.	.	.	.	.	.	5
0	.	.	.	.	.	.	.	0.00	.	.	.	.	.	.	0

T-SCORE TABLE FOR 8-YEAR-OLD CHILDREN

TSCORE	MOTOR	RHYTHM	TACTILE	VISUAL	RECEP SPEECH	EXPR SPEECH	WRITING	READING	ARITH-METIC	MEMORY	INTEL-LECTUAL	LEFT	RIGHT	PATHOG-NOMIC	TSCORE
100	0.61	.	0.71	0.54	0.40	0.75	1.21	1.11	1.51	1.50	1.19	0.77	1.09	0.49	100
95	0.56	1.84	0.65	0.50	0.37	0.68	1.12	1.00	1.38	1.39	1.09	0.72	1.00	0.45	95
90	0.51	1.67	0.59	0.45	0.33	0.62	1.03	0.90	1.25	1.27	1.00	0.67	0.91	0.41	90
85	0.45	1.51	0.53	0.41	0.30	0.55	0.94	0.80	1.11	1.16	0.90	0.62	0.83	0.37	85
80	0.40	1.34	0.48	0.37	0.27	0.48	0.85	0.69	0.98	1.05	0.81	0.57	0.74	0.33	80
75	0.35	1.17	0.42	0.33	0.24	0.41	0.75	0.59	0.84	0.94	0.71	0.52	0.65	0.28	75
70	0.30	1.01	0.36	0.29	0.20	0.35	0.66	0.49	0.71	0.83	0.61	0.47	0.57	0.24	70
65	0.25	0.84	0.31	0.24	0.17	0.28	0.57	0.39	0.58	0.72	0.52	0.42	0.48	0.20	65
60	0.20	0.67	0.25	0.20	0.14	0.21	0.48	0.28	0.44	0.60	0.42	0.37	0.39	0.16	60
55	0.15	0.50	0.19	0.16	0.11	0.14	0.38	0.18	0.31	0.49	0.33	0.32	0.31	0.12	55
50	0.10	0.34	0.13	0.12	0.07	0.08	0.29	0.08	0.18	0.38	0.23	0.27	0.22	0.08	50
45	0.05	0.17	0.08	0.07	0.04	0.01	0.20	.	0.04	0.27	0.13	0.22	0.13	0.04	45
40	.	0.00	0.02	0.03	0.01	.	0.11	.	.	0.16	0.04	0.17	0.05	.	40
35	.	.	.	.	.	.	0.02	.	.	0.05	.	0.12	.	.	35
30	.	.	.	.	.	.	.	.	.	.	.	0.06	.	.	30
25	.	.	.	.	.	.	.	.	.	.	.	0.01	.	.	25
20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20
15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0

T-SCORE TABLE FOR 9-YEAR-OLD CHILDREN

TSCORE	MOTOR	RHYTHM	TACTILE	VISUAL	RECEP SPEECH	EXPR SPEECH	WRITING	READING	ARITH-METIC	MEMORY	INTEL-LECTUAL	LEFT	RIGHT	PATHOG-NOMIC	TSCORE
100	0.42	1.53	0.57	0.82	0.43	0.30	1.74	0.46	1.36	1.59	1.08	0.98	0.67	0.46	100
95	0.38	1.41	0.53	0.75	0.39	0.27	1.59	0.42	1.24	1.47	0.99	0.90	0.62	0.42	95
90	0.35	1.29	0.48	0.69	0.36	0.24	1.45	0.38	1.13	1.34	0.91	0.83	0.57	0.38	90
85	0.32	1.16	0.44	0.62	0.32	0.22	1.31	0.34	1.01	1.22	0.82	0.76	0.53	0.35	85
80	0.28	1.04	0.39	0.56	0.28	0.19	1.16	0.30	0.89	1.09	0.73	0.69	0.48	0.31	80
75	0.25	0.92	0.34	0.49	0.25	0.17	1.02	0.25	0.78	0.97	0.64	0.61	0.43	0.27	75
70	0.21	0.80	0.30	0.42	0.21	0.14	0.88	0.21	0.66	0.84	0.55	0.54	0.38	0.23	70
65	0.18	0.68	0.25	0.36	0.17	0.11	0.73	0.17	0.55	0.71	0.47	0.47	0.34	0.19	65
60	0.15	0.55	0.21	0.29	0.14	0.09	0.59	0.13	0.43	0.59	0.38	0.39	0.29	0.15	60
55	0.11	0.43	0.16	0.23	0.10	0.06	0.45	0.09	0.31	0.46	0.29	0.32	0.24	0.12	55
50	0.08	0.31	0.12	0.16	0.06	0.04	0.30	0.05	0.20	0.34	0.20	0.25	0.20	0.08	50
45	0.05	0.19	0.07	0.10	0.03	0.01	0.16	0.01	0.08	0.21	0.11	0.17	0.15	0.04	45
40	0.01	0.07	0.03	0.03	.	.	0.02	.	.	0.09	0.03	0.10	0.10	0.00	40
35	.	.	.	.	.	.	.	.	.	.	.	0.03	0.06	.	35
30	.	.	.	.	.	.	.	.	.	.	.	.	0.01	.	30
25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25
20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20
15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0

<u>T</u>-SCORE TABLE FOR 10-YEAR-OLD CHILDREN

TSCORE	MOTOR	RHYTHM	TACTILE	VISUAL	RECEP SPEECH	EXPR SPEECH	WRITING	READING	ARITH-METIC	MEMORY	INTEL-LECTUAL	LEFT	RIGHT	PATHOG-NOMIC	TSCORE
100	0.22	0.72	0.55	0.71	0.30	0.25	0.67	0.31	0.00	0.84	0.93	0.81	0.46	0.38	100
95	0.20	0.66	0.50	0.65	0.27	0.23	0.61	0.29	0.00	0.78	0.86	0.75	0.42	0.35	95
90	0.19	0.59	0.45	0.58	0.25	0.20	0.55	0.26	0.00	0.72	0.78	0.68	0.38	0.32	90
85	0.17	0.53	0.41	0.52	0.22	0.18	0.49	0.23	0.00	0.65	0.70	0.62	0.35	0.28	85
80	0.15	0.47	0.36	0.45	0.20	0.15	0.43	0.20	0.00	0.59	0.63	0.56	0.31	0.25	80
75	0.13	0.41	0.32	0.39	0.17	0.13	0.38	0.17	0.00	0.52	0.55	0.49	0.27	0.21	75
70	0.11	0.34	0.27	0.33	0.14	0.11	0.32	0.14	0.00	0.46	0.47	0.43	0.23	0.18	70
65	0.09	0.28	0.23	0.26	0.12	0.08	0.26	0.11	0.00	0.40	0.40	0.36	0.19	0.15	65
60	0.07	0.22	0.18	0.20	0.09	0.06	0.20	0.08	0.00	0.33	0.32	0.30	0.15	0.11	60
55	0.05	0.16	0.14	0.14	0.06	0.04	0.15	0.06	0.00	0.27	0.24	0.23	0.11	0.08	55
50	0.03	0.09	0.09	0.07	0.04	0.01	0.09	0.03	0.00	0.20	0.17	0.17	0.07	0.04	50
45	0.02	0.03	0.04	0.01	0.01	.	0.03	.	0.00	0.14	0.09	0.10	0.04	0.01	45
40	.	.	.	.	.	.	.	.	0.00	0.08	0.01	0.04	.	.	40
35	.	.	.	.	.	.	.	.	0.00	0.01	.	.	.	.	35
30	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	30
25	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	25
20	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	20
15	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	15
10	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	10
5	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	5
0	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	0

T-SCORE TABLE FOR 11-YEAR-OLD CHILDREN

TSCORE	MOTOR	RHYTHM	TACTILE	VISUAL	RECEP SPEECH	EXPR SPEECH	WRITING	READING	ARITH-METIC	MEMORY	INTEL-LECTUAL	LEFT	RIGHT	PATHOG-NOMIC	TSCORE
100	0.29	0.70	0.69	0.57	0.32	0.10	0.57	0.31	0.00	1.18	0.40	0.72	0.44	0.28	100
95	0.26	0.64	0.64	0.52	0.29	0.10	0.52	0.29	0.00	1.08	0.37	0.66	0.40	0.26	95
90	0.24	0.59	0.58	0.47	0.26	0.09	0.48	0.26	0.00	0.98	0.33	0.60	0.37	0.23	90
85	0.21	0.53	0.53	0.42	0.24	0.08	0.43	0.23	0.00	0.88	0.30	0.54	0.33	0.21	85
80	0.19	0.47	0.47	0.37	0.21	0.07	0.38	0.20	0.00	0.78	0.27	0.48	0.30	0.19	80
75	0.16	0.41	0.41	0.32	0.18	0.06	0.33	0.17	0.00	0.68	0.24	0.42	0.27	0.16	75
70	0.14	0.35	0.36	0.27	0.15	0.05	0.28	0.14	0.00	0.59	0.21	0.37	0.23	0.14	70
65	0.11	0.29	0.30	0.23	0.12	0.04	0.24	0.11	0.00	0.49	0.18	0.31	0.20	0.12	65
60	0.09	0.23	0.25	0.18	0.09	0.03	0.19	0.08	0.00	0.39	0.15	0.25	0.17	0.09	60
55	0.06	0.17	0.19	0.13	0.06	0.02	0.14	0.05	0.00	0.29	0.12	0.19	0.13	0.07	55
50	0.03	0.11	0.14	0.08	0.04	0.01	0.09	0.03	0.00	0.19	0.08	0.13	0.10	0.05	50
45	0.01	0.05	0.08	0.03	0.01	.	0.04	.	0.00	0.09	0.05	0.07	0.07	0.02	45
40	.	.	0.03	.	.	.	.	.	0.00	.	0.02	0.02	0.03	.	40
35	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	35
30	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	30
25	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	25
20	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	20
15	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	15
10	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	10
5	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	5
0	.	.	.	.	.	.	.	.	0.00	.	.	.	.	.	0

T-SCORE TABLE FOR 12-YEAR-OLD CHILDREN

TSCORE	MOTOR	RHYTHM	TACTILE	VISUAL	RECEP SPEECH	EXPR SPEECH	WRITING	READING	ARITH-METIC	MEMORY	INTEL-LECTUAL	LEFT	RIGHT	PATHOG-NOMIC	TSCORE
100	0.15	0.71	0.67	0.42	0.24	0.00	0.62	0.00	0.00	1.26	0.21	0.49	0.41	0.26	100
95	0.14	0.65	0.62	0.39	0.22	0.00	0.57	0.00	0.00	1.16	0.19	0.46	0.37	0.24	95
90	0.12	0.60	0.56	0.35	0.20	0.00	0.51	0.00	0.00	1.05	0.17	0.42	0.34	0.21	90
85	0.11	0.54	0.51	0.31	0.18	0.00	0.46	0.00	0.00	0.95	0.16	0.38	0.31	0.19	85
80	0.10	0.49	0.46	0.28	0.16	0.00	0.41	0.00	0.00	0.84	0.14	0.34	0.28	0.17	80
75	0.09	0.43	0.40	0.24	0.14	0.00	0.36	0.00	0.00	0.74	0.12	0.30	0.25	0.15	75
70	0.07	0.38	0.35	0.20	0.12	0.00	0.30	0.00	0.00	0.64	0.10	0.26	0.22	0.12	70
65	0.06	0.32	0.29	0.16	0.10	0.00	0.25	0.00	0.00	0.53	0.08	0.22	0.19	0.10	65
60	0.05	0.27	0.24	0.13	0.08	0.00	0.20	0.00	0.00	0.43	0.06	0.18	0.16	0.08	60
55	0.04	0.21	0.19	0.09	0.06	0.00	0.14	0.00	0.00	0.32	0.05	0.15	0.12	0.05	55
50	0.03	0.16	0.13	0.05	0.03	0.00	0.09	0.00	0.00	0.22	0.03	0.11	0.09	0.03	50
45	0.01	0.10	0.08	0.02	0.01	0.00	0.04	0.00	0.00	0.11	0.01	0.07	0.06	0.01	45
40	0.00	0.05	0.02	.	.	0.00	.	0.00	0.00	0.01	.	0.03	0.03	.	40
35	.	.	.	.	.	0.00	.	0.00	0.00	.	.	.	0.00	.	35
30	.	.	.	.	.	0.00	.	0.00	0.00	.	.	.	.	.	30
25	.	.	.	.	.	0.00	.	0.00	0.00	.	.	.	.	.	25
20	.	.	.	.	.	0.00	.	0.00	0.00	.	.	.	.	.	20
15	.	.	.	.	.	0.00	.	0.00	0.00	.	.	.	.	.	15
10	.	.	.	.	.	0.00	.	0.00	0.00	.	.	.	.	.	10
5	.	.	.	.	.	0.00	.	0.00	0.00	.	.	.	.	.	5
0	.	.	.	.	.	0.00	.	0.00	0.00	.	.	.	.	.	0

APPENDIX D

D.1 RESULTS FROM INDIVIDUAL CLINICAL CASES

As outlined in 3.2.4 the following graphs were plotted from results obtained by testing first 28 brain-damaged children and then selecting a Learning-disabled child and a normal-control child of same sex and age as the brain-damaged child. The performance profiles of each triplet were plotted on the same graph. The top graph shows the results of the MLNNB-YC, -OC and the bottom of the graph illustrates test results obtained using the HRNTB-C on the same children. Performance profiles for the controls were not plotted for the HRNTB-C. Performance on the MLNNB-YC, -OC were scaled in terms of _T_-Scores while the performance on the HRNTB-C was scaled in terms of standard deviation units following Knights (1980) norms. The scaling makes the results on the two different batteries comparable (for MLNNB-C 10 _T_-Scores = 1 SD). Below each graph is a brief description of independent diagnostic findings for each of the BD and LD children.

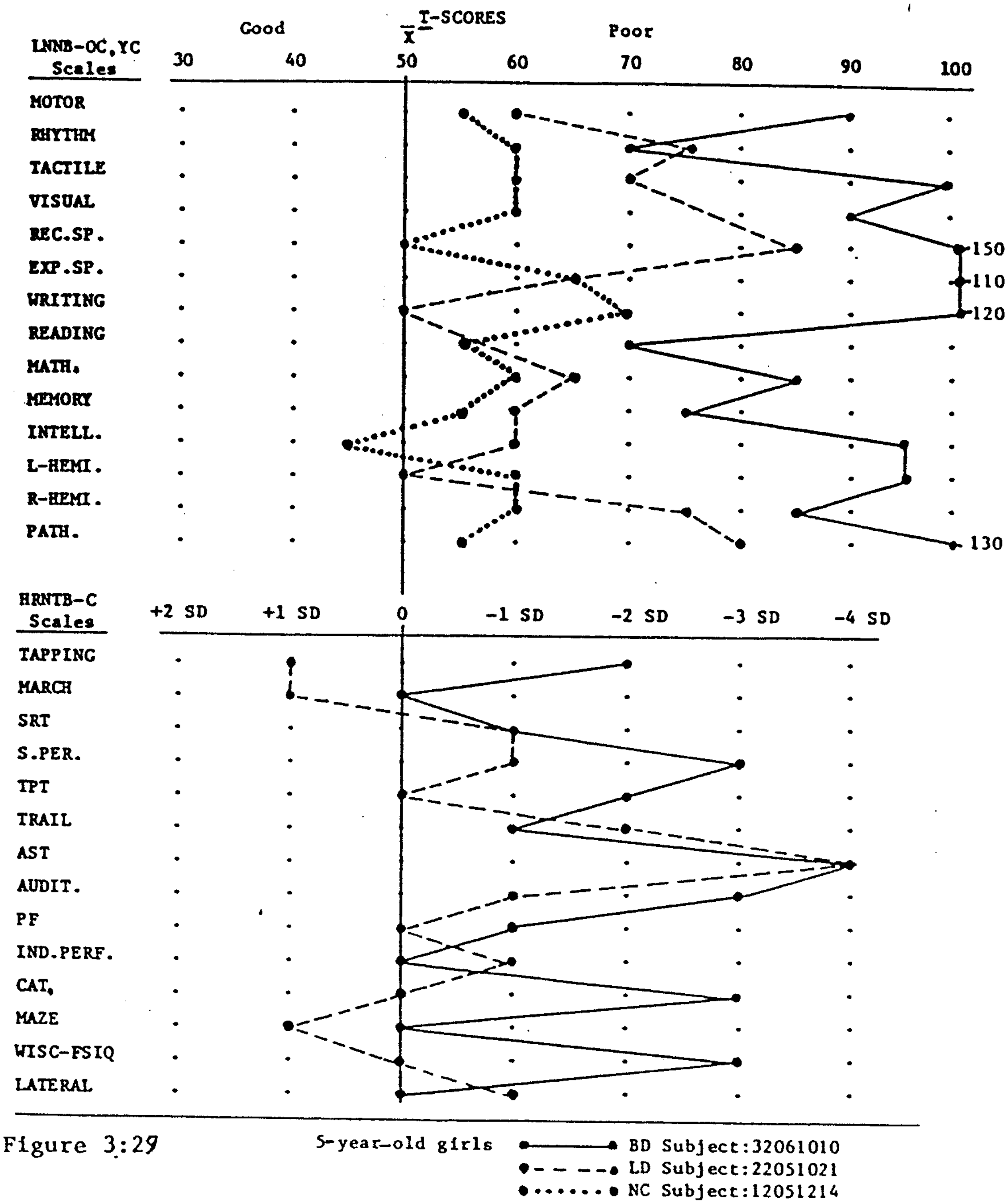


Figure 3:29

Independent diagnostic findings

BD: Grand Mal epilepsi with left temporal lobe foci. Speech and writing deficits.
Impairment Ratio: MLNNB-YC=.72, HRNTB-C=.45.

LD: Extreme difficulty learning pre-grade-1 skills. Currently enrolled in grade 1 program in school. Possibly aphasic. Difficulties understanding instructions in the classroom and receptive-speech problems.
Impairment Ratio: MLNNB-YC=.09, HRNTB-C=.08.

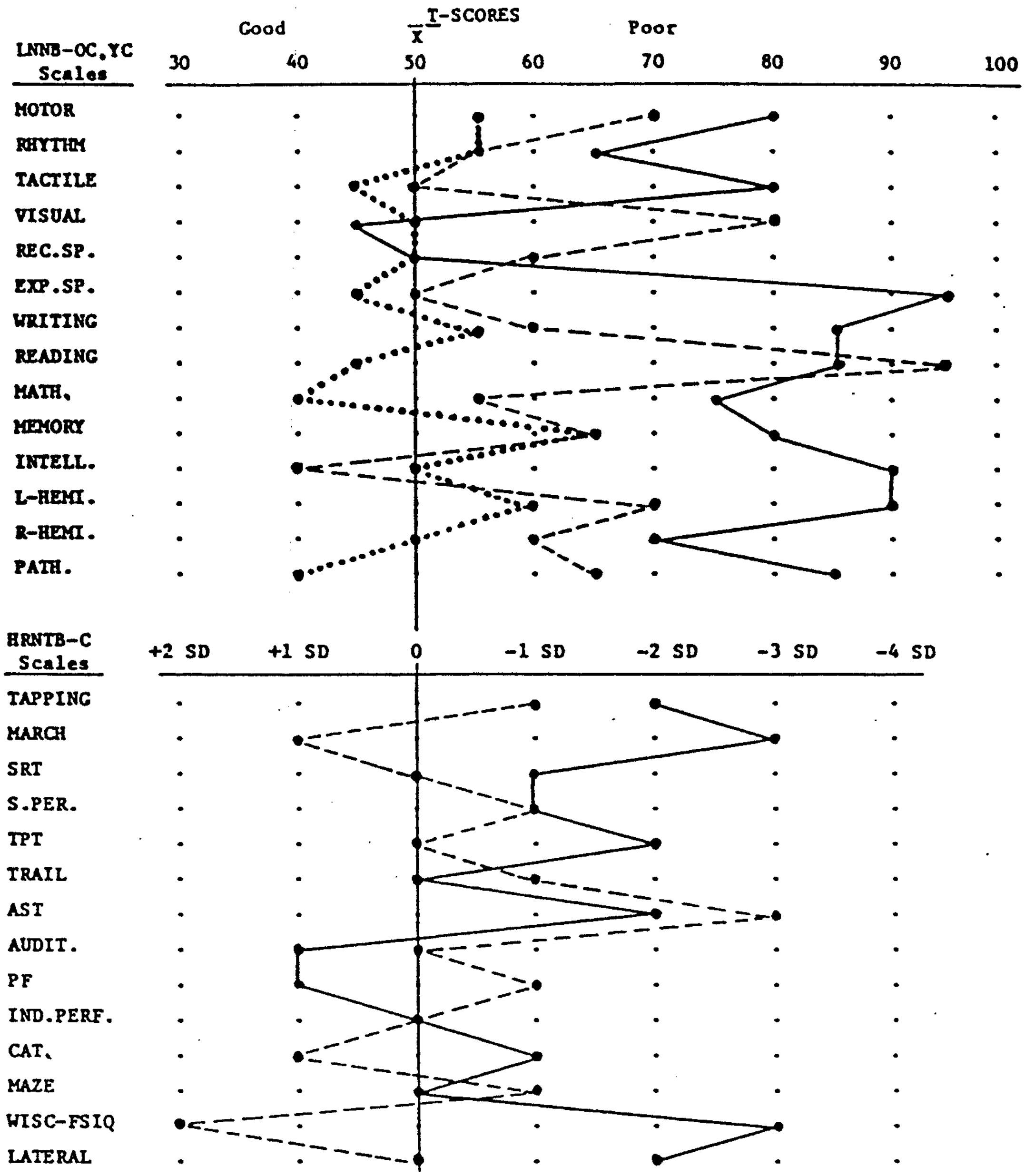


Figure 3:30

6-year-old girls ●———● BD Subject:32061019
●- - - -● LD Subject:22061016
●••••••● NC Subject:11061204

Independent diagnostic findings:

BD: Nutritional deficiencies over a period of three years (from age 1-4). Reported to have poor reasoning ability in school and difficulty learning to read and write. Also speech impediment (pronounciations). Impairment Ratio:MLNNB-YC=.63,HRNTB-C=.18.

LD: Severe problems learning to read despite intensive work over a period of one year by resource teacher. Impairment Ratio:MLNNB-YC=.18, HRNTB-C=.08.

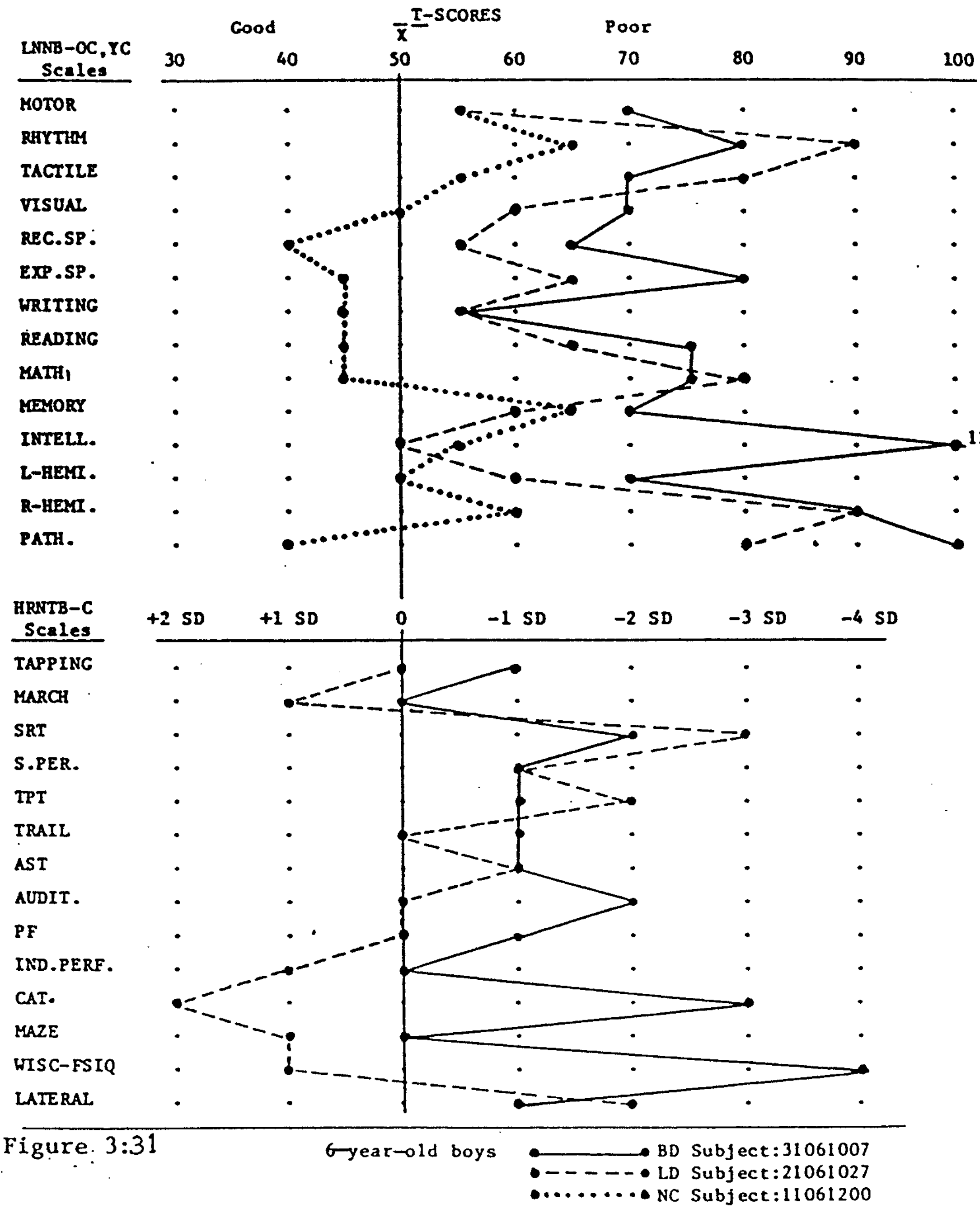


Figure 3:31

Independent diagnostic findings:

BD: Frontal lobe abscess (post-operative). Poor comprehension, difficulty involves following instructional language in class. Impairment Ratio: MLNNB-YC=.27, HRNTB-C=.27.

LD: Very poor performance in arithmetic (grade 1), Impairment Ratio: MLNNB-YC=.27, HRNTB-C=.08.

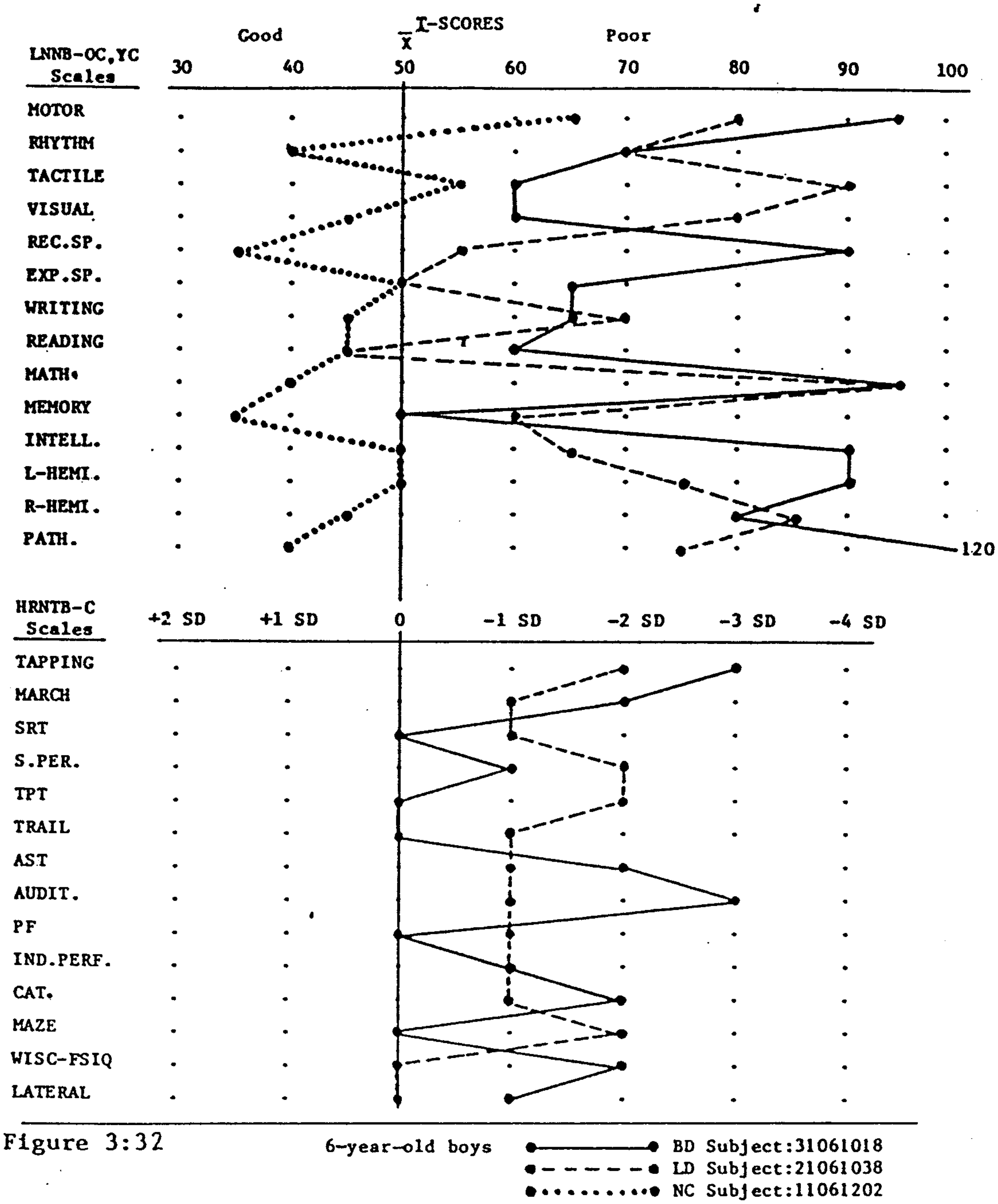


Figure 3:32

<u>*Independent diagnostic findings:*</u>

BD: Skull fracture following accidental blow with baseball bat (top of the skull, parietal area). Some receptive speech problems and very poor short-term memory. Imp.Ratio: MLNNB-YC=.36, HRNTB-C=.32

LD: Difficulty learning how to write despite good reading skills. Math is also a problem (cannot even do simple arithmetic).
Impairment Ratio: MLNNB-YC=.27, HRNTB-C= 0.

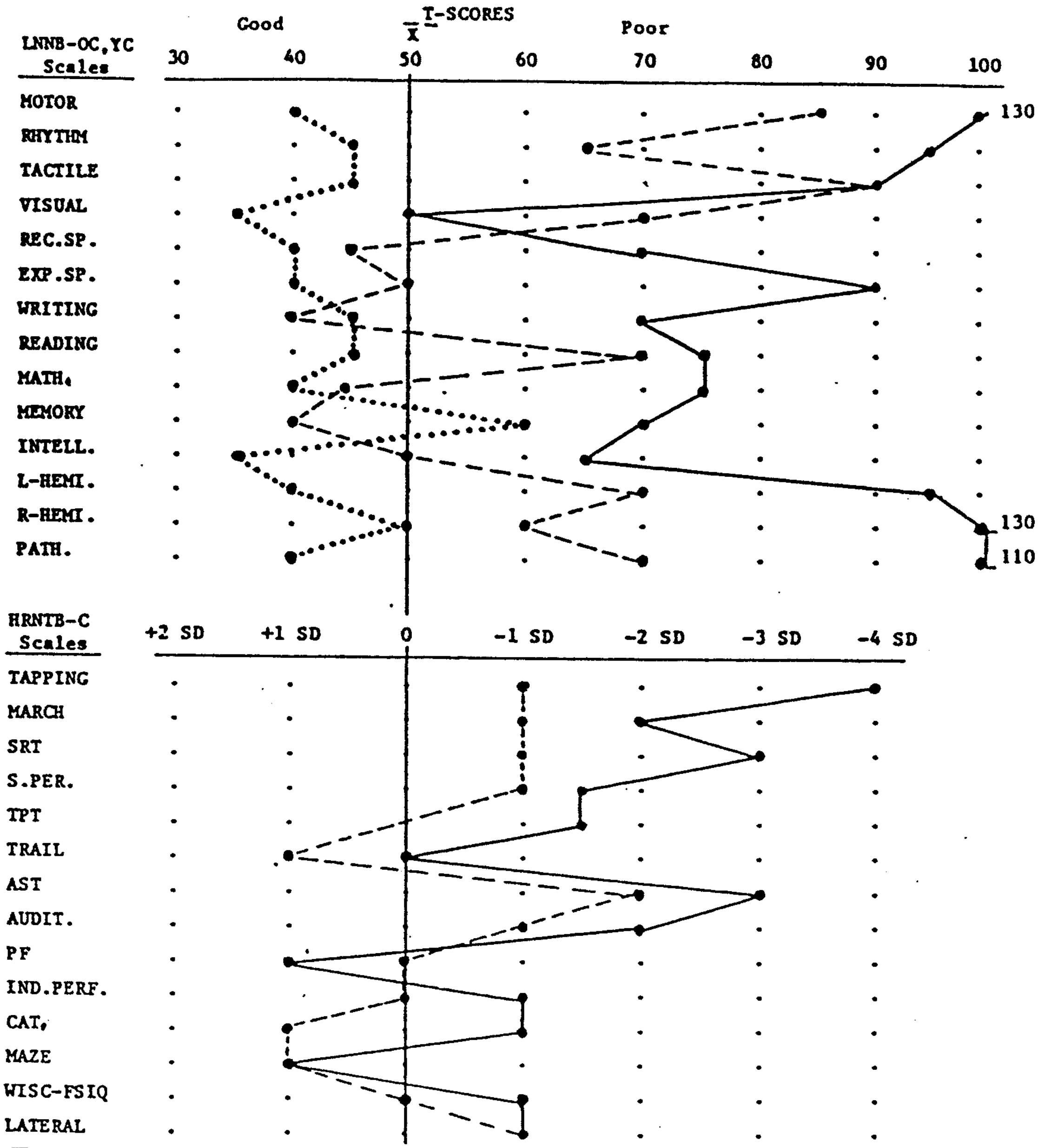


Figure 3:33 7-year-old girls

- ●———● BD Subject:32071011
- ●- - -● LD Subject:22071007
- ●·····● NC Subject:11071160

Independent diagnostic findings

BD: Fetal alcohol syndrome. Gross and fine motor disturbance and poor expressive language. Imp.Ratio: MLNNB-YC=.36,HRNTB-C=.32.

LD: Poor progress in reading skills. Currently enrolled in reading remediation program. Impairment Ratio: MLNNB-YC= .18, HRNBT-C= 0.

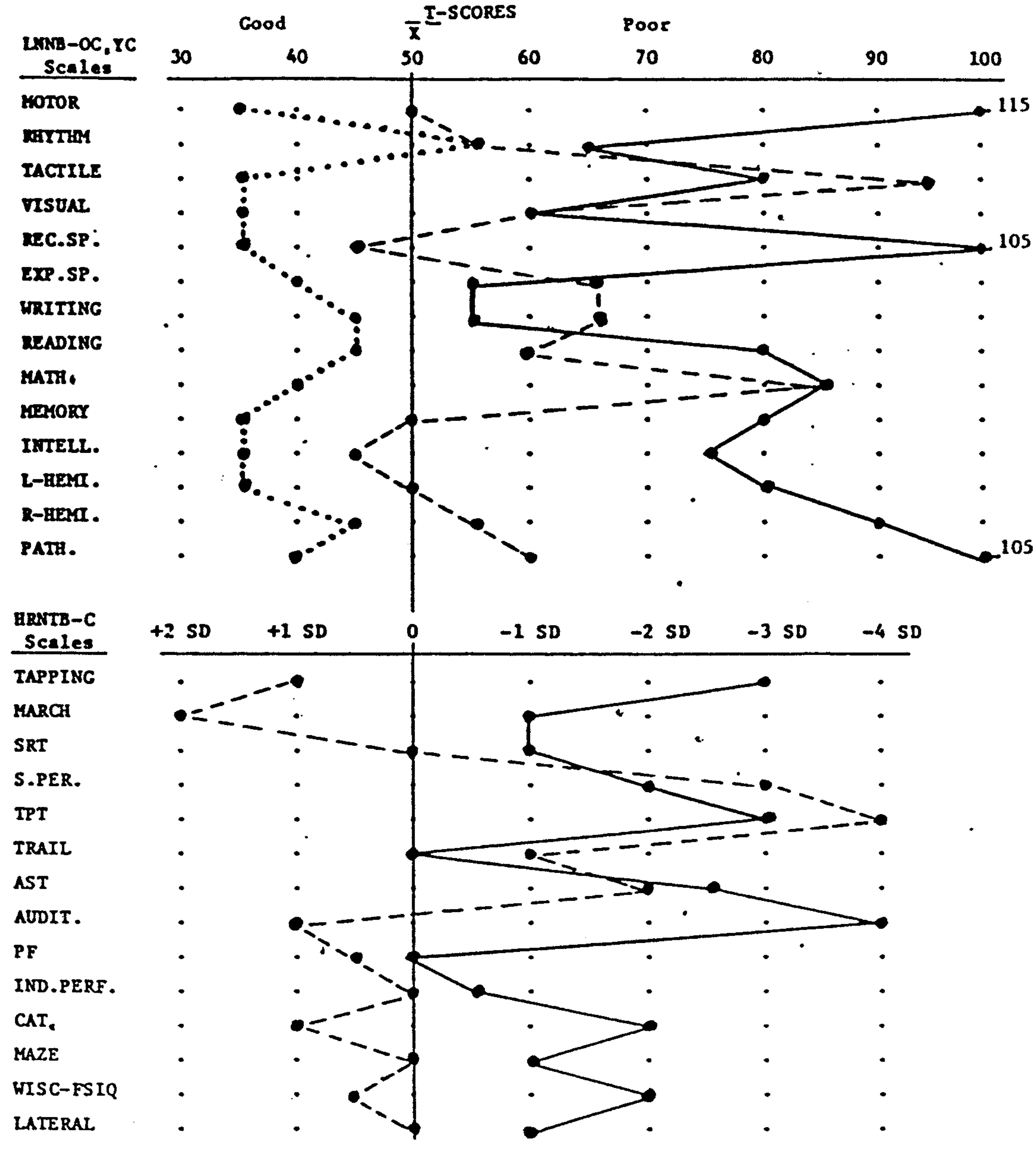


Figure 3:34 7-year-old girls

Independent diagnostic findings

BD: Left fronto-temporal-lobe injury following auto accident. Problems with coordinated motor movements and expressive speech. Currently enrolled in language-disorders class in school. Imp. Ratio: MLNNB-YC=.54, HRNTB-C=.27

LD: Clearly deficient in arithmetic. Otherwise fairly good school record. Impairment Ratio: NLNNB-YC=.18, HRNTB-C=.16.

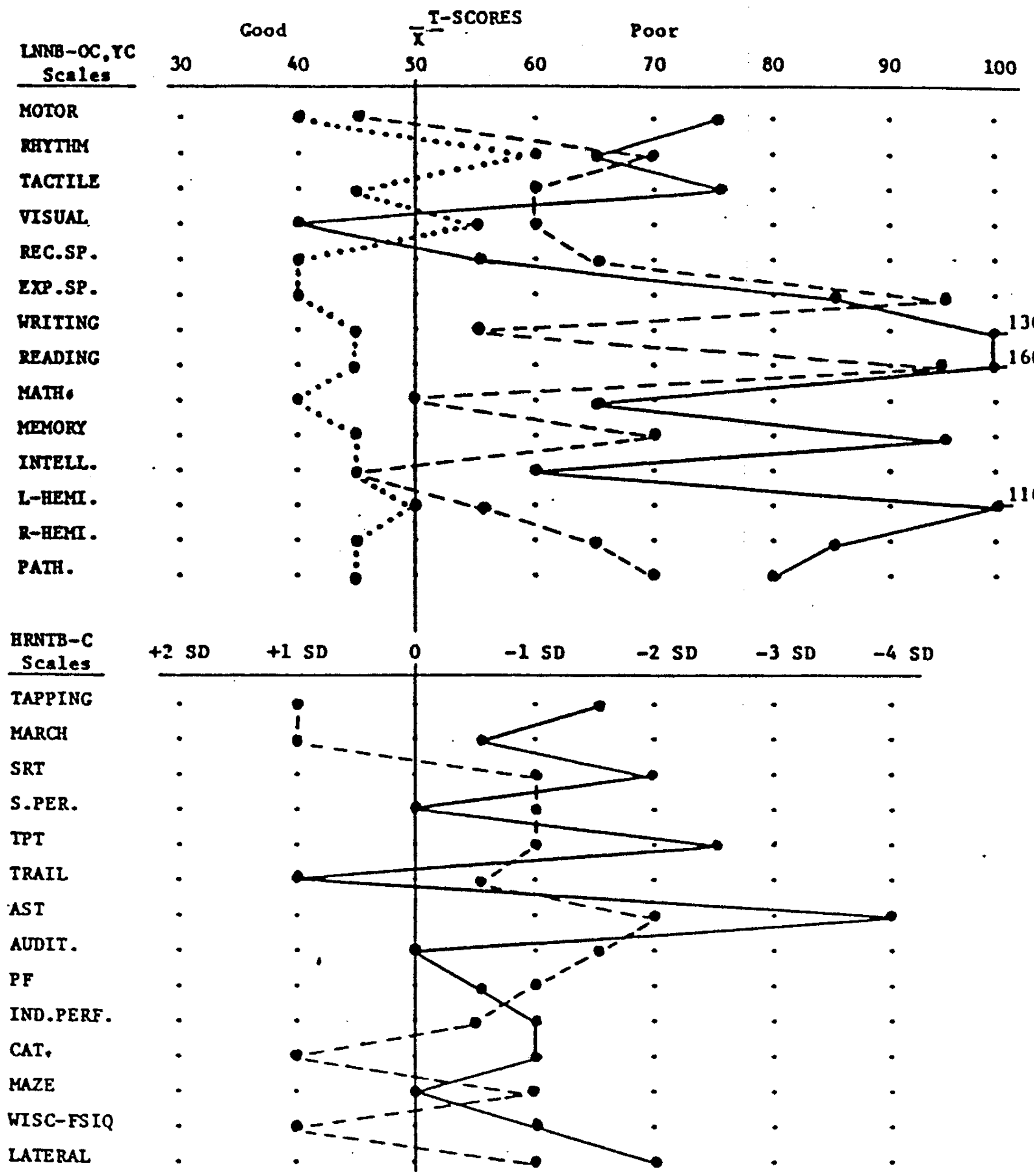


Figure 3:35

7-year-old girls ●———● BD Subject:32071023
●- - - -● LD Subject:22071031
●•••••••● NC Subject:12071172

Independent diagnostic findings

BD: Left-hemisphere injury with intracranial hemhorrage. School records indicate very poor writing, reading, and memory skills. Impairment Ratio: MLNNB-YC=.36, HRNTB-C= .09

LD: Severe reading deficit and language pathology. Impairment Ratio: MLNNB-YC=.18, HRNTB-C=0.

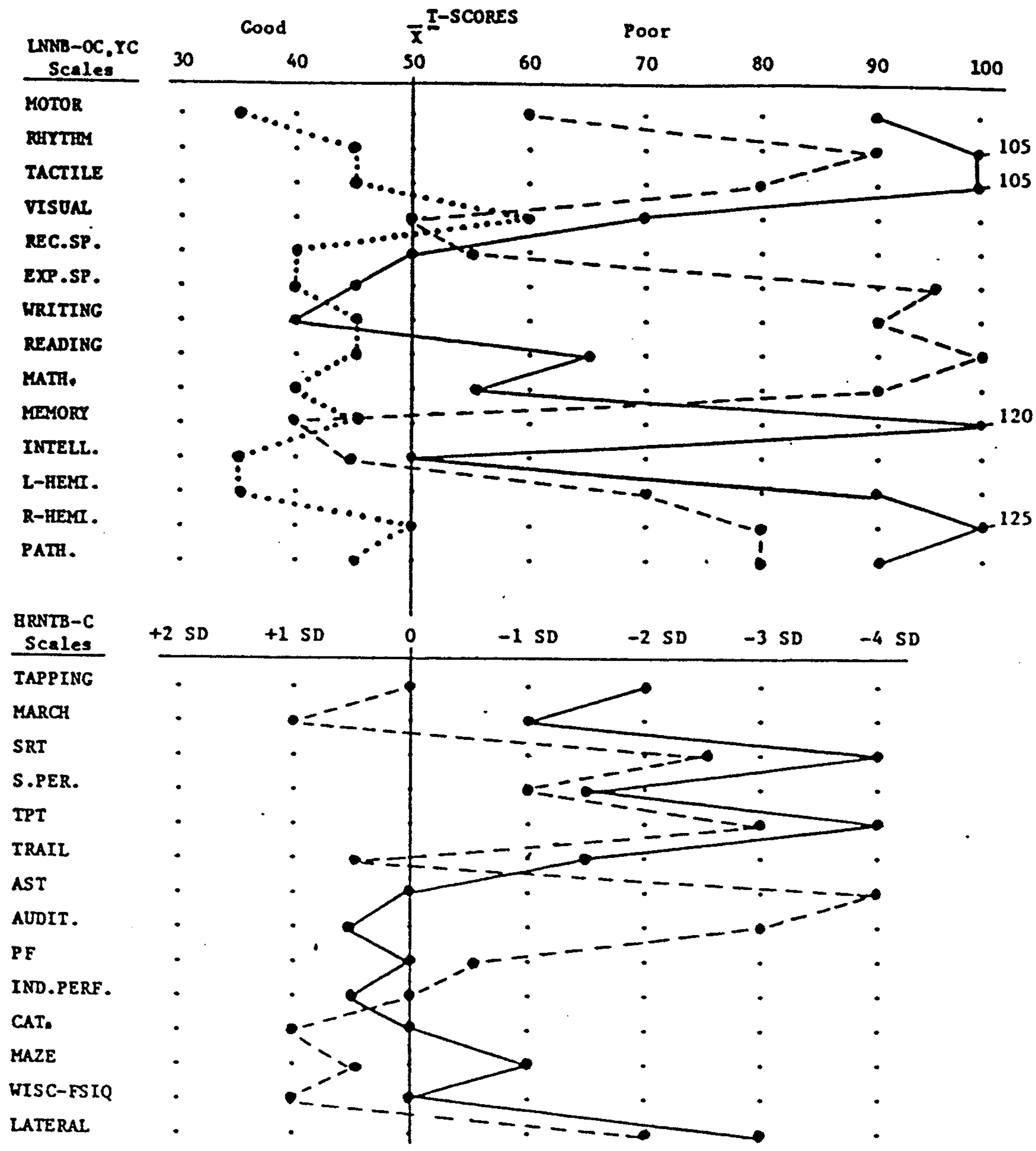


Figure 3:36 7-year-old girls

BD Subject:32071009
LD Subject:22071037
NC Subject:12071162

Independent diagnostic findings

BD: Right parietal injury with abscess. Impairment Ratio:MLNNB-YC=.36,HRNTB-C=.18

LD: Language disorder child with deficit performance in writing, reading, and arithmetic. Impairment Ratio:MLNNB-YC=.54,HRNTB-C=.33.

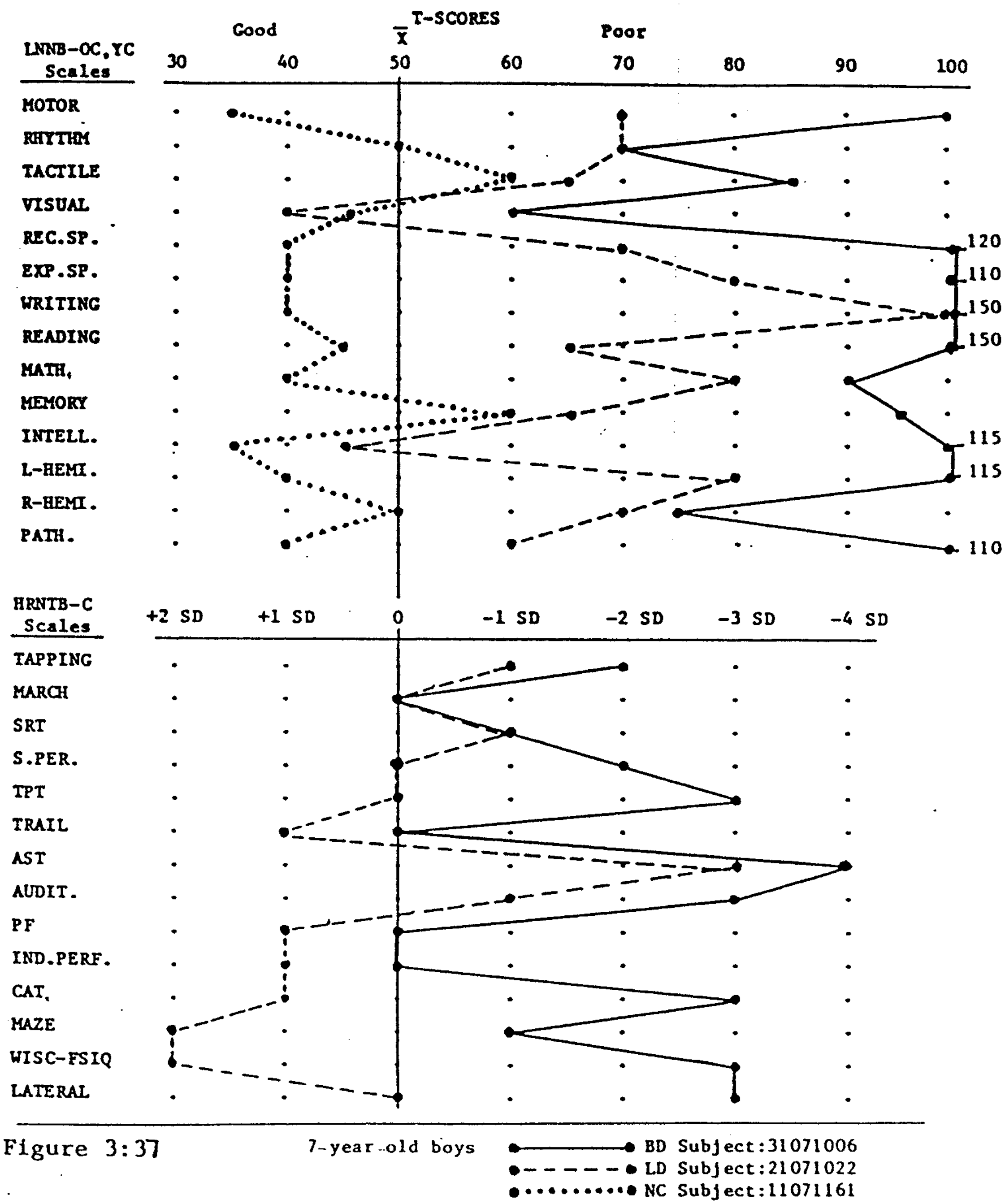


Figure 3:37

Independent diagnostic findings

BD: Neonatal anoxia. Severe deficits in all school subjects. Impairment Ratio: MLNNB-YC=.72, HRNTB-C=.45

LD: Very poor performance in arithmetic. Also agraphia. Impairment Ratio: MLNNB-YC=.27, HRNTB-C=.08.

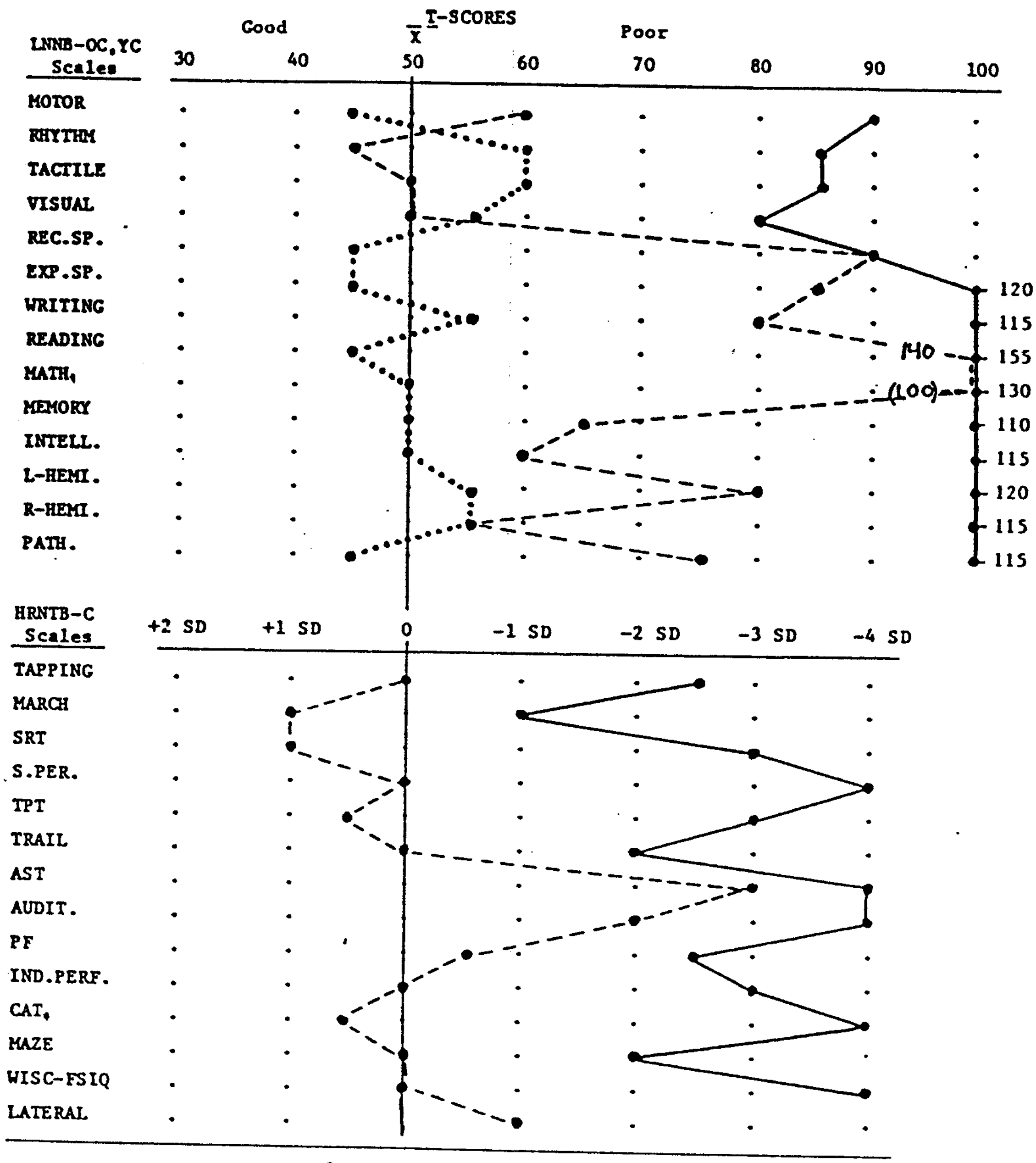


Figure 3:38 8-year-old girls
BD Subject:32081001
LD Subject:22081003
NC Subject:12081122

Independent diagnostic findings

BD: Near drowning accident. Coma lasted three weeks. Currently enrolled in special program for handicapped. Imp. Ratio :LNNB-OC=1.0,HRNTB-C=.63.

LD: Language disorder with severe reading and math deficits. Impairment Ratio: MLNNB-OC=.45, HRNTB-C=.08.

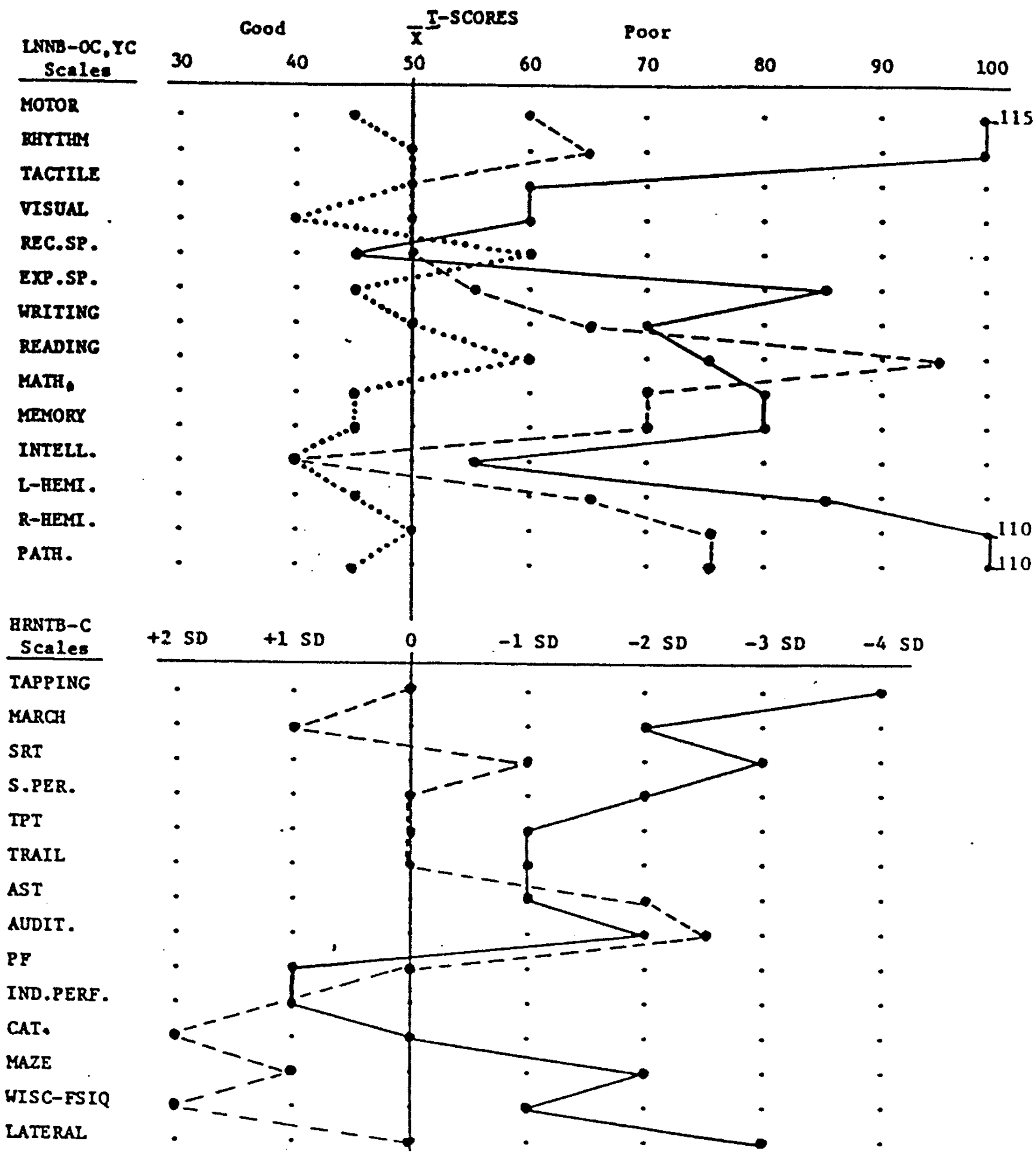


Figure 3:39 8-year-old boys

BD Subject:31081026
LD Subject:22081008
NC Subject:11081134

Independent diagnostic findings

BD: Head injury, right-temporal/parietal area. Fine-motor problems. Impairment Ratio: MLNNB-CC=.45, HRNTB-C=.18.

LD: Severe reading deficit in school. Impairment Ratio: MLNNB-CC=.09, HRNTB-C=0.

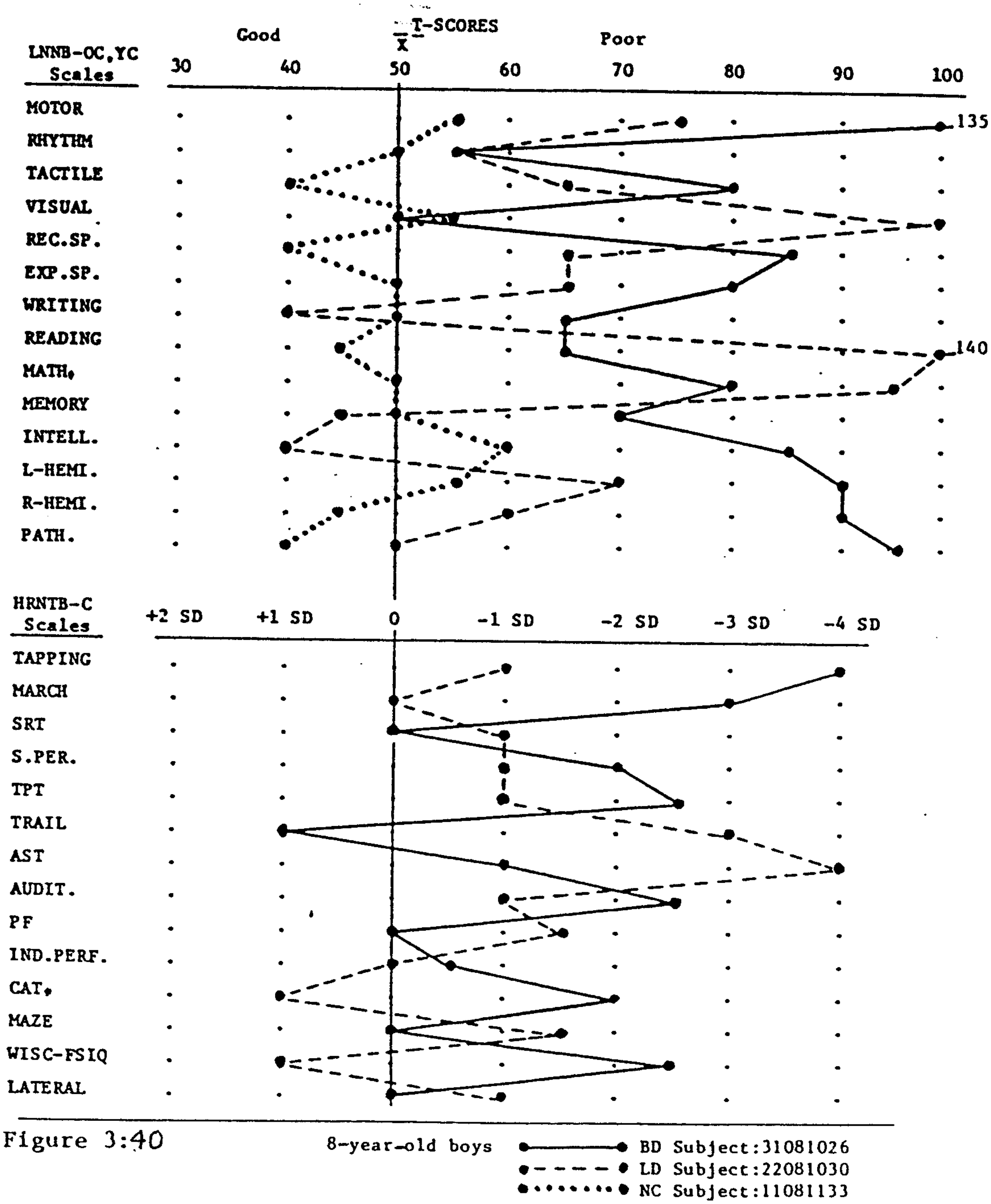


Figure 3:40

Independent diagnostic findings

BD: *Brain injury associated with encephalitis. Slight expressive speech problem (pronounciation). Impairment Ratio: MLNNB-OC=.54, HRNTB-C=.18.*

LD: *Very poor school performance especially in math. Poor memory and hence learning rate is very slow. Impairment Ratio: MLNNB-OC=.27, HRNTB-C=.16.*

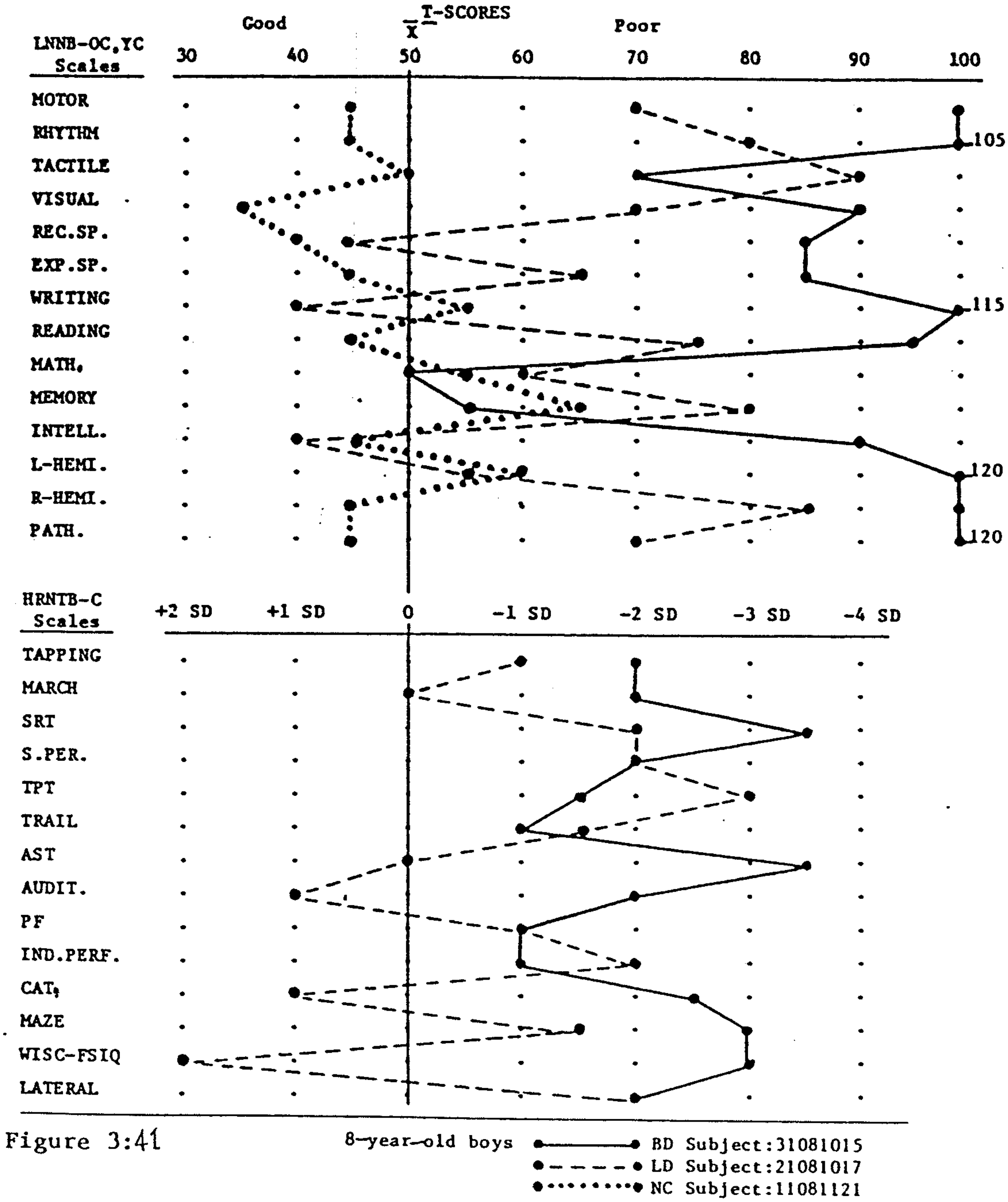


Figure 3:41

<u>*Independent diagnostic findings*</u>

BD: Post-operative tumor, subcortical. Severe reading deficits and very poor fine-motor functions. Impairment Ratio: MLNNB-OC=.73, HRNTB-C=.36.

LD: Reading deficits. Impairment Ratio: MLNNB-OC=.09, HRNTB-C=.08.

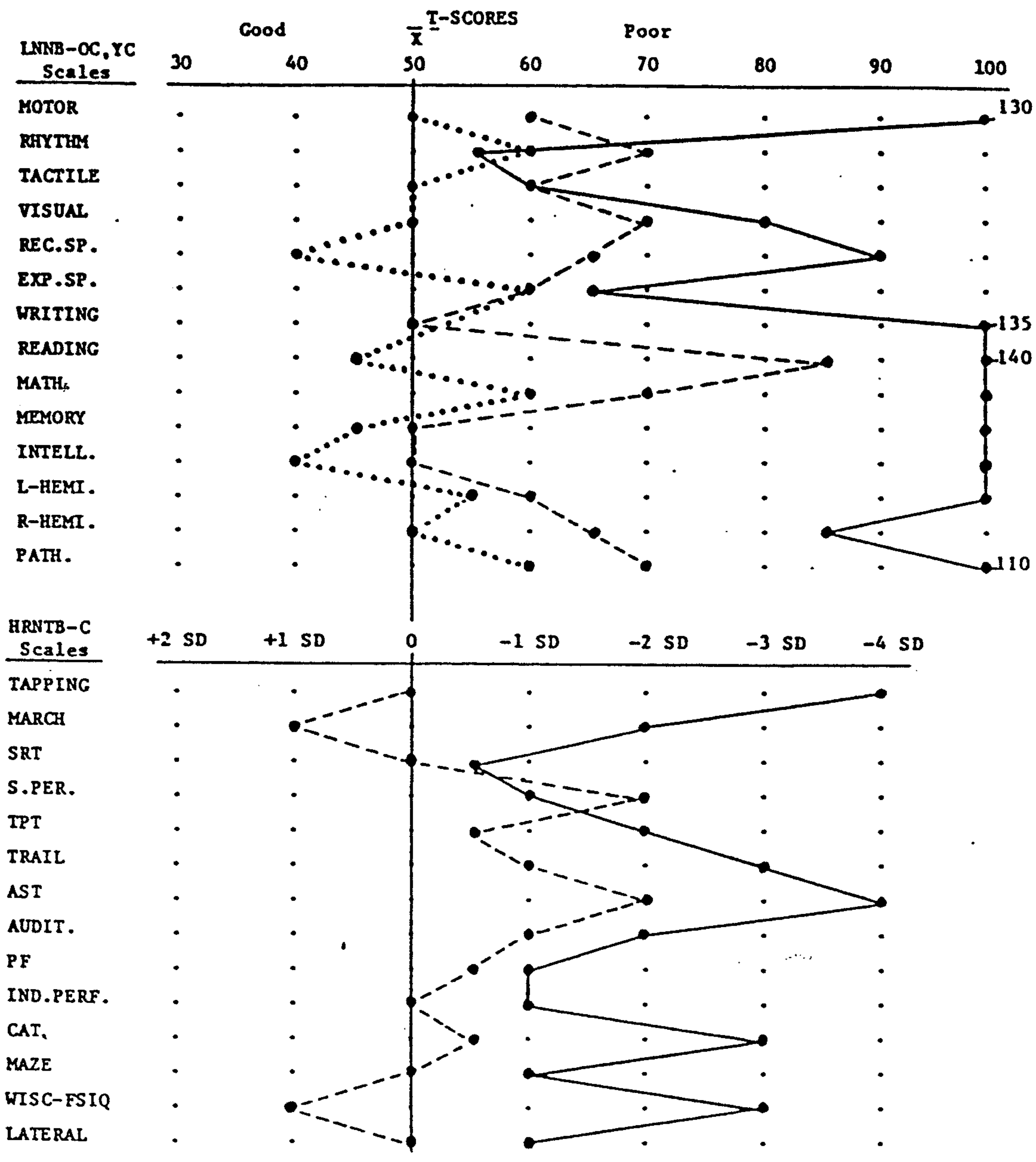


Figure 3:42 9-year-old girls BD Subject:32091003 LD Subject:22091035 NC Subject:12091091

Independent diagnostic findings

BD: Birth trauma (cord wrapped around neck) with anoxia. Impairment Ratio: MLNNB-OC=.73, HRNTB-C=.45.

LD: Very poor reader, at least two years behind age mates. Impairment Ratio: MLNNB-OC= .09, HRNTB-C=0.

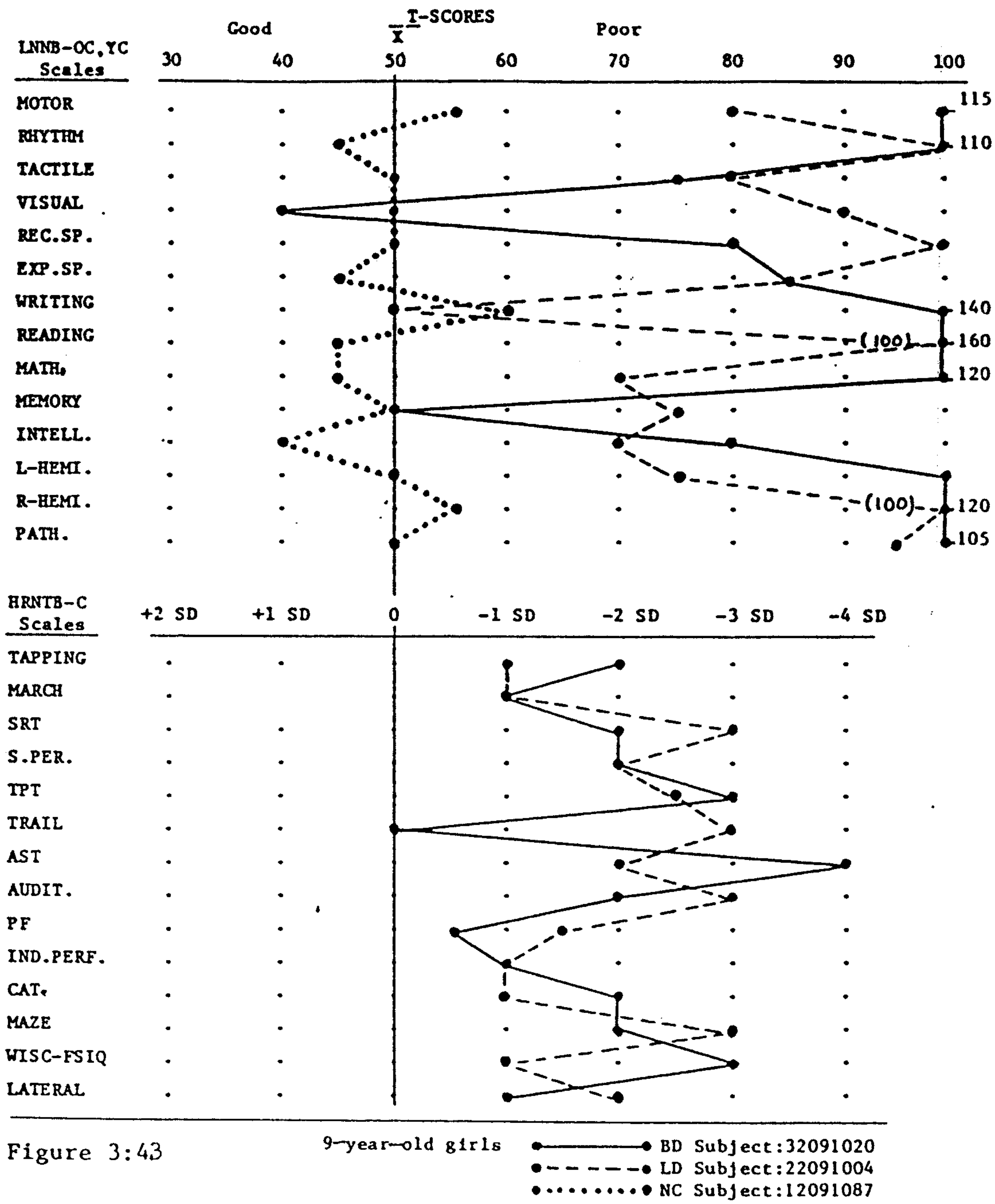


Figure 3:43

Independent diagnostic findings

BD: Post-encephalitic disorder. Three years behind age-mates in school performance. Impairment Ratio:MLNNB-OC=.82,HRNTB-C=.27.

LD: Previously attended language-disorders class with autistic signs. Diagnosed as dyslexic. Impairment Ratio:MLNNB-OC=.54,HRNTB-C=.25

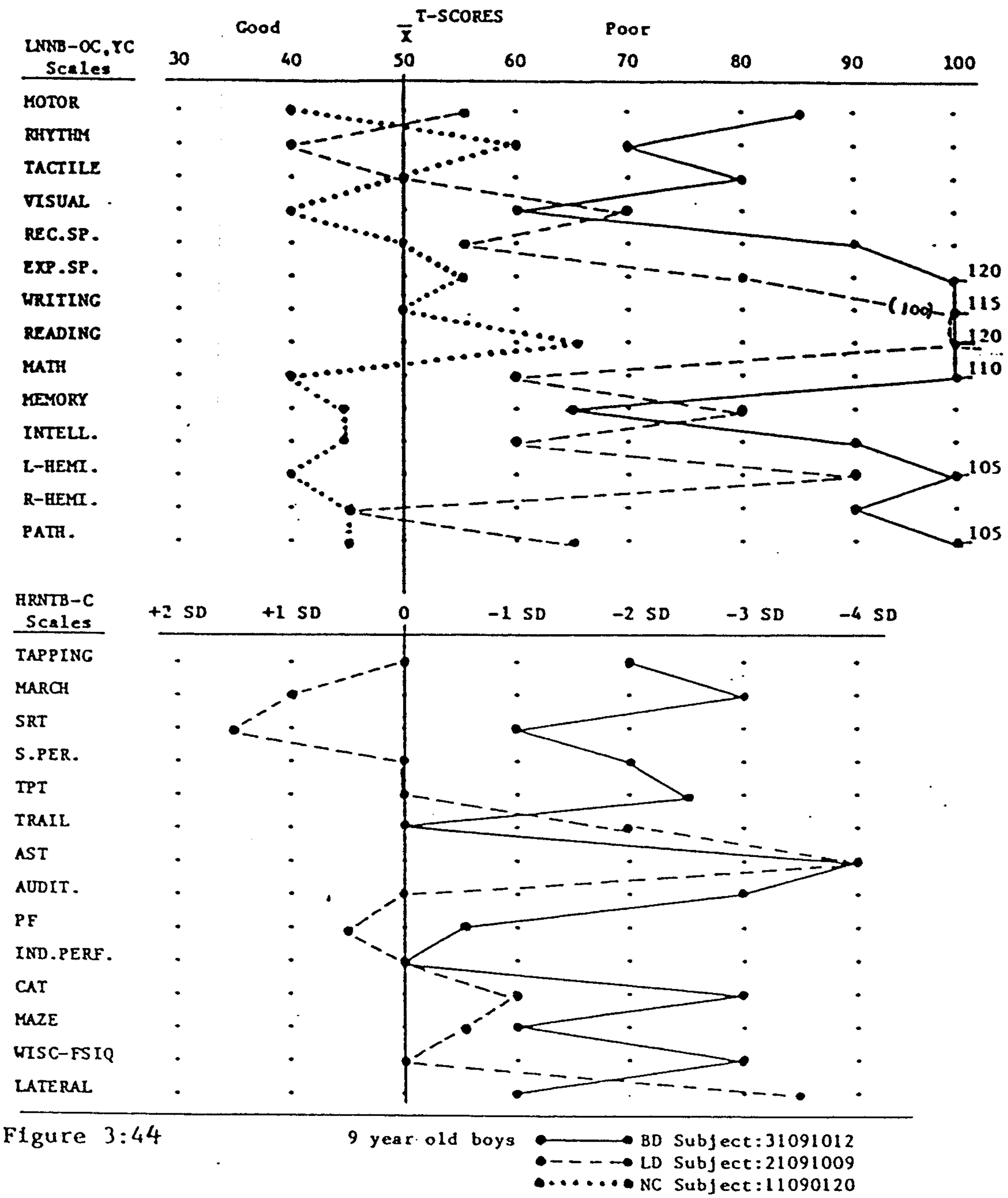


Figure 3:44

Independent diagnostic findings

BD: Right infantile hemiplegia (some paresis). Poor school performance. Impairment Ratio: MLNNB-OC=.73, HRNTB-C=.36.

LD: Severe reading deficits and very poor writing skills 3 years behind age mates in these school subjects. Impairment Ratio: MLNNB-OC=.36, HRNTB-C=.09.

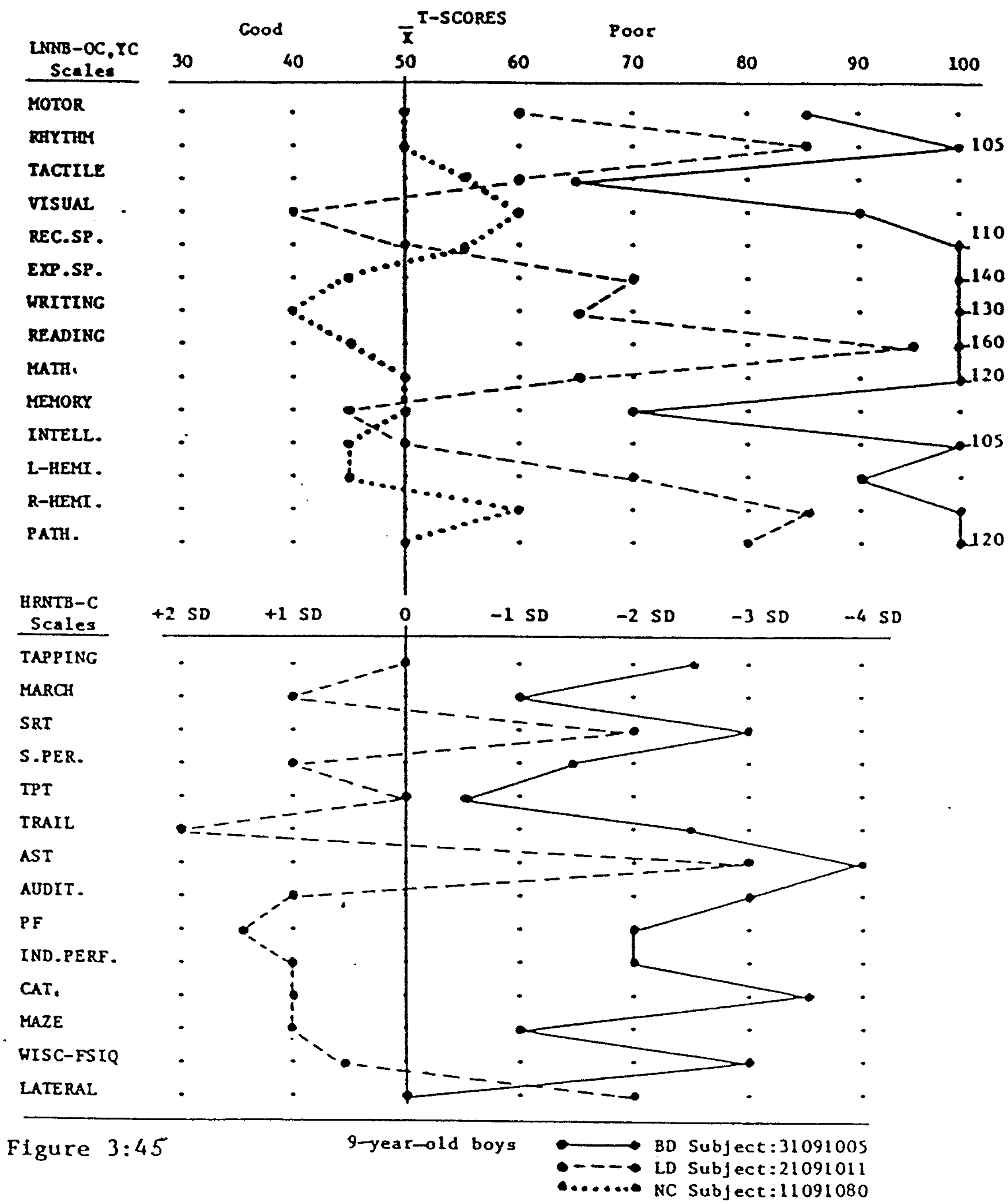


Figure 3:45

Independent diagnostic findings

BD: Auto accident with head injury to the left-parietal/temporal region. Very poor performance in most school subjects. Impairment Ratio: MLNNB-OC=.82, HRNTB-C=.36.

LD: Basically a non-reader. Described by reading clinician as dyslexic. Impairment Ratio: MLNNB-OC=.18, HRNTB-C=0.

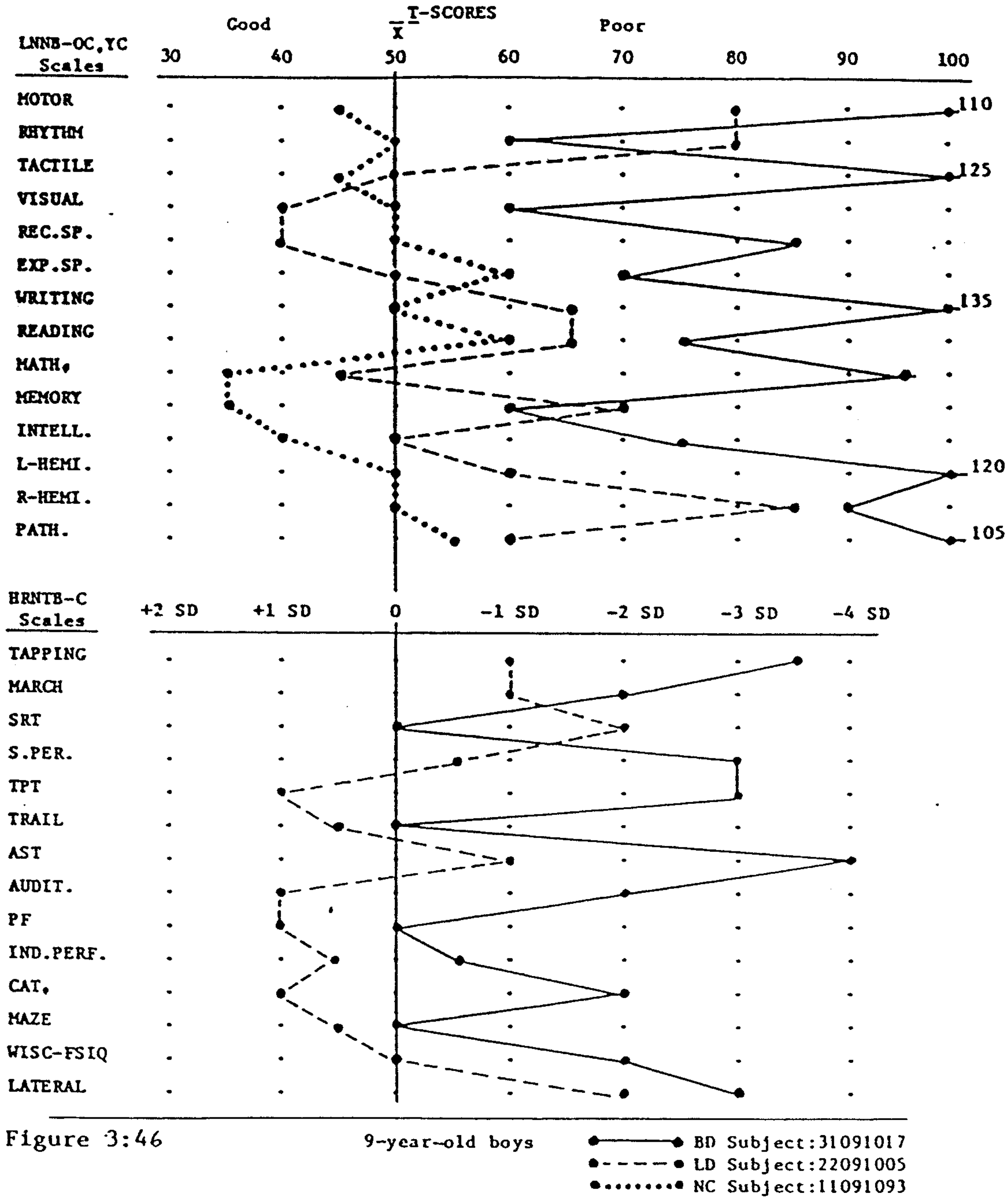


Figure 3:46

Independent diagnostic findings

BD: Auto accident, penetrating left head wound, with contrecoup. Impairment Ratio: MLNNB-OC=.45, HRNTB-C=.36.

LD: Poor in writing, reading, and language arts. Some attention deficits (currently on meds. Ritalin). Impairment Ratio: MLNNB-OC=.18, HRNTB-C=0.

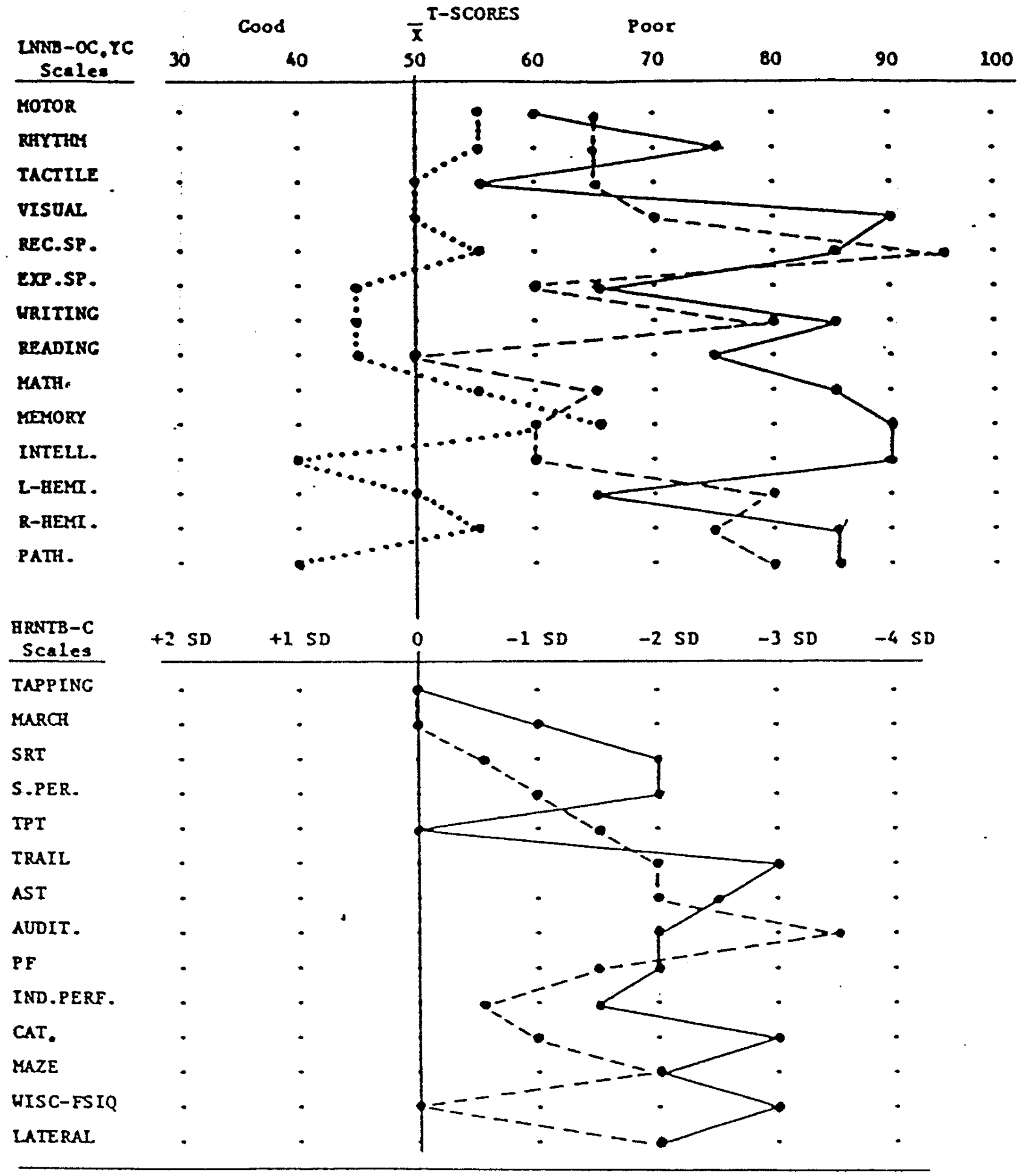


Figure 3:47

Independent diagnostic findings

BD: Carbon-monoxide intoxication. Poort school record over the last year. Impairment Ratio: MLNNB-OC=.54, HRNTB-C=.27.

LD: Language disordered child currently enrolled in language-disorders program at school. Impairment Ratio: MLNNB-OC=.18, HRNTB-C=0.

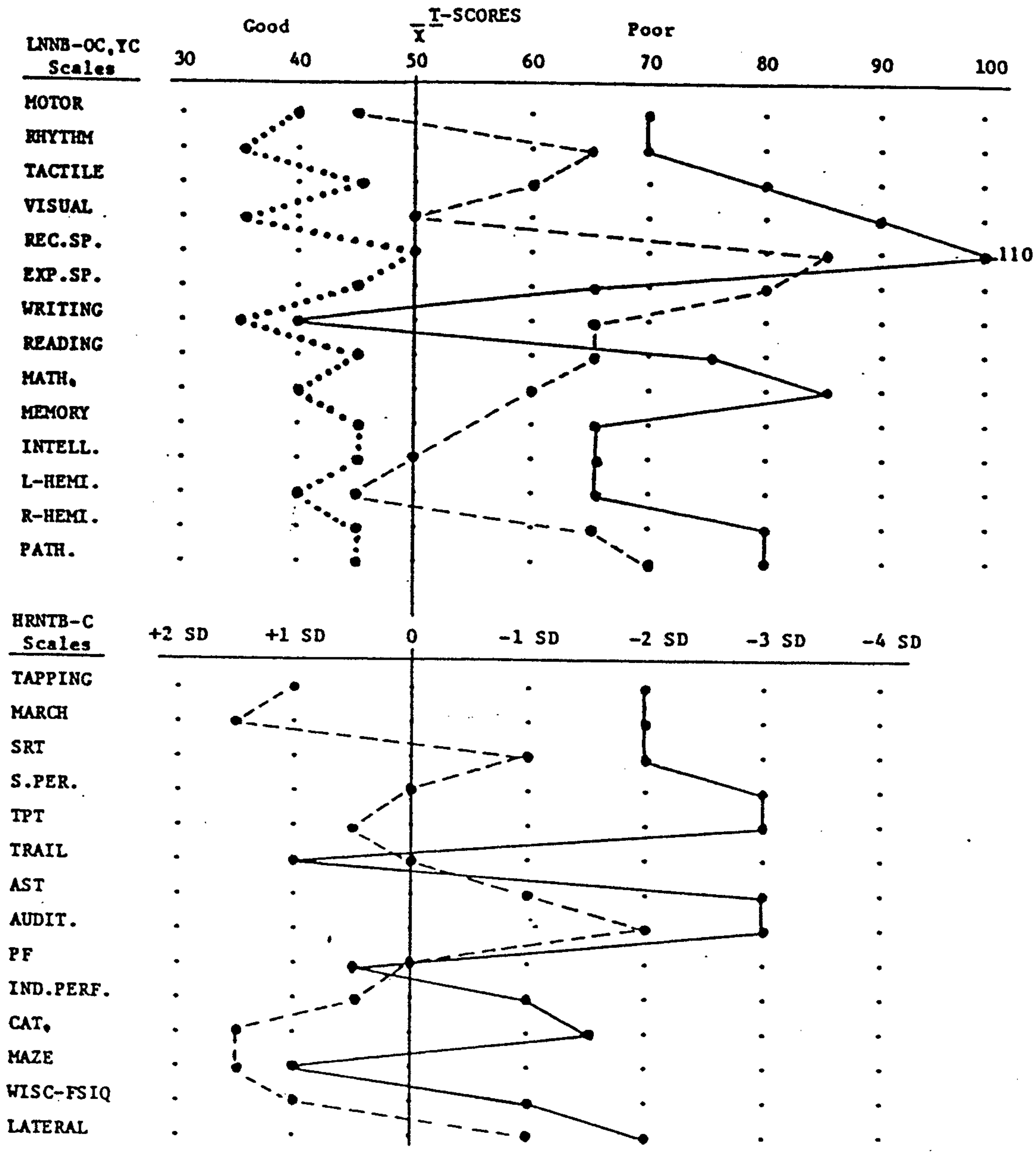


Figure 3:48

10-year-old girls
BD Subject:32101021
LD Subject:21101021
NC Subject:12101048

Independent diagnostic findings

BD: Auto accident with fracture (left side) & subdural hematoma. Impairment Ratio:MLNNB-OC=.36,HRNTB-C=.33.

LD: Language disorder and poor spelling skills. Impairment Ratio:MLNNB-OC=.18, HRNTB-C=0.

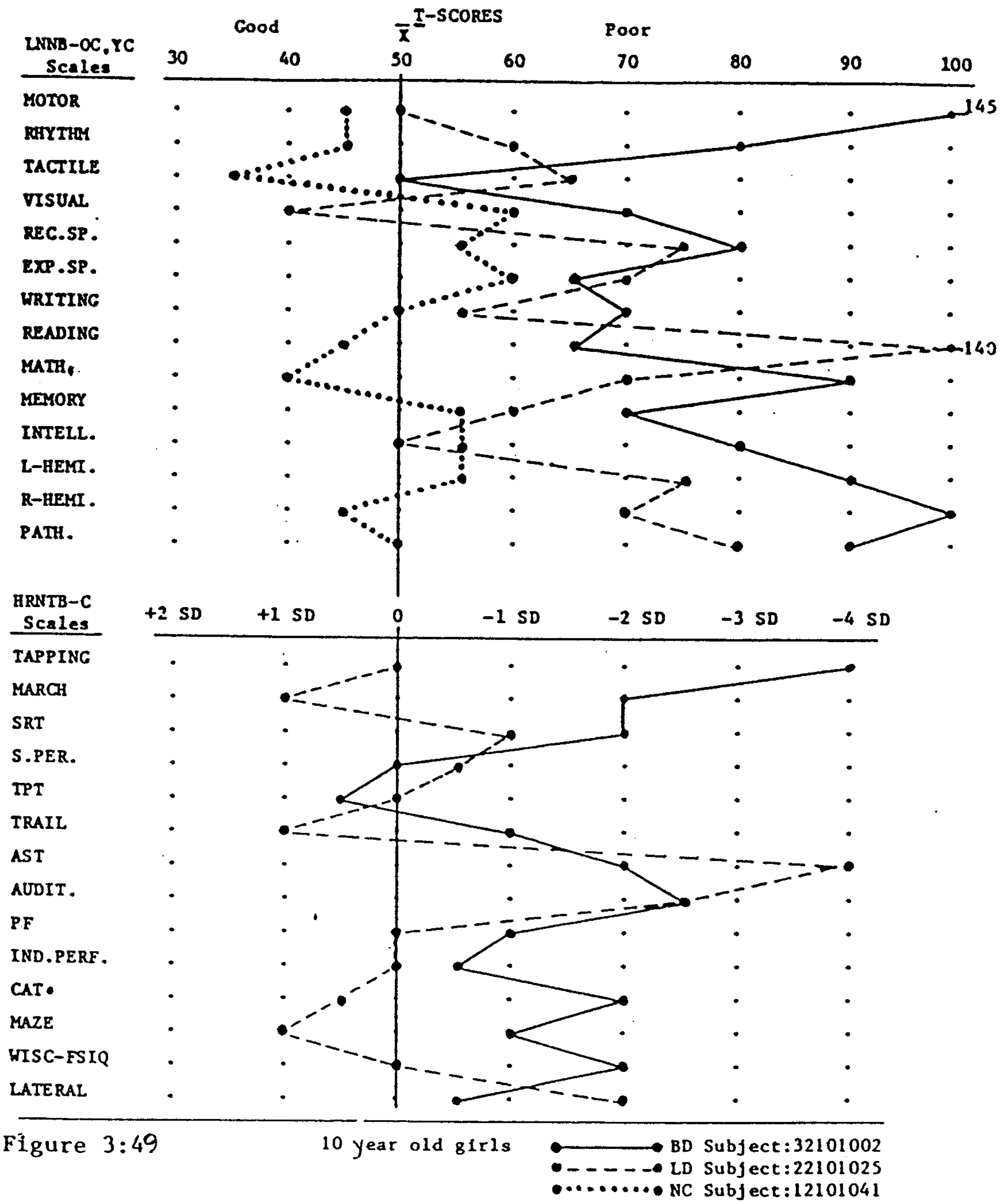


Figure 3:49 10 year old girls

Independent diagnostic findings

BD: Cerebral palsy. Impairment Ratio: MLNNB-OC=.45, HRNTB-C=.09.

LD: Non-reader. Receives resource help in reading 1 hr. per day. Impairment Ratio: MLNNB-OC=.09, HRNTB-C=0.

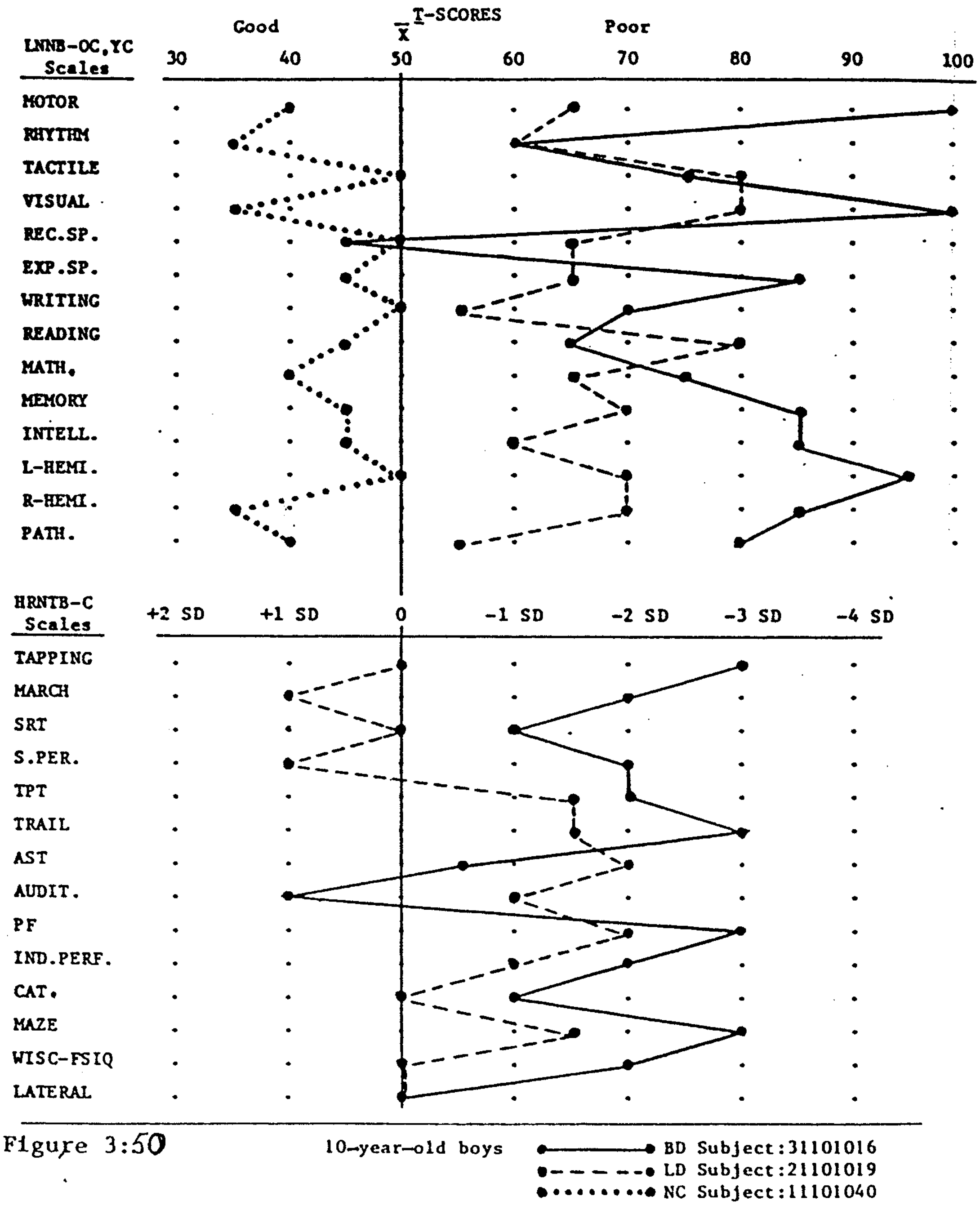


Figure 3:50

Independent diagnostic findings

BD: Multiple sclerosis. Impairment Ratio: MLNNB-OC=.45, HRNTB-C=.36

LD: Reading deficit. Also poor performance in language arts.
Impairment Ratio: MLNNB-OC=.27, HRNTB-C=0.

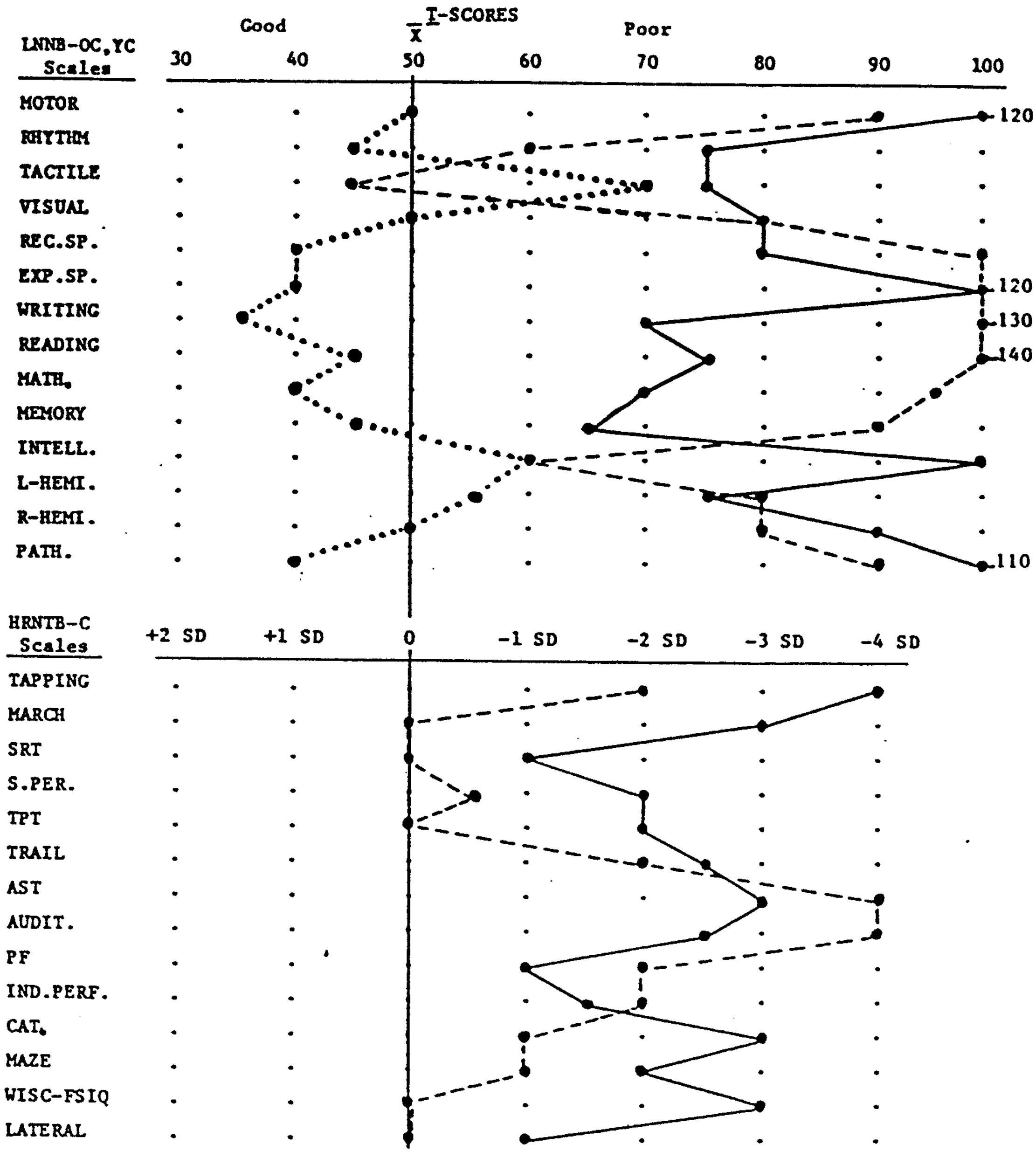


Figure 3:51

10-year-old boys
BD Subject:31101027
LD Subject:21101001
NC Subject:11101042

Independent diagnostic findings

BD: MBD (DMS III). Toxic injury (possible substance abuse). Impairment Ratio: MLNNB-OC=.45, HRNTB-C=.27.

LD: Visual-perceptual dysfunction. Very poor writing and math. skills. Also poor speech with many pronounciation errors. Impairment Ratio: MLNNB-OC=.54, HRNTB-C=.16.

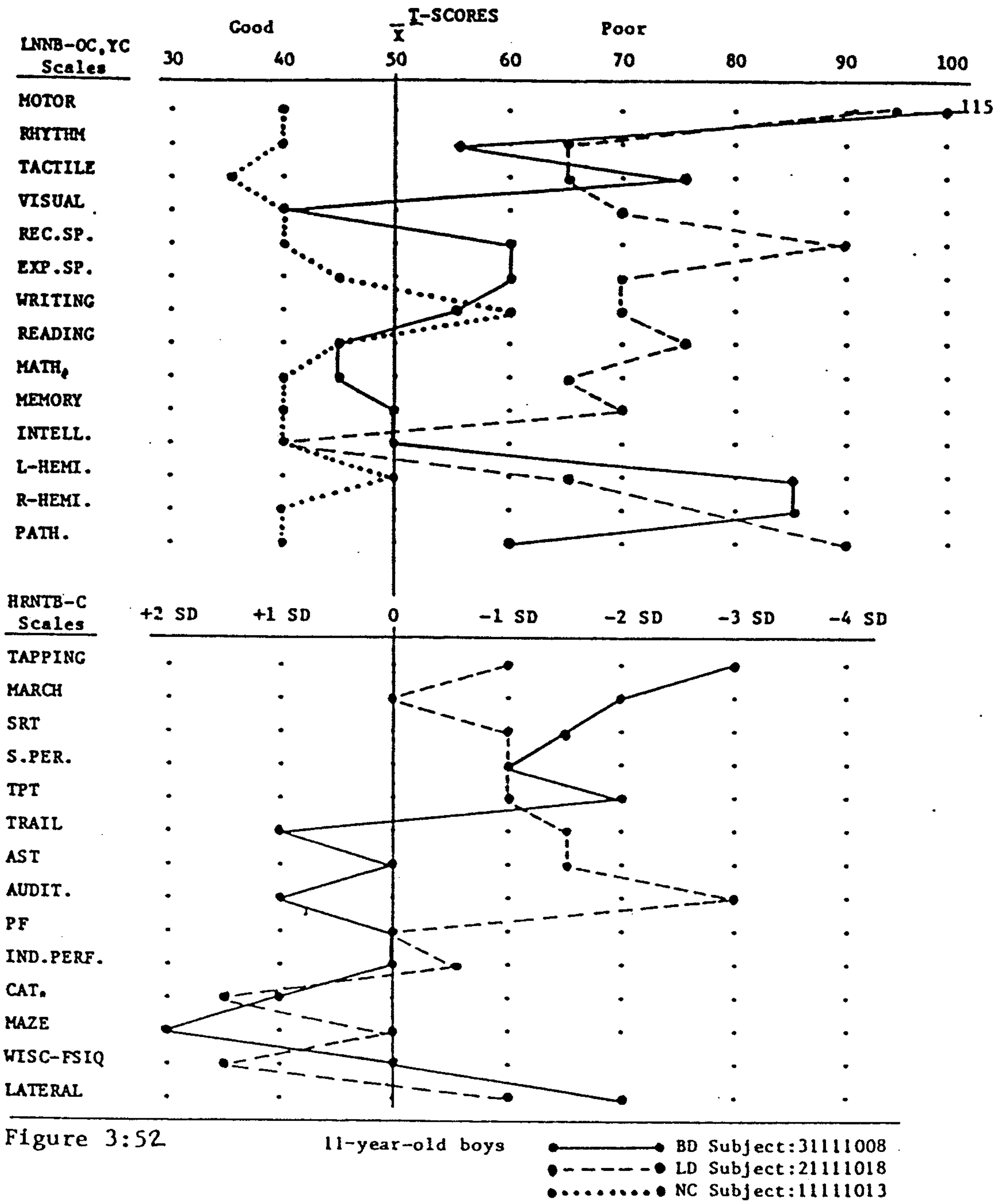


Figure 3:52

<u>*Independent diagnostic findings*</u>

BD: Multiple sclerosis with no visual deficits. Impairment Ratio:MLNNB-OC=.09, HRNTB-C=.08.

LD: Language disorder (primarily receptive according to speech and hearing clinician. Impairment Ratio:MLNNB-OC=.18,HRNTB-C=.08.

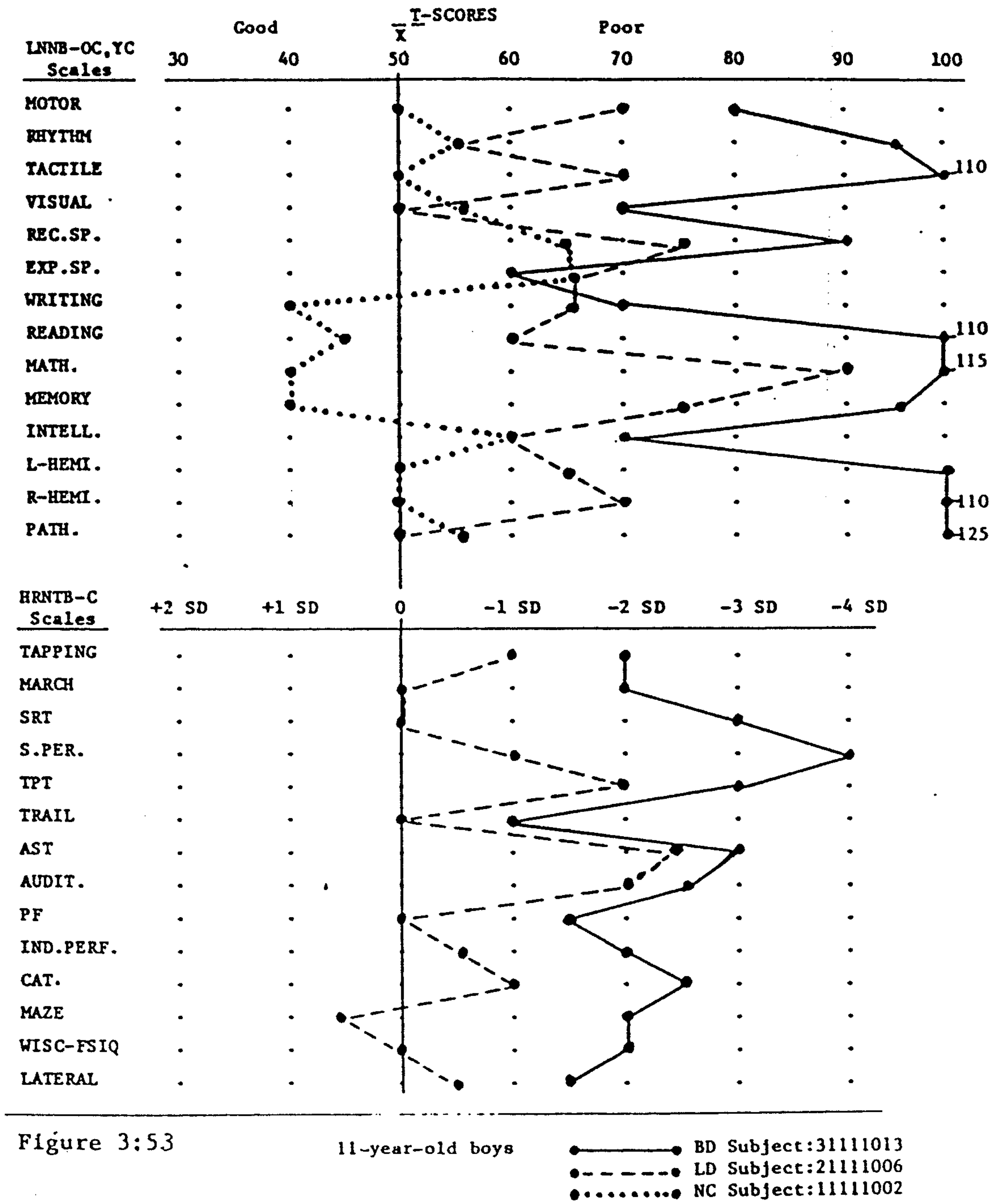


Figure 3:53 11-year-old boys

Independent diagnostic findings

BD: Subcortical tumor in parietal region. Very poor school performance in reading and arithmetic. Impairment Ratio:MLNNB-OC=.63,HRNTB-C=.36

LD: Clearly deficient in math despite recieving resourse help over the last three years. Impairment Ratio: MLNNB-OC=.09,HRNTB-C=0.

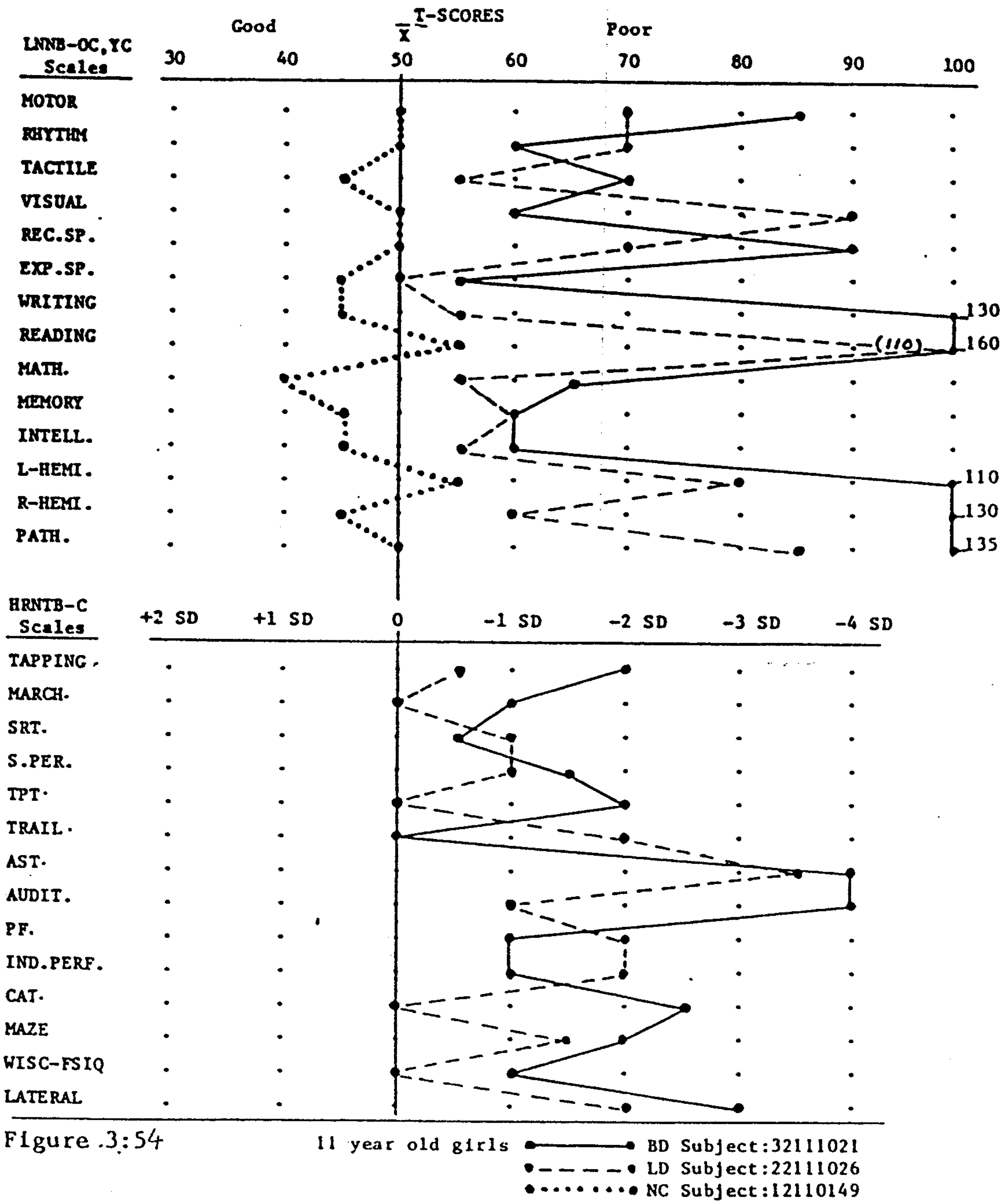


Figure 3:54

Independent diagnostic findings

BD: Tumor localized to right temporal/parietal area. Severe writing and reading problems in school. Impairment Ratio:MLNNB-OC=.36,HRNTB-C=.18.

LD: Severe reading deficits and some visual perceptual problems. Impairment Ratio: MLNNB-OC=.18,HRNTB-C=.08.

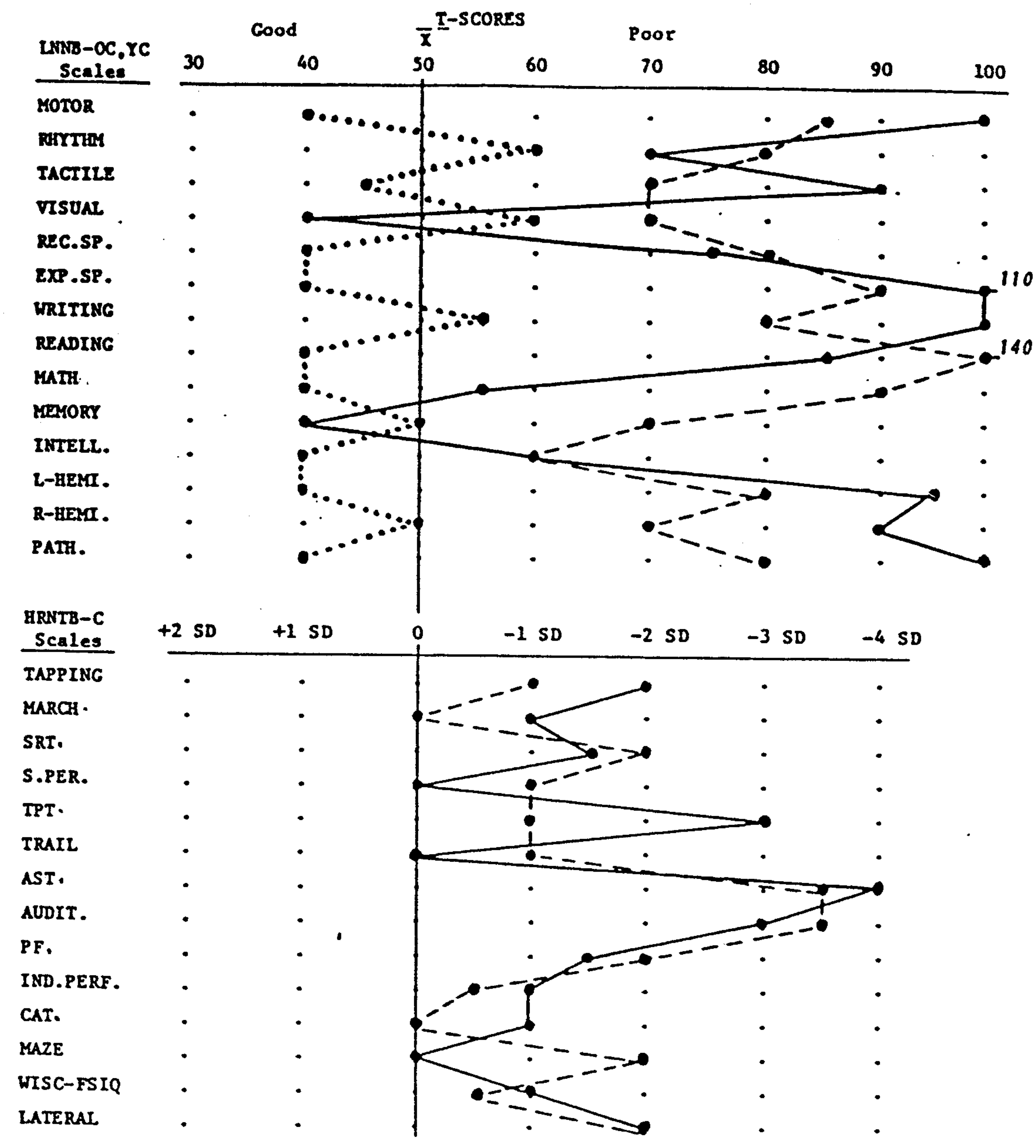


Figure 3:55 12-year-old boys

BD Subject:31121024
LD Subject:21121015
NC Subject:11121006

Independent diagnostic findings

BD: Head injury to left frontotemporal region. Writing and reading problems in school. Impairment Ratio:MLNNB-OC=.45,HRNTB-C=.27.

LD: Essentially a non-reader after several years of daily resource help in reading. Spelling is also very poor. Impairment Ratio:MLNNB-OC= .36, HRNTB-C=.16.

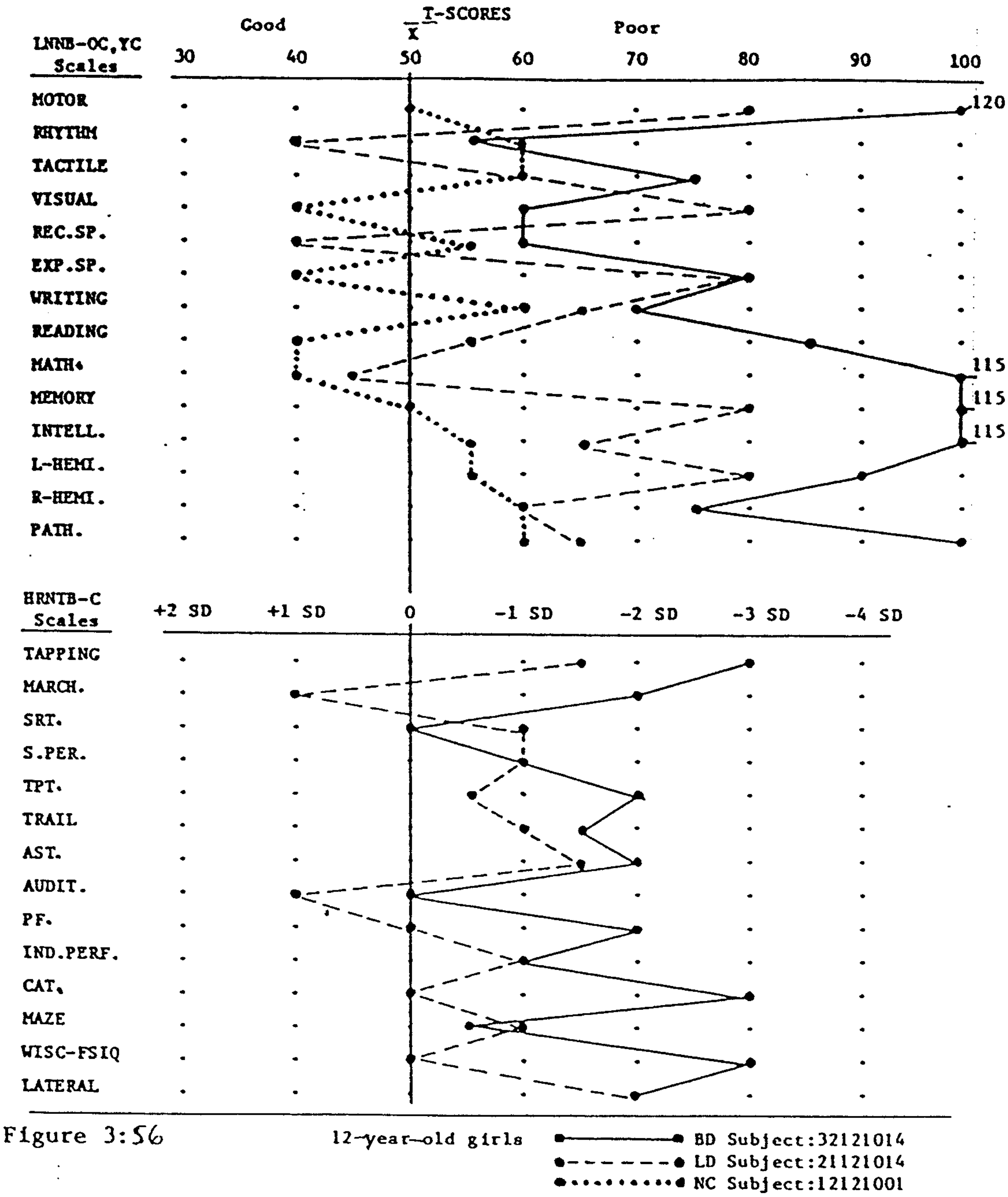


Figure 3:56

<u>Independent diagnostic findings</u>

BD: Post-encephalitic disorder. Poor school record due to memory losses. Impairment Ratio: MLNNB-OC=.45, HRNTB-C=0.

LD: Very poor writing skills and visuo-spatial spelling errors. Impairment Ratio: MLNNB-OC=.27, HRNTB-C=0.

APPENDIX E

E.1 Results of factor analyses on the MLNNB-YC, -OC.

The factor analytic explorations had two major objectives:
a) Exploratory: to discover groups of items which form clusters of significant intercorrelations and to generate scales which are psychometrically more meaningful than the present MLNNB scales.
b) Confirmatory: to check whether or not the present grouping of items into MLNNB scales results in factorially homogeneous variables. It should be remembered that the present grouping of MLNNB items into the scales labelled by Golden and his coworkers (Golden et. al, 1981) was not based on factor analysis, but on apparent psychological similarity.

All three groups (i.e., NC, BD, LD) were pooled in order to increase the number of data sets and to achieve maximum score variability. Thereafter, all MLNNB items were intercorrelated to generate a 149x149 correlation matrix. Inspection of this correlation matrix (not reported for reasons of size) shows that most items of a given scale show significant intercorrelations with each other, but showed nonsignificant intercorrelations with items from other scales. In fact, significant correlations between items belonging to different scales were rarely seen, suggesting that the major scales would be factorially independent of one another. The correlation matrix suggests that the present grouping of items into scales seems meaningful and justified. The principal axes factor structure (not reported for reasons of size) supports the same conclusion, in that items of the same scale tend to have significant loadings on the same factor.

The next analyses involved items associated with individual scales. Using the pooled sample (NC, BD, LD) only items of a given scale were intercorrelated. The inspection of the correlation matrix of a given scale usually showed that some items in the scale did not correlate significantly (r < .15) with any other items of the same scale. These items were judged to be factorially independent and were then eliminated from the correlation matrix. The correlation matrix of the remaining items was then factor analyzed. All 11 major scales were separately analyzed in the following way: Squared-multiple correlations were used as communality estimates in the diagonal. The principal-axes matrix was calculated. Several criteria were used to determine the number of factors in a given scale: a) The eigenvalues of the last common factor should exceed 1.00. b) The last common factor should account for the proportion of the variance equivalent to that of about 2 variables, e.g., in the case of 34 items, to about 6% of the variance. c) The number of significant loadings (i.e., loadings greater than + or -.40) of the last common factor should be at least equal to that of the rank order of the factor, e.g., in a 3-factor solution, common factor 3 should have at least 3 significant loadings. d) Graphs plotting eigenvalues against factor number should show a change in slope at the level of the last common factor. e) Items with significant loadings on a given common factor should have significant intercorrelations with each other. In most cases, the criteria agreed well with each other as to the number of factors in a given scale. Items which did not load significantly on any common principal-axes factor were identified and considered to be factorially independent. Thereafter, only those items which loaded significantly on a given principal axes factor were factor analyzed again. Items with significant loadings resulting from this second factor analysis were judged to constitute a group of factorially "pure" items and could be combined to form a new psychometrically meaningful scale. The table below gives the results of the above analyses showing the groups of items (identified by number) which form a factorially pure scale.

Table E

GROUPS OF ITEMS FORMING FACTORIALLY PURE SCALES.

Scale Name	Factor	Items with Significant*Loadings
Motor	1	1,2,3,4,5,6,7,16,17,18,29,31
	2	22,24,26,28,30,32
	3	8,9,10
Receptive Speech	1	67,68,69,73,75,78,79,80
	2	81,82,83
Expressive Speech	1	89,90,91,92,93,99,100,101,102,103,104
	2	85,87,96
	3	97,98
Rhythm		35,36,37,38,39,40,41,42
Tactile		43,44,45,46,49,57,58
Writing		105,106,107,108,109,110,111
Reading		112,114,115,116,117,118
Arithmetic		119,120,121,122,123,124,125,126,127
Memory		128,129,131,132,134,135
Intellectual Process		136,141,142,143,144,145,146,147,148

*Factor loadings greater than + or -.40 were judged to be significant.

Three scales, i.e., Motor, Receptive Speech and Expressive Speech turned out to be multidimensional in the sense that they had more than one common factor. The remaining 7 scales yielded one-factor solutions and may, therefore, be regarded as being unidimensional. The interpretation of the factors of multidimensional scales was based on examination of items associated with that factor and should be regarded as tentative.

The first factor of the Motor Scale appears to represent simple elementary motor functions, such as test items requiring hand movements dependent upon kinesthetic feedback, or visual and auditory cues. The second Motor factor appears to reflect qualitative aspects involved in the production of geometric figures (graphic items) and may be regarded as being indicative of construction praxis. Items 8,9,10 contributed to the third motor factor which seems to require crossing of the midline of the body (i.e., right-left discrimination, touching-the-left- ear-with-the-right-hand, and pointing-to-right-eye-using-the-left-hand).

The first factor of the Expressive Speech scale appears to represent the "predictive" and "reproductive" (Luria's terms) forms of speech and the articulation of speech sounds. The second factor appears to reflect a higher-order speech involving more complex speech functions. The items associated with the third factor require serial ordering and reflective forms of speech.

The Receptive Speech scale generated two factors. Eight items loaded significantly on the first factor, while only three items loaded on the second factor. The first factor appears to represent elements of identification and classification of words, objects, and cues. Factor two involves items which tap into logical grammatical structures, such as attributive, comparative and inverted constructions.

The seven scales with single-factor solutions appear to have an underlying dimension suggested by the scale name. It should be noted that these scales also have some items which are factorially independent of these underlying dimensions. The tentative results emerging from the factor analyses provide some justifications for Golden's grouping of items into scales. They also suggest that future factor analyses based on large samples of BD children may suggest groupings of items which form factorially purer scales than the present scales.