VALIDATION OF A PRELIMINARY SCREENING PROCEDURE FOR THE
IDENTIFICATION OF NONVERBAL LEARNING DISABILITIES (NLD) IN
SCHOOLS: A PARENT RATING SCALE

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CHAPTER 1

INTRODUCTION

General Description

*Prevalence of Nonverbal Learning Disabilities (NLD)*

The prevalence rate of learning disabilities among school children in the United States has been reported by Smith and Adams (2006) to approximate 4-6% (Learning Disabilities Association), 7.7% (U.S. Department of Health and Human Services-Centers for Disease Control and Prevention, 2002), and 6.1% (U.S. Department of Education, National Center for Education Statistics, 2005). Blanchard, Gurka, and Blackman (2007) estimated learning disabilities at 9.7% as the most commonly diagnosed emotional, developmental, or behavioral problem of children aged 0 to 17 years in the U.S. In effect children with learning disabilities constitute approximately half of school children receiving special education. Of every 10 children with a learning disability (LD), one has been identified with nonverbal learning disabilities (NLD) (Little, 2002).

According to the Nonverbal Learning Disorders Association (NLDA) (2005), a non-profit corporation advocating for NLD, the assets and deficits of each individual with NLD are manifested in different combinations and different intensities although most of them share the basic configuration of relative impairment in social perception, visual-spatial abilities, and mechanical arithmetic, with well developed verbal skills and rote memory. Rourke (1989) estimated the prevalence of NLD within the LD clinic population at 5% to 10%. The syndrome represents between 0.1% and 1.0% of the entire general population of the U.S, with an overall ratio of male to female of approximately 1.2 to 1.0 (Pennington, 1991; Zillmer & Spiers, 2001). More recently, Rourke (2006n)
increased the prevalence estimate of NLD to 18% of the LD population.

However, few professionals have been trained to assess NLD and it is likely that current incidence percentages may be a gross underestimation (Forrest, 2004). Although LD is heterogeneous, presenting a range of learning styles and diverse areas of strengths and weaknesses, the diagnosis has been perceived by most laypeople and many teachers to mean difficulties in reading (Semrud-Clikeman, 2005). This misperception could be traced to the considerable progress that has been made in the area of verbal learning disabilities, but nonverbal deficits have been less recognized in both children and adults (Myklebust, 1975). In schools, few educators are expected to have a working knowledge of NLD (Thompson, 1997). Hence it is suspected that the incidence of NLD could be as high as one-third of children identified with learning disabilities (Elksnin & Elksnin, 2004; Palombo, 2006). Whitney (2002) indicated that NLD is now thought to be as prevalent as dyslexia. It is expected that as school assessment and intervention procedures improve, a higher proportion of children will be identified with NLD (Thompson, 1995).

**The Concept of Nonverbal Learning Disabilities (NLD)**

The concept of nonverbal learning disabilities as a neuropsychological disorder has been developed largely during the past 40 years by the ongoing empirical investigations of Byron Rourke, who hypothesized the etiology of NLD in the “white matter” model as well as the hierarchical conception of the syndrome. The “white matter” model states that the disorder will be manifested to the extent that white matter (long myelinated fibres) in the brain is underdeveloped, damaged, or dysfunctional (Rourke 1995a). Furthermore, the NLD syndrome is apparent in many individuals who have
significant perturbations of right cerebral hemisphere (Rourke, et al., 2002). Children with NLD are a heterogeneous group who are currently conceptualized, according to Rourke’s model, as exhibiting primary or core neuropsychological deficits in tactile perception, visual-spatial-organization, psychomotor functioning, and novel problem solving skills. Their neuropsychological assets are evident in most areas of auditory perception, auditory attention, and auditory memory, especially for verbal material (Rourke et. al., 2002). Rourke’s hierarchical concept of the developmental dynamics (causes and effects) of the NLD syndrome hypothesized that these primary neuropsychological assets and deficits lead to secondary, tertiary, and verbal assets and deficits. The interaction of these neuropsychological assets and deficits eventuate directly in a particular pattern of academic, psychosocial and adaptive abilities and deficiencies (Rourke & Tsatsanis, 2000). According to Myklebust (1975), nonverbal disturbances present more debilitating problems than verbal learning difficulties.

*Psychosocial deficits in NLD.* In her literature review of NLD, Little (1993) found some support for the notion that individuals with NLD may be at greater risk than other individuals with learning disabilities for both internalizing and externalizing emotional, behavioral, or social problems. Manifestations of socioemotional disturbance have been reported to be significantly and markedly greater in children and adolescents with NLD than in other subtypes of learning disability (Rourke, 1988; Rourke, Young & Leenaars, 1989). Of particular concern is evidence that students with NLD may be at increased risk for withdrawal, loneliness, and suicide during their adolescent and young adult years (Rourke, 1995a; Telzrow & Bonar, 2002). Thus, it appears that serious consequences
may arise if a child with NLD fails to be diagnosed at an early age and interventions promptly put in place.

*Identification of Children with NLD in Schools*

Thompson (1997) pointed out that our existing school system tends to discriminate unfairly against children with NLD, adding that most do not currently receive adequate services, and therefore, do not receive a free and appropriate public education. The problem could be traced to the absence of legal or formal recognition of NLD. Under the Individuals with Disabilities Education Act (IDEA), currently it would be unlikely for a student with NLD to qualify for special education services under the IDEA regulations for identification of specific learning disabilities, although he or she could meet the criteria for LD in mathematics calculation and problem solving, listening and reading comprehension, written expression, and perceptual disabilities. The student with NLD may also qualify for language impairment under the IDEA regulations for speech or language impairment. Similarly, Section 504 of the Rehabilitation Act of 1973 - a federal law designed to protect the rights of individuals with disabilities - does not specifically address the needs of the student with NLD. Neither is NLD ‘officially’ recognized by American Psychiatric Association (APA) in the Diagnostic and Statistical Manual of Mental Disorders-Fourth Ed., Text Revision (DSM-IV-TR).

The legislative and APA exclusion of NLD may contribute to the misdiagnosis of the disorder. Difficulties of identification are compounded by the complexities of comorbidity with ADHD, emotional and behavioral disorders; of overlapping of symptoms with other disorders such as Williams syndrome and Asperger’s Syndrome; and of the greater risk of the adolescent with NLD in developing anxiety disorder and
depression. It is therefore not surprising that the disability would easily be wrongly identified or overlooked in schools. From his clinical experience, Palombo (2006) noted that children with NLD often arrive for an initial assessment after being previously evaluated by a variety of professionals and having received a variety of diagnoses and interventions. Apparently little progress has been made to date in diagnosing and servicing students with NLD.

Our school system could do more for children with NLD, schools being one of the two most important environments influencing their development. Because of the pervasive and debilitating nature of the disability, educators should not wait for these children to fail and present an adequately large discrepancy between their standardized intelligence and achievement test scores before meeting eligibility requirements for special education services. Presently NLD is considered by schools as either a medical diagnosis or a severe disability that requires identification by medical or clinical practitioners knowledgeable of the disability. Nevertheless, professionals within the schools, specifically the school psychologist, share in the duty with parents for the early assessment and intervention of children with NLD. The major obstacle in the process of identifying these children is the lack of screening techniques designed specifically for NLD detection in schools.

**Availability of Screening Measures for NLD Identification in Schools**

*The Pupil Rating Scale: Screening for learning disabilities (PRS).* An extensive literature search revealed only one published comprehensive screening scale that alludes to NLD - The Pupil Rating Scale: Screening for Learning Disabilities (Myklebust, 1971). The Pupil Rating Scale (PRS) was developed for rating by the regular classroom teacher
to identify students with learning disabilities, which Myklebust has shown to be suitable as a screen for nonverbal deficiencies (Myklebust, 1975). Of the five areas of verbal and nonverbal behaviors included in the Pupil Rating Scale (PRS), *Orientation, Motor Coordination, and Personal-Social Behavior* items were combined to provide a single score for nonverbal learning, which match closely with those that have been identified by Rourke et al. (2002) as elements of the NLD syndrome, namely deficits in tactile perception, visuospatial perception, psychomotor coordination, and socioemotional functioning. Furthermore, the PRS items for *Auditory Comprehension* and *Spoken Language* were combined to provide a single score indicative of verbal learning that approximates Rourke’s factors of auditory perception and verbal assets and deficits. The PRS was validated with teachers’ ratings obtained from a research sample of 2,176 children in third and fourth grades of four large suburban school systems. Myklebust’s screening Scale is therefore limited to teacher’s observations and a normative population in the 70’s and age range of around 8 to 9 years old.

Other screening procedures. However, more recent measures which purport to screen for NLD do not cover the dimensions of NLD comprehensively as does Myklebust’s PRS. For example, Cornoldi, Venneri, Marconato, Molin, and Montinari (2003) developed the Shortened Visuospatial Questionnaire (SVS) to screen for students with deficits in visuospatial abilities, while the Diagnostic Analysis of Nonverbal Accuracy (DANVA) (Nowicki & Duke, 1994) was designed to assess children’s ability to send and interpret nonverbal cues, such as facial expressions, gestures, and tone of voice, for four basic emotions. The DANVA could be used to clarify the social perception deficits presented by children with NLD (Petti, Voelker, Shore & Hayman-
Abello, 2003). Since the DANVA is confined to measuring the socioemotional aspect of NLD, it is inadequate in describing the range of NLD assets and deficits. Similarly, DANVA FACES 2 (Nowicki & Carton, 1993), DANVA2-Posture Test (Pitterman & Nowicki, 2004), DANVA2-Child Paralanguage (Rothman & Nowicki, 2004) and DANVA2-Adult Prosody (Baum & Nowicki, 1998) tapping various aspects of nonverbal communication i.e., facial expressions, postures and prosody, are not omnibus screening instruments for the NLD syndrome.

Parents, an Invaluable Resource for NLD Identification and Intervention

The current situation provides the impetus to develop a parent rating scale as a brief and inexpensive screening procedure for an initial and informal assessment of NLD for use by school psychologists in collaboration with parents. This is consistent with regulations that recognize the role of parents as part of the multidisciplinary special education team. Parent feedback and information are necessary for a comprehensive multi-assessment and multi-modal evaluation for special education services. Given the complexity of the NLD syndrome, the importance of developmental history, and the common difficulties in securing adequate services for children with NLD, it is necessary to involve parents in the evaluation. Parents’ participation helps to demystify assessment procedures, avails the parents of shared information, and fosters parental understanding of their child's condition. The informed parent can then understand and support the programs of intervention offered in school.

The school psychologist is expected to use the parent rating scale in conjunction with other tools that access information of the child from teachers. The parent rating scale is designed to be used only for screening purposes to alert the school psychologist to the
possibility of NLD, so that referrals could be made to clinicians, such as the neuropsychologist, who may pursue further with appropriate diagnostic tests.

Problems and Purpose of Research

The Evolving Concept of NLD

The main reason for the lack of progress made currently in the identification and servicing of children with NLD may be attributed to the fact that our understanding of the concept of the disability is still evolving (Denckla, 1991; Keller, Tillery, & McFadden, 2006; Myklebust, 1975; Palombo, 2006). One of the first descriptions of NLD defined by Johnson and Myklebust (1971) was in terms of social-skill deficits in learning-disabled children (Semrud-Clikeman & Hynd, 1991). Myklebust (1975) observed other problems, such as visual cognitive processing (perception deficits unlikely), storage (versus recall) of imagery and memory, visual-spatial processing and motor deficits. He found far more abnormal electroencephalograms (EEG’s) present in the NLD population compared to the verbal disabled, and noted that the basic disability presented by children with NLD is disturbed social relationships. In addition, arithmetic deficits were included in this original definition of NLD by Johnson and Myklebust (1971).

Several studies followed that supported the notion that nonverbal social-emotional difficulties as well as arithmetic deficits are related to right-hemispheric dysfunction, given that both involve the manipulation of imagery, visuoperception and spatial processes (Badian, 1983; Denckla, 1978; D. Tranel, Hall, Olson, & N. N. Tranel, 1987; Voller, 1986; Weintraub, & Mesulam, 1983). In her investigation of dyscalculia and nonverbal disorders of learning, Badian (1983) indicated the need for greater specificity in research on learning disabilities, while presenting a model for types of developmental
dyscalculia which has implications for researchers when reporting arithmetic deficits in children with NLD.

Byron Rourke and his colleagues have contributed extensively to our understanding of NLD through their empirical research on learning disabilities since the 1970’s (Rourke, 1978, 1989, 1991, 1995a). The subjects of their early studies were chosen solely on their patterns of reading, spelling, and arithmetic achievement scores. Rourke and Finlayson (1978) delineated the subtype nonverbal perceptual-organization-output-disabled (NPOOD) that characterized children with average to above average ability in reading and spelling reflecting verbal/language strength and significantly weaker arithmetic skills coupled with visuospatial deficits. These children were found to have difficulties interpreting nonverbal social cues and integrating new situations with previous learning. Their social relations tended to be stereotyped, and their speech monotonic and flat (Ozols & Rourke, 1985; Rourke, 1982). Strang and Rourke (1985) found that NPOOD children showed a significantly different profile on the Personality Inventory for Children (PIC) that is more suggestive of psychopathology than that of children with verbal learning disability. NPOOD was the precursor to NLD.

By the late eighties, there was mounting evidence that “children with right-hemisphere disabilities” were suffering social ostracism, emotional distress, and eventually poor vocational success. Semrud-Clikeman and Hynd (1991) voiced concern for their late identification and suggested that schools routinely screen children for social readiness through parent questionnaires and observations of their social skills in the classroom. The researchers noted the scarcity of data for carefully defined subtypes of learning disabilities, particularly nonverbal learning disabilities, and called for the
diagnosis of social and learning difficulties to be more fully validated empirically.

In this respect, advances were made on NLD identification in the nineties by Rourke and his colleagues in their attempts to validate the subtypes of learning disability within an explicitly neuropsychological and developmental framework (Rourke, 1991). The results indicated that although the NLD typology possessed clinical validity with functional abilities and deficiencies clearly delineated, the typology’s success at correctly identifying individuals remained speculative. The researchers hypothesized that because some features of NLD are pathognomonic (e.g., severely impaired performance on tasks of speeded eye-hand coordination and fine finger dexterity with the left hand) whereas others may not be as predictive (e.g., the presence of an arithmetic disability), the weight placed on the individual features is influential to some extent for the anomaly. They suggested that it was more likely that there exists a subset of the features that best serve to identify individuals considered to exhibit the NLD syndrome, and further empirical investigations are needed to establish the typology’s construct validity (Casey & Rourke, 1991).

Soon after, Little (1993) conducted a literature review of investigations on learning disabilities. She concluded that a NLD subtype, that includes deficits in performance and/or visuo-motor skills, weaknesses in arithmetic computation and reading comprehension (but not reading decoding), strengths in rote verbal abilities, and difficulty solving nonverbal problems, is a fairly robust finding. However, she found socioemotional functioning and social skills more difficult to establish.

Further inroads were made by Rourke and his colleagues when they attempted to identify the principal features of NLD (Harnadek & Rourke, 1994), and establish
classification rules for NLD identification of older (ages 9-15) and younger (ages 7-8) children (Drummond, Ahmad & Rourke, 2005; Pelletier, Ahmad & Rourke, 2001). The results indicated that tests for tactile imperception would identify older children with NLD majority of the time, whereas visual-spatial-motor deficits would identify most of younger children. However, as with all research on NLD, the generalization of these results is limited by sample selection biases and small sample size. Drummond et al. (2005) indicated that the identification criteria needed refinement.

Of late proposals have been made to delineate subtypes of NLD in view of the diversity of symptoms (Palombo, 2006). Forrest (2004) found the current NLD criteria to be too broad and difficult to apply clinically and suggested creating NLD categories of visual-spatial disability and social processing disorder. In his recent discourse on NLD, Palombo (2006) focused on the social features of NLD and noted the challenge ahead to find measures to assess the weight to be given to each factor that contributes to the social and emotional behaviors of children with NLD. Rourke (2006d), however, disagreed and pointed that no studies so far have indicated subtypes of NLD, and suggested that the variations in the expression of NLD may be reasonably considered as mild, moderate, and severe manifestations of NLD at any particular developmental stage.

Despite uncertainties among some researchers (Ellis & Gunter, 1999; Forest, 2004; Palombo, 2006; Schultz, Romanski, & Tsatsanis, 2000), Rourke’s hypotheses of NLD are presently widely accepted and applied (McDonald, 2002). The bulk of empirical studies on NLD today were carried out by Rourke and his colleagues over the past forty years. Many of the conclusions and generalizations were arrived at as a result of their studies that have consistently focused on subgroups of children chosen solely on the basis
of specific variations in patterns of academic performance (Rourke, 2000). Over the years Rourke was able to develop his concept of the NLD syndrome based on empirical evidence from studies using the same research methodology. Rourke’s current conception of the NLD syndrome and his “white matter” model appear to be capable of explaining the multiple and complex outcome behavioral characteristics of NLD.

Problems of Empirical Investigation in NLD

The problems that plague all studies of children with NLD are the low incidence of the disorder, sample selection bias, and difficulty of obtaining a sufficient sample size as well as the lack of appropriate tests for measuring the presumed deficits (Petti, Voelker, Shore, & Hayman-Abello, 2003). The limitations of Rourke’s investigations may include the use of clinical referred samples, employment of selection criteria and profile, restricted age range studied, and the use of original assessment tests that have since been revised (Pelletier, Ahmad, & Rourke, 2001). Denckla (1991, p. 723) indicated the need to employ “large unselected nonclinical populations of males and females of many ages in a developmental framework…”

Other difficulties encountered in research resulting in misclassification of subjects include the heterogeneous presentations of NLD characteristics over the life span; frequent comorbidities with other disorders such as ADHD, anxiety and depression; “look alike” or overlapping characteristics with Asperger’s Syndrome, High-Functioning Autism, Hyperlexia, and Williams Syndrome; and the number of etiologies in which NLD is evident, such as seizure disorder, early hydrocephalus or Turner Syndrome.

According to Palombo (2006), although there is consensus among investigators supporting the conditions of nonverbal learning disabilities, there is much debate on the
definition of the construct, and its validity remains a work in progress. This less than desirable situation as noted by Palombo (2006) summarily concludes the section of this research that has attempted to show the evolving concept of NLD over four decades in an effort to explain the slow progress in and dearth of screening measures for the identification of children with NLD in schools.

**Purposes of Research**

The purpose of this research is to design a screening procedure in the form of a parent rating scale that can be used by school psychologists as one of the preliminary procedures towards a referral for NLD diagnostic assessment. The second purpose of research following the construction of the parent rating scale is to determine its validity and reliability in screening for nonverbal learning disabilities.

The research shall involve identifying the constructs and the impact of each contributing to the deficits as well as assets that characterize children with NLD. The formulation of the screening scale shall be based on experimental evidence gleaned from research; current practice of specialists/clinicians who are familiar with children with NLD; and information from NLD association, NLDline website, and the networking of parents of children with NLD support groups.

The experimental sample shall consist of parents of children who have been given a medical diagnosis of NLD in a clinical setting by clinicians such as neuropsychologists, pediatric neurologists or clinical psychologists. The parents and their children with NLD would most likely be members of support groups formed under the auspices of non-profit organizations such as NLDline and Nonverbal Learning Disorders Association (NLDA). Instead of a control group with verbal learning disabilities or phonological dyslexia as
found in practically all studies on NLD by Rourke, an Asperger’s Syndrome (AS) group shall be used to test the sensitivity of the parent rating scale in differentiating NLD from Asperger’s Syndrome (AS) in view of their several shared characteristics (Klin, Sparrow, Volkmar, Cicchetti, & Rourke, 1995). This sample shall also consist of parents of children who have been given a medical diagnosis of Asperger’s Syndrome (AS) in a clinical setting. The reason for choosing Asperger’s Syndrome (AS) over a verbal learning disabled group is a very practical one, since it is more likely in school for a child with NLD to be misdiagnosed with Asperger’s Syndrome (AS) than with verbal learning disability. The second control group is non-learning disabled, consisting of parents of children who have never been given a medical or specific learning disabilities (LD) diagnosis which would qualify them for special education services.

Research Questions

The collection and analyses of data for the validation of the parent rating scale are to answer the following research questions:

1. Is the nonverbal learning disabilities (NLD) group significantly different from the non-learning disabled control groups on the parent rating scale? If so, what construct(s) on the parent rating scale most differentiate(s) the NLD group from the control group?

2. Is the NLD group significantly different from the Asperger’s Syndrome (AS) group? If so, what construct(s) on the parent rating scale most differentiate(s) the NLD group from the AS group?

Definition of Terms

The following definitions apply to this research project:
**Asperger’s Syndrome group:** Children and adolescents who have been given a clinical diagnosis of Asperger’s Syndrome and are showing major difficulties in social interaction and restricted and unusual patterns of interest and behavior.

**non-learning disabled (control) group:** Children and adolescents whose academic achievements are average in the classroom. They do not have a learning disability or other disorders and are not receiving special education or speech/language services.

**nonverbal learning disabilities group:** Children and adolescents who have been given a formal diagnosis of nonverbal learning disabilities (NLD) by clinicians such as neuropsychologists. The NLD group does *not* include individuals who have the syndrome much later in life after having enjoyed a normal early developmental course.

**Significance of Research**

The absence of a suitable screening scale for identifying children with NLD in schools lends significance to this research. All too often, these children are misdiagnosed and are either not treated at all, or are provided with inappropriate, counterproductive treatment (Whitney, 2002). The most common misdiagnosis which school assessment teams, lacking in knowledge of NLD, come up with is Severely Emotionally Disturbed (Thompson, 1997). Children with NLD are not ‘ED’, unless their disabilities are overlooked and they are left to fend for themselves. Little (2002) found that junior high school and high school children with Asperger’s Syndrome and NLD are at greatest risk for peer shunning, bullying and gang attacks because of their profound lack of social skills. By adolescence, children with NLD may withdraw (Rourke, 1995a), seeing their situations as hopeless, and feeling that no one understands. An extreme sense of hopelessness may lead to teen suicide (Rourke, Young, & Leenars, 1989).
On the other hand, the prognosis of children with NLD can be positive with early identification and the right interventions put in place. For this reason - that appropriate interventions do work and children with NLD can grow up to lead healthy and productive lives - all the more educators should familiarize themselves with the characteristics of NLD and be prepared to screen students suspected of the disability (Thompson, 1997). The sole purpose for an accurate diagnosis of NLD is so that special education services could be provided and appropriate intervention strategies implemented at home and in school. A major obstacle to NLD identification is that schools do not have a brief and inexpensive screening procedure which can be easily administered as a preliminary before referring the child suspected of NLD to the clinician for a full battery of neuropsychological tests that is both time consuming and costly. Schools could use Myklebust’s Pupil Rating Scale as a complementary teacher form, but bearing in mind that it was published in 1971 and the norm sample consisted of third and fourth graders only.

This research recognizes parents as a valuable source of information for an accurate diagnosis and considers parents as therapy partners. Thompson (1997, p. 21) speaks eloquently for parents of children with NLD: “Parents are in the best position to observe their child close at hand on a daily basis…No one knows the child better…than her parents. Pediatricians, teachers, and other professionals must take time to listen carefully to the concerns reported by parents that may indicate the presence of nonverbal learning disabilities.” During the development of strategies for interventions, Thompson (1997) urged educators to benefit from the knowledge parents have of their child by adapting the same strategies that have worked at home for more success in the classroom.
In summary, the reasons supporting and justifying this research to construct a parent rating scale as a preliminary screening procedure for the identification of NLD in schools include the following:

- The lack of a parent form of a screening scale for NLD.
- Parents are invaluable partners with schools.
- A formal full evaluation of NLD is time consuming and costly.
- There are serious consequences for the child with NLD if misunderstood, overlooked or misdiagnosed.
- Early interventions are found to be effective and can change the child’s prognosis for the better.

Assumptions

The basic assumptions underlying the construction of a parent rating scale in this research are as follows:

1. Parents or primary care-givers are objective, accurate, and reliable observers and raters who know their children well from birth, infancy or toddler years.
2. All parents or primary care-givers are equally knowledgeable, competent, and compassionate in caring for their charge.
3. The individual differences of parents or primary care-givers are not significant.
4. The experimental group children have been correctly diagnosed with NLD.
5. Children in the Asperger’s Syndrome group have been correctly diagnosed.
6. None of the children in the non-learning disabled control group have learning disabilities or any other disorders that may qualify them for special education services.
7. Children with NLD comorbid with other disorders do not exhibit significantly
different NLD assets and deficits from those who do not have comorbidities.

Limitations

The generalizability of the results of this research project is expected to be
affected by the following limitations:

1. Sample size - The incidence of NLD/AS is relatively low compared to other
   learning disabilities say, dyslexia, and identification of NLD/AS is fraught with
difficulties.

2. Misdiagnosis – Clinicians may not agree on the same definition or concept of
   NLD/AS. Not all may choose the definitions in DSM-IV or ICD-10 for the
diagnosis of AS.

3. Selection bias - The participants will be obtained from certain clinics and parent
   support groups meeting in some U.S. states only.

4. Impact of interventions/therapies and special education services – It is most
   probable that many of the children with NLD/AS in this research are already
   receiving help which would mitigate the results.

5. The significance of etiologies and comorbid disorders could also affect the
   outcome of this research.

Summary

This introduction has attempted to provide an overview of the problems and
difficulties that fetter the process of identifying children with NLD in school districts
today. Although reports on NLD are numerous, most, however, have relied on anecdotal
evidence gathered from clinical observation or on Rourke’s published reports rather than
on original empirical data (Volden, 2004). The major obstacle in NLD identification appears to be the lack agreement amongst researchers on the construct of NLD and the contributing factors, although there is general consensus on the existence of the disability. In addition, the findings of research studies on NLD may be difficult to generalize in view of sampling problems, especially the use of convenient samples in clinical settings.

For the purpose of facilitating the NLD identification process in schools, this research is an attempt to overcome some sampling problems by turning to parents, who are an invaluable resource for NLD identification that appears to be often overlooked by researchers. The problems of defining the NLD construct and delineating factors faced by researchers remain challenging. Nevertheless, an extensive review of literature on NLD and related studies is expected to provide sufficient information for the construction of a parent rating scale for NLD screening.
CHAPTER 2
REVIEW OF LITERATURE

Historical Background

Clinical Observations of LD, NLD

Introduction. Although quite heterogeneous, learning disabilities (LD) have been historically subsumed under reading disability or dyslexia, such that a historical overview of LD is largely concerned with studies on reading disability (Collins & Rourke, 2003). Prior to the proposed LD definition of psychoneurological learning disability by deficits in learning, the term “learning disability” was virtually synonymous with reading and/or spelling deficiencies for many (Rourke & Strang, 1978). Other early designations for children with learning disabilities found to be inadequate for the purpose of educational remediation included minimal brain damage, Strauss Syndrome, neurophrenia, perceptually handicapped and minimal cerebral dysfunction syndrome (Johnson & Mykelbust, 1967).

Early studies on NLD - Johnson and Myklebust (1967). With more than fifteen years of research on learning disabilities at the Institute of Language Disorders (Northwestern University) behind them, Johnson and Myklebust (1967) recognized that the group of children having psychoneurological learning disabilities are not “mentally retarded, emotionally disturbed, cerebral palsied or sensorially impaired …but who are not able to learn normally”. The astute researchers observed that this group is heterogeneous in that many types and degrees of learning disabilities are present, such as “deficits in acquiring the spoken word, in learning to read, to use written language, to spell, to tell time, to judge distance, size, length, height, or to calculate, though they are
not hyperactive”. Johnson and Myklebust deduced that there is “a neurology of learning which relates to verbal functions and a neurology of learning which relates to nonverbal functions”, and they were led to coin the term, nonverbal learning disabilities for the latter. In essence, individuals with nonverbal learning disabilities have difficulty comprehending the significance of many basic nonverbal aspects of their environment and in their daily living.

Johnson and Myklebust (1967) conceded that the most basic experiences are nonverbal and on a hierarchy of experience, the most primitive level is sensation. By gradation it evolves to perception, imagery, symbolization and lastly to conceptualization. Verbal learning disabilities fall at the level of symbolization, thus often affecting conceptualization. On the other hand, nonverbal learning disabilities (NLD) fall at the perception and imagery levels and therefore constitute a more fundamental distortion of total experience. It is the experience itself which is distorted, not ability to use spoken language or to read and write. Children with NLD are like those who lack color vision. They have no difficulty in learning the word red, but they cannot acquire the experience red, so they cannot distinguish it from the experience green or yellow. When they use the word red, as required by daily activities, it connotes only a vague, conglomerate impression often unrelated to the actual circumstances.

The researchers assumed that neurological systems predominant in the right hemisphere have been developmentally disrupted in children with nonverbal learning disabilities (NLD). These children’s verbal abilities may exceed those of their peers and yet they are unable to understand the relevance of time, space, size, and direction. They have difficulties performing simple nonverbal routines like judging the distance of an
approaching vehicle or the spatial orientation involved in hanging a jacket on an ordinary hanger.

Johnson and Myklebust (1967) emphasized that a nonverbal learning disability includes dimensions of inter-personal relationships and self-perception as well as perception of others which are collectively termed social perception. These children fail to grasp the meaning of the actions of others. They are unable to pretend and anticipate and so are unable to play the game of ‘superhero’. They do not understand the implications of the actions of their playmates from their gestures, facial expressions, and attitude. Many such children are largely unrecognized since test procedures for identifying them, as well as procedures for educational remediation, have been slow in developing.

Early studies on NLD - Myklebust (1971, 1975). In a major study of children with learning disabilities in public schools, the Pupil Rating Scale (PRS) constructed by Myklebust (1971) was used as a screening technique for both verbal and nonverbal learning (Myklebust, 1975). The results indicated the PRS can be used to screen for nonverbal deficiencies, such as inabilitys to judge time, size, distance and weight; to acquire spatial orientation; and to learn right from left and directions. Myklebust (1975) pointed out that because these nonverbal facets of learning are essential for coping with the many demands of daily living, they must be acknowledged with the needs of children with NLD. He was concerned that, while the study of language disorders has a long history that is invaluable in developing constructs for understanding verbal learning disabilities in children, nonverbal deficits have been less recognized in both children and adults although these are more debilitating than verbal disabilities.
Myklebust (1975) referred to nonverbal learning disabilities (NLD) as an evolving concept, emphasizing that children with NLD exhibit similarities and dissimilarities, and their individual differences must be noted. He indicated that the basic deficiency does not appear to be in perceptual processes per se but in imagery and memory as well as deficit in storage rather than recall. For example, individuals with NLD can identify colors and design but cannot execute the task (e.g. Block Design or Object Assembly). He singled out deficiencies in motor abilities, in planning the corresponding motor act as well as in visual-spatial processes involved in the writing process, as primary characteristics of NLD. By comparison, the typical dysgraphic does not manifest both poor motor function and lack of ability to space on the page. However, Mykelbust highlighted that the basic disability these children present is disturbed social relationships, the most critical perhaps being their inability to learn the meaning of the actions of others.

*Early Empirical Studies on LD, NLD.*

Besides Johnson and Myklebust (1967) who first identified NLD as a subtype of learning disability, perhaps Byron Rourke and his colleagues have contributed more significantly to the field through extensive empirical studies of children with learning disabilities (LD), particularly NLD. The concept of NLD as a neuropsychological disorder was developed by the ongoing investigations of Rourke who attempted to identify the neurocognitive, psychosocial and adaptive characteristics of children with learning disabilities. The pattern of abilities and deficits that Rourke has now classified under the rubric of NLD was first investigated in the general context of children with various subtypes of LD. In their early investigations which laid the foundation for their conceptualization and validation of the NLD syndrome (Casey & Rourke, 1991), Rourke
and his colleagues examined the neuropsychological and academic manifestations of children with LD classified according to Verbal IQ-Performance IQ (VIQ-PIQ) discrepancies on the Wechsler Intelligence Scales for Children (WISC; Rourke, Dietrich, & Young, 1973; Rourke & Telegdy, 1971; Rourke, Young, & Flewelling, 1971). Subsequent studies were conducted to determine the neuropsychological and socio-emotional correlates of children with LD classified according to their different patterns of performance on the Reading, Spelling and Arithmetic subtests of the Wide Range Achievement Test (WRAT; Rourke & Finlayson, 1978; Rourke & Strang, 1978; Strang & Rourke, 1983). Together, these studies led to the identification of the NLD syndrome; the delineation of its neuropsychological relationship to other LD types (e.g., reading disabilities), and provided the foundations for the development of the NLD model (Casey & Rourke, 1991).

**Empirical Studies on Neuropsychological Subtyping of LD based on VIQ-PIQ Discrepancy**

*First VIQ-PIQ discrepancy study.* In the first series of VIQ-PIQ studies, the purpose of Rourke, Young and Flewelling (1971) was to assess the relationship between VIQ-PIQ discrepancies and selected verbal, auditory-perceptual, visual-perceptual and problem-solving abilities in children with learning disabilities. Rourke et al. (1971) grouped 90 children aged 9 to 14 years old of WISC IQ range 79-119 according to their VIQ and PIQ pattern of scores: Group 1 with high PIQ and low VIQ of at least 10 points discrepancy (HP-LV); Group 2 with approximately equivalent VIQ and PIQ within 4 points of each other (V=P); and Group 3 with high VIQ and low PIQ of at least 10 points difference (HV-LP).
The dependent measures employed were a battery of achievement and neuropsychological tests: Peabody Picture Vocabulary Test (PPVT); Reading, Spelling and Arithmetic subtests of the Wide Range Achievement Test (WRAT); Reitan’s modification of the Halstead Category Test for older children (CT); aphasoid errors on Reitan’s modification of the Halstead-Wepman Aphasia Screening Test for older children (AST); first 30 items on the Halstead Speech Perception Test (SPT) as modified by Reitan for older children; Seashore Rhythm Test (SRT); Target Test (TT); and Trails A and B of the Trail Making Test (TMT).

The results indicated that the HV-LP group was clearly superior to HP-LV group on the verbal, language and auditory-perceptual skills (PPVT, 3 WRAT subtests, AST, SPT, SRT). The HP-LV group was superior to the HV-LP group on tasks that primarily involved visual-perceptual skills (Trails A, TT). Also, the performance of the V=P group was roughly intermediate between the other two groups on most measures. On the Category Test which is a non-verbal measure of problem-solving ability, no significant differences were found among the groups.

An unexpected finding was that the HV-LP group did well on Trials B relative to Trials A while the HP-LV group did poorly on Trials B relative to Trials A. Trials B is more complicated in that it necessitates shifting back and forth between the numeric and alphabetic series in order to complete the spatial pattern. In addition, the study revealed an interesting finding regarding the HV-LP group children whose Reading and Spelling scores (high) were strikingly different from their Arithmetic performance (low). No such differences were found within either of the other two groups. The researchers suggested
that the type of arithmetic abilities tapped by the WRAT Arithmetic subtest involved something more than what was usually referred to as “verbal” ability.

Second VIQ-PIQ discrepancy study. Based on studies by Reitan (1955) who, among others, had suggested that verbal skills are usually mediated by the left cerebral hemisphere and that visual-spatial and visual-motor abilities are usually mediated by the right cerebral hemisphere, Rourke and Telegdy (1971) sought to determine whether patterns of WISC Verbal IQ-Performance IQ (VIQ-PIQ) discrepancies reflect the differential integrity of the two cerebral hemispheres. Reitan and his associates studied adult patients with recently imposed brain lesions (Doehring, Reitan, & Klove, 1961), while Rourke and Telegdy were interested in older (aged 9 to 14 years old) children with learning disabilities. Their subjects were grouped in the same manner as Rourke, Young and Flewelling (1971) and assessed on 25 neuropsychological measures of motor and psychomotor tasks (grip strength, Maze Test, Graduated Holes Test, Grooved Pegboard Test, Finger Tapping and Tactual Performance Test) which allowed for separate assessments of right-hand and left-hand efficiency.

The results of the study offered no support for the hypothesis of relative superiority of left-hand performance for the HP-LV group and relative superiority of right-hand performance for the HV-LP group, implying that there was no support for asserting relationships between HP-LV and selective impairment of the left cerebral hemisphere or between HV-LP and selective right cerebral hemisphere impairment.

However, the results indicated clear superiority of the HP-LV group on most measures of complex motor and psychomotor abilities regardless of which hand was employed in performing the tasks. From these results and those of Rourke, Young, and
Flewelling (1971), the researchers concluded that the HV-LP group exhibited relative superiority on tasks thought to be subserved primarily by the left cerebral hemisphere (e.g., reading, spelling, arithmetic, speech-sounds discrimination) and relative inferiority on tasks thought to be subserved primarily by the right cerebral hemisphere (e.g., spatial visualization, visual memory, complex visual-motor coordination), whereas the opposite pattern of relative superiority and impairment characterized the performance of the HP-LV group. In summary, the results were considered to be consistent with the view that discrepancies in WISC Verbal IQ-Performance IQ reflect the differential integrity of the two cerebral hemispheres in older children with learning disabilities.

*Third VIQ-PIQ discrepancy study.* The third study in the series by Rourke, Dietrich and Young (1973) was designed as a developmental extension of the Rourke, Young and Flewelling (1971) and Rourke and Telegdy (1971) investigations to determine if patterns of relationships similar to those obtained for groups of older children with learning disabilities would be in evidence for similarly composed groups of younger children (5 to 8 years old). The three groups of children – Group 1 (HP-LV), Group 2 (V=P) and Group 3 (HV-LP) – were assessed on two categories of tests: 1) the verbal, auditory-perceptual, visual-perceptual, and problem-solving tests similar to those employed in the Rourke, et al. (1971) study; and 2) the motor and psychomotor tests similar to those employed by Rourke and Telegdy.

The performances of these younger children did not yield the same clear-cut differences observed in the previous studies with older (9 to 14 years old) children with learning disabilities who had been divided into groups on the basis of VIQ-PIQ discrepancies of an identical magnitude. These results argue for very guarded clinical
interpretation of WISC Verbal IQ-Performance IQ discrepancies of this magnitude in the case of younger children with learning disabilities.

*Empirical Studies on Neuropsychological Subtyping of LD based on Academic Performance*

First study based on academic performance. In the second series of early investigations, Rourke and his colleagues focused upon the neuropsychological aspects of reading, spelling and arithmetic disorders in children (Rourke, 1978). The Rourke and Finlayson (1978) study was an attempt to determine if children who exhibited “arithmetic retardation” within the context of differing patterns of reading and spelling performances would also exhibit differing patterns of brain-related abilities. Forty five children between the ages of 9 and 14 years who fit the general definition of learning disabilities were divided into three groups on the basis of their academic performance, i.e., Wide Range Achievement Test (WRAT) Reading, Spelling and Arithmetic subtests. The subjects in Group 1 were uniformly deficient in reading, spelling and arithmetic with standardized scores at least 2 years below their expected grade level. Group 2 was composed of subjects whose reading and spelling grade-equivalent scores were at least 1.8 years below their arithmetic performance which was still impaired relative to age norms. The subjects in Group 3 exhibited the opposite pattern, i.e. average or above average reading and spelling scores were at least 2.0 years greater than arithmetic scores. All three groups were equivalent in terms of age and full-scale IQ, and Groups 2 and 3 did not differ in their arithmetic performance.

A battery of neuropsychological measures of two main categories was administered, namely a) verbal and auditory-perceptual and b) visual-perceptual and
visual-spatial. The verbal and auditory-perceptual tests were Wechsler Intelligence Scales for Children (WISC) Verbal subtests (Arithmetic included), Peabody Picture Vocabulary Test (PPVT; Dunn, 1965), Halstead-Wepman Aphasia Screening Test (Reitan & Davison, 1974), Halstead Speech-Sounds Perception Test (Reitan & Davison, 1974), Auditory Closure Test (Kass, 1964), and Sentence Memory Test (Benton, 1965). The visual- perceptual and visual-spatial tests consisted of WISC Performance subtests (Coding included), and Target Test (Reitan & Davison, 1974).

The results showed that Groups 1 and 2 performed better than Group 3 on measures of visual-perceptual and visual-spatial abilities, while Group 3 was superior to Groups 1 and 2 on verbal and auditory-perceptual abilities. Rourke and Finlayson (1978) interpreted that the group with relatively poorer arithmetic scores (Group 3) may have a relatively dysfunctional right cerebral hemisphere, and that Groups 1 and 2 showed a relatively dysfunctional left cerebral hemisphere. This inference was felt to be reasonable because Group 3 did particularly poorly only on those tasks ordinarily thought to be subserved primarily by the right cerebral hemisphere, whereas Groups 1 and 2 were particularly deficient only in those skills ordinarily thought to be subserved primarily by the left cerebral hemisphere.

Second study based on academic performance. To test this hypothesis of differential hemispheric integrity among these same three groups of children, Rourke and Strang (1978) studied their patterns of performance on motor, psychomotor and tactile-perceptual tasks. The motor tests included the Finger Tapping Test (Reitan & Davison, 1974) and the Strength of Grip Test (Reitan & Davison, 1974). The psychomotor measures included time measures for Maze Test (Knights & Moule, 1968), Grooved
Pegboard Test (Knights & Moule, 1968), and Tactual Performance Test (Reitan & Davison, 1974). The tests for tactile-perceptual disturbances are Tactile Perception, Finger Agnosia, Finger Tip Number-Writing Perception, Coin Recognition (Reitan & Davison, 1974).

The group with an outstanding deficiency in arithmetic (i.e., Group 3) did indeed perform lower than age-level expectations on the more complex psychomotor and tactile perceptual tasks and were markedly deficient compared to the other two groups. Specifically, Group 3 children exhibited evidence of bilateral impairment on a composite measure of tactile-perceptual abilities, which impairment was more marked on the left side of the body. These (Group 3) children scored lower on measures of abilities ordinarily thought to be subserved primarily by the right cerebral hemisphere. In contrast, they scored much higher on measures of abilities ordinarily thought to be subserved primarily by the left cerebral hemisphere. These results were interpreted as supporting evidence that Group 3 children showed a relatively dysfunctional right cerebral hemisphere within the context of satisfactory left hemisphere functioning, whereas the group that performed better in arithmetic than in reading and spelling (Group 2) exhibited some indications that would be consistent with the opposite pattern of hemispheric integrity.

**Third study based on academic performance.** In the third study of the neuropsychological significance of specific arithmetic impairment in childhood, Strang and Rourke (1983) investigated possible differences in the nonverbal concept formation capacities of Groups 2 and 3 types of children. Similarly constituted groups of 9- to 14-year old children i.e., Group 2 with reading difficulties relative to arithmetic skill and
Group 3 with specific problems in arithmetic relative to their reading performance, were given the Halstead Category Test (Reitan & Davison, 1974), which is a relatively complex concept-formation test involving nonverbal abstract reasoning, hypothesis testing, and the ability to use positive and negative informational feedback in concept formation.

The results indicated that Group 3 children performed worse at 1 standard deviation below age expectation compared to Group 2 children who performed in an age appropriate range. Furthermore, Group 2 children tended to improve with experience on the Category Test while Group 3 children did not benefit nearly as much from experience on this test. Strang and Rourke (1983) informed that Group 3 children typically exhibit other educational difficulties which may include reading comprehension and handwriting, problems with general organizational abilities, and difficulties with virtually any complex subject area (e.g., natural science). In addition, among other kinds of adaptive deficiencies often exhibited by Group 3 children were problems with social adjustment and peer interaction. The researchers suggested that these children were quite similar to the group of children described by Myklebust (1975) as those with “nonverbal learning disabilities”.

Overall, Strang and Rourke (1983) concluded that these three initial studies (Rourke & Finlayson, 1978; Rourke & Strang, 1978; Strang & Rourke, 1983) illustrated the broad range of neuropsychological impairments characteristic of this subgroup of learning disabled children.
Fourth study based on academic performance. Ozols and Rourke (1991) essentially repeated previous studies involving older (9- to 14-year old) children in the areas of auditory-linguistic, visual-spatial-organization, motor, psychomotor, tactile-perception, and concept-formation with LD children aged 7 and 8 years. In addition, the three groups of children were compared on their social behavior with the Behavior Problem Checklist (BPC; Quay & Peterson, 1979).

The results of verbal, auditory-perceptual and visual-spatial skills and abilities were quite comparable with those obtained in the studies of 9- to 14- year-old children. However, there were fewer similarities between the younger and older groups on the motor, psychomotor and tactual-perceptual measures. While young Group 3 children exhibit difficulties with visual-spatial and visual-perceptual skills, they do not perform poorly on tests of psychomotor development at these young ages. Older Group 3 children on the other hand show deficits in visual-spatial-organizational skills and psychomotor skills. In contrast, Group 2 children seem to exhibit similar neuropsychological profiles at young ages as they do at older ages. Furthermore, the performance of Group 2 was superior to that of Group 3 on most of these measures, as was the case in Rourke and Strang (1978).

On the test of concept formation, the younger children performed better than Group 1 and 2 children, while the older children found difficulty (relative to Group 1 and 2) on the older children’s version of the test. One possible reason for this difference is that the younger children’s version of the Category Test is mainly a test of linguistic ability rather than higher-order concept formation skills.
Finally, the finding that young Group 3 children obtained elevated scores on the Behavior Problem Checklist (BPC) is consistent with reports that Group 3 children have psychosocial difficulties (Rourke, 1988; Rourke, Young & Leenaars, 1989). Results of this study also suggested that young Group 3 children are more likely to exhibit “externalized” types of personality disorders.

Fifth study based on academic performance. Following from previous studies (Rourke and Finlayson, 1978; Rourke and Strang, 1978; Strang and Rourke, 1983; Ozols and Rourke; 1991), Rourke (1993) conducted a qualitative analysis of the mechanical arithmetic errors of Group A (Arithmetic or Group 3) children and found them to be far different from that obtained for Group R-S (Reading-Spelling or Group 2).

The most prevalent types of errors Group A children made pertained to spatial organization (e.g., misaligning numbers in columns); visual detail (e.g., misreading mathematical sign); procedural errors (e.g., miss or add a step to arithmetic procedure); failure to shift psychological set; graphomotor, memory, and judgment and reasoning. The failure to generalize a particular skill so that it can be adapted to a new, slightly different situation is a predominant feature of the general adaptive characteristic of Group A children. Rourke (1993) also found that Group R-S children tend to fare far better in social situations than do Group A. He concluded that the very maladaptive social behavior of Group A children is seen as stemming from the same neuropsychological deficits as their problems in arithmetic calculation (e.g., those in visual-perceptual-organizational, psychomotor, and concept-formation skills, and difficulties in dealing with novel problem-solving situations).
Conclusions of studies based on patterns of academic performance. Although both Group R-S and Group A children have equally impaired levels of arithmetic achievement, their patterns of neuropsychological assets and deficits are vastly different (Rourke, 1993). He concluded that Group A children exhibit a pattern of neuropsychological assets and deficits of the nonverbal learning disabilities (NLD) syndrome that leads to specific patterns of impairment in mechanical arithmetic and psychosocial functioning. The other pattern (Group R-S), which he labeled Basic Phonological Processing Disorder (BPPD), is found to lead to particular patterns of academic deficits (including arithmetic), but not to psychosocial dysfunction.

Up to this point, Rourke’s (1993) conceptualizations of the two subtypes of LD are as follows:

a) Children with BPPD are those who exhibit many relatively poor psycholinguistic skills in conjunction with very well-developed visual-spatial-organizational, tactile-perceptual, psychomotor, and nonverbal problem-solving skills. They exhibit very poor reading and spelling skills and significantly better, though still impaired, mechanical arithmetic competence.

b) The other group, children with NLD, exhibits outstanding problems in visual-spatial-organizational, tactile-perceptual, psychomotor and nonverbal problem-solving skills within a context of clear strengths in psycholinguistic skills, such as rote verbal learning, regular phoneme-grapheme matching, amount of verbal output and verbal classification. Children with NLD experience their major academic learning difficulties in mechanical arithmetic but exhibit advanced levels of word-recognition and spelling.
Empirical Studies on Psychosocial Subtyping

Patterns of personality and psychosocial functioning in children with LD. Besides discerning distinct neuropsychological profiles, Rourke and his colleagues have demonstrated that heterogeneity is also evident in the socio-emotional functioning of children with learning disabilities (LD). Rourke (1988) suggested that psychosocial disturbance may arise as a direct expression of the same pattern of neuropsychological assets and deficits that underlie the academic learning difficulties of these children. Rourke and his colleagues carried out a series of 5 studies (including Fuerst, Fisk, & Rourke, 1989, 1990; Fuerst & Rourke, 1993, 1995; Porter & Rourke, 1985) to examine patterns of personality, psychosocial functioning and LD.

LD and Psychosocial functioning. The results of a series of five studies termed ‘The Windsor Taxonomic Research’ (Rourke & Fuerst, 1991, p. 48-68) suggest strongly that some children who meet commonly accepted definition of LD show signs of significant socioemotional disturbance, whereas others do not; on balance, it appears that most do not. Furthermore, where LD is undifferentiated into subtypes, studies revealed that children with LD do not show increased incidence of psychopathology with advancing age, and this inference was later supported by Fuerst & Rourke (1995).

In the Fuerst & Rourke (1995) study, a sample of 728 children with LD was divided into three age groups: “Young” (7-8 years old); Middle” (9-10 years old); and “Old” (11-13 years old). The results of cluster analyses performed at each of the three age levels and a profile-matching analysis of Personality Inventory for Children (PIC) scores in that sample strongly suggested that children with LD do not become more susceptible to socioemotional disturbance with increasing age. Rather, the patterns and levels of
psychosocial functioning in this sample of children with LD remained relatively stable over time. Earlier, Strang and Rourke (1985) also found no indication of any increased incidence of psychopathology (as measured with the PIC) over cross-sectional comparisons of undifferentiated groups of learning disabled children between the ages of 8 and 12 years.

_Heterogeneity of LD, personality subtypes, and psychosocial functioning._

However, Rourke and his colleagues have demonstrated that children with LD constitute a heterogeneous group based on academic achievement and neurocognitive performance (Rourke & Finlayson, 1978; Rourke & Strang, 1978; Rourke, Young, & Flewelling, 1971; Strang & Rourke, 1985). In the ‘Windsor Taxonomic Research’ studies (Rourke & Fuerst, 1991), they also demonstrated that LD is heterogeneous with respect to psychosocial functioning. Various multivariate statistical subtyping techniques were used with scores on a parent-report measure of children’s behavior, attitudes and interpersonal relations, i.e., the Personality Inventory for Children (PIC).

Five distinct subtypes of psychosocial functioning (_normal, mild anxiety, somatic concern, internalized psychopathology and externalized psychopathology_) emerged fairly consistently across different clustering methods and samples of children with LD. Two other subtypes were identified (_mild hyperactive and conduct disorder_) but only in one or two studies. Approximately 60% of the children with LD could be described as experiencing either mild psychosocial disturbance (_somatic concern and mild anxiety_) or _normal_ patterns of functioning. The remaining 40% of children with LD exhibited profiles indicative of clinically significant psychosocial disturbance. Twenty percent were characterized by _internalizing_ problems, such as depression, anxiety, inappropriate affect
and social isolation. The final 20% had *externalizing* behavior problems, such as hostility, impulsivity, acting-out, aggression and hyperactivity. These results indicate that reliable and distinct patterns of psychosocial functioning exist within heterogeneous groups of children with LD (Greenham, 1999).

**Relationship between cognitive and academic performances and psychosocial functioning in LD subtypes.** Rourke and Fuerst (1992) emphasized that they do not maintain that learning disabilities (LD) and psychosocial disturbance are inextricably intertwined. What they have found was that some subtypes of children with LD are quite prone to psychosocial maladjustment whereas others are not. The investigations of Fuerst, Fisk, & Rourke (1990), and Fuerst and Rourke (1993) indicated that children with LD who exhibit well-developed verbal skills relative to visual-spatial-organizational skills (VIQ>PIQ) appear to be at greater risk for the development of significant psychopathology when compared to children with either the opposite pattern of skills (VIQ<PIQ) or equally well-developed (VIQ=PIQ) skills in these two domains. In addition, children with LD who exhibit relatively well-developed rote language skills (high Reading and Spelling scores) as compared to visual-spatial-organizational skills (low Arithmetic score), such as children with NLD, are at greater risk for developing internalized psychopathology, as compared to children demonstrating a very different and largely opposite pattern of skills (e.g., children with basic phonological processing disabilities or BPPD) (Rourke, 1988, 1993, 2000; Rourke & Fuerst, 1992, 1995; Strang & Rourke, 1985).

Moreover, empirical evidence consistent with these findings was shown by Casey, Rourke, and Picard (1991) who contrasted the psychosocial functioning of samples of
younger (about 8 years old) and older (about 13 years) children with NLD. The mean PIC profile of the older children was clearly more deviant than that of the younger children, with an extreme score on the Psychosis scale, and significant elevations on the Depression and Social Skills scales.

Thus, although children with LD may in general show no apparent predisposition for increased psychopathology with advancing age, a specific subpopulation of children - those with NLD - is at risk for developing significant psychopathology of the internalizing kind with increasing age (Rourke & Fuerst, 1991).

*Empirical Studies on the Developmental Course of the NLD Syndrome*

*General description of developmental course of NLD.* One issue that arose in the context of research on the NLD syndrome was whether and to what extent its manifestations might change over the course of development. Johnson (1987) reported the different symptoms of children with NLD during early childhood, later childhood and early adolescence, and adulthood which were observed by both parents and professionals. These clinical observations of children with NLD were confirmed on standardized tests and research instruments from the results of diagnostic evaluations, diagnostic teaching and several studies undertaken by faculty and students at the Program in Learning Disabilities, Northwestern University (Johnson, 1987).

While the overall pattern of high verbal/low performance ability is manifested throughout life, the specific concerns of NLD vary with age and expectancies. During early childhood, the exploratory behavior and motor skills of the infant-toddler with NLD lag behind his language development. In the elementary years, children with NLD tend to misinterpret what they see and frequently miss the point on filmstrips and television.
programs or reading comprehension passages. Their social problems are compounded by adolescence because they do not know how to play well and have facial recognition difficulty due to poor visual-spatial integration. Most need help with both academic and nonacademic skills. In adulthood, most need assistance with many life skills. Women with NLD often have significant difficulties in the kitchen and in general home management (Johnson, 1987).

**Empirical evidence of developmental changes in neuropsychological features.** There is evidence to suggest that the neuropsychological deficiencies of individuals with NLD become more debilitating with advancing age. Rourke, Young, Strang, and Russell (1986) found that adults who demonstrated a configurational pattern of neuropsychological abilities and deficits similar to that observed in children with NLD exhibited more pronounced deficiencies (relative to their age-peers) than their younger counterparts (relative to their age-peers) on measures of psychomotor coordination, visual-perceptual-organizational abilities, and complex problem-solving and concept-formation abilities. In contrast, both groups performed as well as their respective age-peers on measures of verbal and linguistic functioning. However, these results are tentative in view of the small sample size of 8 adults and sampling bias, being made up of persons referred by a hospital-based psychiatry service (B. P. Rourke, Del Dotto, S. B. Rourke, & Casey, 1990).

**Evidence of developmental changes in neuropsychological, academic and socioemotional functioning.** Casey, Rourke, and Picard (1991) undertook to examine whether and to what extent the features of the NLD syndrome would change in a predictable manner during the middle childhood and early adolescent years. The subjects
were divided into two groups, “Young” (15 children aged 5.9-10.5 years) and “Old” (15 children aged 10.8-14.9 years), and administered cognitive, achievement and neuropsychological tests.

It was found that, with increasing age, children with NLD made age-appropriate development of verbal, simple tactile, and simple motor skills and abilities that correspond with similar gains in the academic skills of word recognition and spelling. In contrast, the older children failed to make age-appropriate gains on neurocognitive measures that emphasized visual-perceptual, complex tactile and psychomotor, and problem-solving skills and abilities. Moreover, they were found to be further behind their normally achieving age-peers in mechanical arithmetic skills as compared with the younger children relative to their own age-peers.

Despite the small sample size ($n = 6$ for each group), the researchers found a clear pattern in the socioemotional and behavioral adjustment of these children. The older children demonstrated greater disturbance of the internalized variety as compared with the younger children. Measure of externalized psychopathology of both age groups did not decline but remained stable and within the clinically insignificant range over time. The mean Personality Inventory for Children (PIC) profile for the younger children suggested that parental concerns were limited to poor school performance and some degree of overactivity and distractibility. In contrast, the mean PIC profile of the older children suggested limited communication, social, perceptual and motor skills, poor physical education skills, clumsiness, a tendency to act younger than their age, and indifference toward their personal appearance. Furthermore, the profile is characteristic of children who are rejected by their peers, have difficulty making and keeping friends,
and to seek friends among younger children. They are also described as sad and are likely to be socially isolated and emotionally labile.

**Evidence from longitudinal study on developmental changes in academic and neuropsychological features.** A longitudinal investigation of clinic-referred children with outstandingly deficient arithmetic skills and many NLD features was carried out by Del Dotto, Fisk, McFadden & Rourke (1991) to determine whether and to what extent the academic and neuropsychological abilities of NLD individuals remain stable or changes over time. Of the initial 28 subjects (aged 9.5 to 15.5 years old) who met the researchers’ criteria for NLD, five (2 females and 3 males aged 16 to 23 years old) agreed to participate and were administered a neuropsychological test battery in the follow-up study. The WRAT Reading, Spelling and Arithmetic subtest scores indicated that there was relative stability in the pattern of academic retardation over time where performances on Arithmetic were consistently lower than the other two subtests. Similarly, the VIQs and PIQs of initial and follow-up studies revealed the mean PIQ scores being consistently lower. Thus, the academic and neurocognitive abilities of this sample of NLD individuals have remained remarkably stable over time. However, no consistent pattern of socioemotional disturbance was discernible on the objective personality measures although 4 of the 5 subjects had clinically elevated Minnesota Multiphasic Personality Inventory (MMPI) profiles and a significant number of maladaptive behaviors on the Vineland Adaptive Behavior Scales (VABS). These results are limited by the very small sample size and sampling bias.
Evidence of the NLD Syndrome from Clinical Studies and Electrophysics

General description. Besides Rourke and his colleagues who have contributed significantly to the empirical research on NLD, several independent investigators have examined some of the specific deficits of the NLD profile, such as visuospatial and motor skills, social perception, language, and arithmetic. Although these clinician-researchers have classified the learning disability under different labels, such as right-hemisphere learning disability, there are more similarities with NLD in the behavioral manifestations than differences, i.e., the characteristics are strikingly similar to NLD. Most contained children with average intellectual capacity who experienced difficulties in arithmetic but not reading, had social skill deficiencies, were unable to interpret gestures and facial expressions, and had left-sided neurological markers. Finally, there are studies that have used electrophysiological techniques to measure electrical brain activity in subtypes of LD that have indicated evidence of hemispheric differences in event-related potentials (ERPs) between the two subtypes, namely reading and spelling deficiency (subtype R-S) and arithmetic disability (subtype A or NLD).

Evidence of NLD from earlier clinical studies. Denckla (1978), a self-confessed cautious defender of the term “MBD” (minimal brain dysfunction), was “just beginning to collect cases of …the child with a left hemisyndrome” that implicates right-brain impairment associated with NLD. The neurologist linked reading disability with a right hemisyndrome and an associated left-hemisphere-deficient neuropsychological profile. She cautioned against the oversimplification of older assumptions that verbal functions do not suffer from imbalance if right hemisphere contribution is deficient, adding that the “attribution of the substrate of language to the left brain and visuospatial to the right brain
was a crude kind of dichotomy and true only at low levels”. While Denckla (1978) did not mention NLD in summarizing deficits associated with left hemisindrome, she linked the loss of the right hemisphere contribution with the behavioral correlates that are strikingly NLD in our present conception of the disorder, namely deficits in higher-order verbal skills, spatial orientation skills, mathematical understanding, and normal give-and-take of social-emotional expressions.

Weintraub and Mesulam (1983) studied 14 patients characterized by emotional and interpersonal difficulties, shyness, visuospatial disturbance, and inadequate paralinguistic communication skills. The patients had at least average intellectual capacity with verbal IQ markedly superior to performance IQ, and they demonstrated arithmetic failure. Most of them avoided eye contact, had problems understanding gestures and prosody, and had difficulty conveying their feelings although there was no evidence that they could not experience affect. Weintraub and Mesulam suggest that there is a syndrome of early right-hemisphere dysfunction that may be genetically determined and that is associated with poor social perception, chronic emotional difficulties, inability to display affect, and impairments in visuospatial functioning.

Citing Johnson and Myklebust (1967), Badian (1983) highlighted the association between the social imperception and specific arithmetic disability in children with nonverbal learning disorders (NLD). She inferred that a right hemisphere dysfunction may be a common denominator for the NLD deficits in interpreting emotions (as seen in children with social imperception) and in visual-spatial tasks (e.g., arithmetic), since both involve the manipulation of imagery, visuoperception and spatial processes. In the Badian and Ghublikian (1983) study, children with a specific arithmetic disability were
rated lower in personal-social behavior than were children poor only in reading. Children with excellent arithmetic skills were found to have good social adjustment, while children with low arithmetic ability evidenced significant emotional difficulties. According to Badian (1983), recent research evidence has revealed that the right cerebral hemisphere is more important to arithmetic than was believed earlier, and that emotional sensitivity is a function of the right hemisphere.

Voeller (1986) profiled 15 children aged between 5 to 13 years whose characteristics bear striking similarity to NLD features. Using the results from neuropsychological test batteries, CT scans and EEGs, she found indications of right hemispheric dysfunction in all these children who displayed significant difficulty in displaying appropriate affect and an inability to decipher the emotional states of others. As a group, these children showed left-sided neurological findings, higher verbal than performance skills, and higher reading than arithmetic abilities. Significantly, the researcher found that 14 of the 15 children had attention deficit disorder (ADD) and 8 were also hyperactive. Eight of the children were withdrawn and isolated, while 7 were obtuse and behaved inappropriately and often were involved in fights. They often could not grasp the nuances of social situations and had difficulty maintaining friendships. One child had no fear of strangers and did not know when an adult was furious with him. A 13-year old had been arrested for shoplifting because she had been assured by another child that “nothing would happen” if she took the purse. Half of the children appeared to have atypical prosody, and some had a limited repertoire of expressions, inappropriate facial expressions, and deficient eye contact. The older children were generally in
psychotherapy or counseling but responded poorly, suggesting a close affinity with children manifesting NLD socio-emotional problems.

From a somewhat similar perspective, Tranel, Hall, Olson and Tranel (1987) studied 11 patients whose constellation of symptomatology the researchers conclude constitutes a developmental learning disability of the right hemisphere. Ten of the 11 patients had significantly inferior nonverbal intellectual abilities relative to verbal skills as evident in the VIQ-PIQ split. They tended to show failure in arithmetic but not in reading or spelling as measured on the Wide Range Achievement Test (WRAT). Their verbal versus visual memory reveals a pattern of verbal superiority. On the whole, their performances tend to show visuospatial disorganization and poor visuomotor integration. All patients had normal propositional language output, with fluent, grammatical, nonparaphasic speech production. In contrast, paralinguistic abilities, including prosody, eye contact, and gesturing, were not normal. All patients had a long history of poor social and emotional adaptation, and 10 of them had been treated for depression at least on one occasion. Significant physical clumsiness and awkwardness were also consistently reported among them.

Evidence of NLD from later clinical studies. Gross-Tsur, Shalev, Manor and Amir, (1995) studied the clinical characteristics of twenty Israeli children (mean age 9.5 years) with developmental right-hemisphere syndrome (DRHS) who also manifested attention-deficit/hyperactivity disorder (ADHD), severe graphomotor problems and marked slowness of performance. The children were referred to the Neuropediatric Unit at the Shaare Zedek Medical Center and were selected based on the criteria of emotional and interpersonal disorders; paralinguistic communication problems; impaired
visuospatial skill with Verbal IQ > Performance IQ; dyscalculia (>1 year below expected grade level); and soft neurological signs on the left side of the body. They were assessed on a battery of neuropsychological, academic and emotional and behavioral tests. The results indicated that the NLD neuropsychological and behavioral profile was very similar to the DRHS profile of these children, including neurological body signs that were more marked on the left side of the body. It appeared to the researchers that the syndromes described as DRHS and NLD are very similar, if not the same.

In the study of psychiatric adult patients with a right hemisphere developmental learning disability (RHLD), Grace and Malloy (1992) referred to the syndrome as synonymous with “nonverbal learning disability” and developmental right hemisphere dysfunction. The RHLD syndrome is characterized by features similar to those found in acquired right hemisphere lesions. These include neuropsychological deficits in visuospatial functioning, impaired mathematical abilities in the presence of at least average intellectual and reading abilities, inadequate paralinguistic communicative abilities, and neurological “soft signs” of right cerebral dysfunction, especially asymmetrical posturing of the left arm during complex gait. The researchers postulated that the right hemisphere plays a strong role in emotional processing and disorders of affective language result from focal right hemisphere lesions. Difficulties with the acquisition of right hemisphere functions (e.g., affect regulation, communicative competence) due to underlying early injury may create a special vulnerability for later psychiatric disorder. The researchers made reference to Rourke, Young & Leenars (1989) who reported that children with this disability (NLD) are at particular risk for depression and suicide.
Evidence of NLD from electrophysiologic studies. Electrophysiologic studies have found reliable hemispheric differences in event-related potentials (ERP) between Rourke’s two subtypes of LD, namely children demonstrating deficits in Reading-Spelling (R-S) or Arithmetic (A). The Stelmack, Saxe, Noldy-Cullum, Campbell, and Armitage (1988) study was one of the first ERP investigations to explicitly select children with reading disabilities to conform to the academic pattern described as Rourke’s R-S subtype, i.e., Wide Range Achievement Test (WRAT) reading and spelling scores are poorer than arithmetic score by around 10 points.

An electroencephalography (EEG) study by Mattson, Sheer, and Fletcher (1992) examined cerebral activity in children with R-S and A types of LD by comparing with nondisabled control children who exhibited a task-related dependent shift in lateralization of 40 Hz EEG. Results from the study showed that children of R-S subtype had proportionately less left hemispheric 40 Hz activity than did control and A subtype children during a verbal task. Conversely, the A subtype children generated proportionately less right hemisphere activity during a nonverbal task than control or R-S subjects (Collins & Rourke, 2003).

Miles and Stelmack (1994) compared ERPs in children corresponding to Rourke’s LD subtypes R-S and A, and a third group who is deficient in both reading and spelling as well as arithmetic (R-S-A) on auditory and visual priming tasks. For normal control group, N450 amplitude was reduced on both visual and auditory primed tasks. In contrast, subtype A children showed reduced N450 amplitude on auditory-verbal primed task but not on the visual task indicating that they have deficits in visual-spatial processing, while the R-S and R-S-A groups did not exhibit reduced N450 amplitude.
either on the visual or auditory-verbal primed tasks indicating that they have problems with auditory-verbal processing. The researchers concluded that the distinct ERP effects for the groups support LD subtyping based on academic performance in arithmetic, reading, and spelling.

More recently, an ERP study by Greenham, Stelmack, and Vlugt (2003) examined the role of attention in the cognitive processing of pictures and words in a group of children with LD classified as either R-S or A subtypes. ERPs were recorded during picture and word naming tasks presented individually or in superimposed picture-word arrays. The ERP findings suggest that the word-naming deficiency for subtype R-S children was not a selective attention deficit but rather a specific linguistic deficit that develops at a later stage of processing. In contrast to R-S and control groups, the ERP results of subtype A suggest a selective attention deficit that develops at an early stage of visual-spatial processing.

In summary, the findings from ERP studies are consistent with Rourke’s (1989, 1995) NLD model to account for the differential patterns of assets and deficits presented by the R-S (basic phonological processing disorder or BPPD) and A (NLD) subtypes. According to this model, children of the R-S (BPPD) subtype are thought to have dysfunctional left hemisphere auditory-verbal processes, whereas children of the A (NLD) subtype are thought to have dysfunctional right hemisphere visual-spatial processing (Collins & Rourke, 2003). The Greenham, Stelmack, & Vlugt (2003) study lends support for the deficit in visual attention to nonverbal material typically found in children with NLD (subtype A in the study).
Theoretical Bases of the NLD Syndrome

Rourke’s Conception of the Content and Dynamics of the NLD Syndrome

The unique feature of Rourke’s model of the NLD syndrome is its hierarchical structure comprising of the causative and sequential (i.e., primary → secondary → tertiary → linguistic), and dependent (i.e., academic and psychosocial) dimensions of the dynamic relationships among categories of assets and deficits of NLD (Rourke et al. (2002). The emphasis in Rourke’s conception is that the patterns of academic, psychosocial, and adaptive abilities and deficiencies experienced by individuals who exhibit NLD are viewed as the direct result of the interaction of the primary, secondary, tertiary, and linguistic neuropsychological assets and deficits (Rourke & Tsatsanis, 2000).

Rourke (1995a, 2006a) described summarily the content and dynamics of NLD syndrome in Figure 1.

The syndrome is characterized by significant primary deficits tactile perception, visual perception, complex psychomotor skills, and in dealing with novel circumstances. These primary deficits lead to secondary deficits in tactile and visual attention and to significant limitations in exploratory behavior. In turn, the secondary deficits lead to tertiary deficits in tactile and visual memory and in concept-formation, problem-solving, and hypothesis-testing skills. Finally, these deficits lead to significant difficulties in the content (meaning) and function (pragmatics) dimensions of language.

Neuropsychological assets of NLD are evident in most areas of auditory perception, a primary asset which leads to the developments of auditory attention (secondary asset), and auditory memory (tertiary asset), especially for verbal material. Simple motor skills
are most often well developed, as are rote verbal memory, language form, amount of verbal associations, and language output.

![Figure 1. Content and dynamics of the NLD syndrome (Rourke, 2006a)](image)

This mix of neuropsychological assets and deficits of NLD eventuates in some formal learning (e.g., academic) assets, such as single-word reading and spelling. It also increases the likelihood of significant difficulties in other aspects of formal learning (e.g., arithmetic, science) and informal learning (e.g., during play and other social situations). Psychosocial deficits, primarily of the externalized variety, often are evident early in development; psychosocial disturbances, primarily of the internalized variety, are usually
Rourke’s model describes the developmental manifestations of NLD in children and adolescents who have been afflicted since their earliest developmental stages, which is in contrast with the later onset of the syndrome in the older child or adult who have enjoyed a normal early developmental course (Rourke et al., 2002). The child with NLD has early deficits in tactile-perceptual, visual-perceptual, and psychomotor domains which lead to restricted exploratory behavior and limit the sensorimotor learning necessary for forming the basic building blocks of more advanced mental structures, i.e., conceptual thinking, creative problem solving, communication skills, and socioemotional interactions. As the child moves into adolescence and developmental tasks become increasingly complex, the functional deficits become more apparent (Zillmer & Spiers, 2001). The linguistic deficiencies may be characterized by repetitive, rote speech; poor psycholinguistic pragmatics; minimal speech prosody; and reliance on language for social relating, information gathering, and relief from anxiety.

The mechanisms that underlie the NLD developmental course may be explained from two perspectives: Piaget’s cognitive-developmental theory and Rourke’s white matter model.

A Cognitive-Developmental Perspective

Piaget (1954; Piaget & Inhelder, 1969) emphasized sensorimotor functioning as one of the early developmental features upon which formal operational thought is founded i.e., the adequacy of the child’s sensorimotor experience is seen to be directly related to his or her cognitive development. At the earliest stages, the interaction between
self and environment is effected through sensory processing and movement (Piaget, 1954). The external world is known to the young child principally through touch, vision, and goal-directed behavior in investigating the environment. Manipulation of the environment through action, exploration and experimentation yields information that is thought to lead to the formation of mental schemata. These early activities are proposed to engender the development of formal operational abilities, i.e., an understanding of cause-and-effect relationships, hypothesis testing, nonverbal concept formation, reasoning abilities, and the ability to employ symbols and representations (Rourke, 1995a). Of interest is evidence from EEG studies that postnatal spurts in brain growth coincide with Piaget’s main stages of intellectual development. Intracortical connections have been found to demonstrate growth spurts and plateaus overlapping with Piagetian stages (Tsatsanis & Rourke, 1995).

In this regard, children with NLD have deficits in precisely those areas, i.e., tactile perception, psychomotor and visual perception, that are essential to early learning. They are apparently ‘stuck’ at the sensorimotor stage and have extreme difficulty moving through the stages to achieve the final phase of formal operational thinking, which is evident in their fundamental inability to organize or make sense of complex and novel stimuli in their environment (Rourke & Tsatsanis, 2000). As a result, they have difficulties comprehending mathematical concepts and interacting socially, the latter of which requires perception, the analysis of novel situations, and application of nonverbal cues (Rourke, 1995a). According to Piaget (1954), schemata are developed and applied to the social experience. It is through play that children practice social skills, learn social nonverbal cues, and develop relationships, but in the case of children with NLD, their
exploratory play-based learning is restricted by their neuropsychological deficiencies which consequently affect their ability to interact socially.

In contrast, language is transmitted to the child in ready-made and compulsory form (Piaget & Inhelder, 1969). Young children receive structured auditory input and highly directed speech in their interactions with caregivers. As such, children with NLD excel at the rule-governed aspects of language (e.g., language form) but struggle with the semantics and pragmatics of language which are acquired through social interactions during play (Rourke & Tsatsanis, 2000).

*The White Matter Model*

Rourke’s white matter model hypothesized that the NLD syndrome will be manifested to the extent that white matter (long myelinated fibers) systems, either confined to the right hemisphere or spread more diffusely through out the brain, are underdeveloped or dysfunctional and, moreover, abilities subserved by the right hemisphere will be will preferentially affected (McDonald, 2002). Rourke (1995a) perceives the cognitive and behavioral deficiencies of NLD as consistent with impaired intermodal integration such as dealing with novel and complex information. As intermodal integration is dependent on intact white matter connections between primary and associated cortex, and the right hemisphere has relatively more white matter than the left hemisphere which has a higher percentage of gray matter, Rourke theorized that white matter disruption would cause greater right than left hemisphere dysfunction (McDonald, 2002). Thus, white matter disturbances will involve inter- rather than intramodal processing and thereby have a more profound effect on higher cognitive functions (Tsatsanis and Rourke, 1995).
Rourke proposed that although the right hemisphere damage is *sufficient* condition to produce NLD syndrome, it is the destruction of the white matter that is *necessary* for producing the disorder (Rourke et al., 2002). The model’s main principle is that the more white matter that is destroyed or dysfunctional, the more likely it is that the NLD syndrome will be manifested (Rourke, 1995a).

*Cerebral hemispheric differences.* Originally, Rourke attributed the deficit profile in NLD to damage or dysfunction in the right versus the left cerebral hemisphere because observed domains of relative weakness (e.g., visuospatial processing, tactile perception) were generally regarded as controlled by the right hemisphere (Rourke & Finlayson, 1978; Volden, 2004). Rourke adopted Goldberg and Costa’s (1981) theorization of brain functioning in conceptualizing the neuropathogenesis of the NLD syndrome.

Goldberg and Costa proposed that the right hemisphere, relative to the left, is more diffusely organized, has more association regions, and shows greater specialization for interregional integration of information. Because of its capacity to integrate input from multiple brain regions, the right hemisphere is more adept at processing complex, novel, or ambiguous information. In contrast, the left hemisphere is more focally organized, presents greater modality-specific cortical regions, and shows greater specialization for intraregional integration of input. The specialization of the left hemisphere is hypothesized to relate to the routine application of previously acquired cognitive strategies. The two hemispheres complement one another with the right hemisphere showing prominence in establishing new rules, routines or strategies, and the left storing and applying these newly established computations in similar situations or with comparable tasks in the future (Zillmer & Spiers, 2001).
The white matter model. Although initially Rourke (1995a) maintained that the primary deficits of tactile-perceptual, visual-perceptual and psychomotor abilities of the NLD syndrome are consistent with damage or dysfunction of right hemisphere interregional integration, he later extended his model and shifted focus to underdevelopment of, damage to, or dysfunction of the white matter (long myelinated fibers) in the brain as the source of the disorder (Rourke et al. 2002; Volden, 2004).

Rourke expanded on Goldberg and Costa’s (1981) hypothesis that the short fibers between modalities in the left hemisphere would seem to be most adaptable to the analyzing and categorizing of data, and the long myelinated interregional fibers (i.e., white matter) of the right hemisphere would be most adaptable to integrating input from many modalities at once to form a coherent whole of novel and complex schematic stimuli. These views are similar to the popular perception of a holistic-analytical dichotomy of right-left hemisphere functions. Information in the left hemisphere is thought to be processed in a step-by-step, analytical fashion, whereas the right hemisphere is believed to be adept at processing in a more global manner (Semrud-Clikeman & Hynd, 1990).

Cortical functions of white fibers. Rourke (1995) described three principal types of white fibers in the brain: 1) Commissural fibers that cross the midline and interconnect similar regions in the two cerebral hemispheres, with the largest set of these fibers constituting the corpus callosum; 2) Association fibers that interconnect cortical regions of the same cerebral hemisphere; and 3) Projection fibers that project from the diencephalons to the cerebral hemispheres (“input”), and from the hemispheres to the diencephalons, brain stem and spinal cord (“output”). The development of the NLD
syndrome can be caused by damage to 1) the commissural fibers accessing the right hemisphere; 2) the association fibers connecting cortical regions within the right hemisphere; or 3) the projection fibers linking cortical to subcortical regions within the right hemisphere.

Rourke hypothesized that damage to these different communicating fibers accompanies diverse disorders in association with the NLD syndrome. For example, early damage to the association fibers of the right and left hemispheres could potentially cause both the primary deficits of NLD and the global linguistic deficiencies that characterize autism (Zillmer & Spiers, 2001).

Significance of White Matter Development and Dysfunction

Tsatsanis and Rourke (1995) emphasized the significance of examining white matter tracts with respect to childhood disorders. Few fiber tracts are completely myelinated at birth; the most rapid period of myelination occurs within the first two years of life. Myelinogenesis is important because the functional maturity of the fiber tract appears to coincide with the termination of its myelination. Furthermore, postnatal growth spurts in the brain occur without a concurrent increase in neuronal proliferation which, including migration, are complete at birth. Rather, the growth of dendritic processes, synaptogenesis, and myelination are said to account for these postnatal increases in brain weight. In addition, the elimination of excess neurons, dendrites and synapses in the process of refining cortical connections occur during early childhood. Thus, both the development of axonal connections (white matter pathways) and the process of myelination are far from complete in a very young child’s brain, which have implications for the expressions of childhood disorders.
There appears to be two primary consequences of a disturbance in the normal development of white matter: 1) a reorganization or alteration in the normal path of axonal migration, and 2) a blockade of the normal process of axonal elimination. These two processes result in an altered pattern of connectivity in the brain which will bear upon specialization or lateralization of function. Thus, Rourke (1995a) proposed a second major principle in his white matter model: Which white matter is destroyed or dysfunctional, and the stage of development at which white matter is destroyed or dysfunctional, will bear upon the manifestations of the NLD syndrome.

Evidence of NLD Syndrome in Pediatric Neurological Conditions

B. P. Rourke, Del Dotto, S. B. Rourke, and Casey (1990) noted the NLD neuropsychological profile in children with a variety of neurological disorders, such as moderate to severe head injury, hydrocephalus, congenital absence of the corpus callosum, and post-radiation survival of childhood cancer. The commonality among these conditions was not right hemisphere damage, but rather various types of cerebral lesions involving destruction or disturbance of white matter which may differ significantly. For example, *shearing* in the case of the head-injured child; *absence* in the case of children with congenital corpus callosum agenesis, and *removal of tissue* within the right hemisphere. Because the ratio of white matter to grey matter is higher in the right hemisphere, the right hemisphere is more often implicated.

These disorders represent a spectrum of neurodevelopmental conditions that vary in the severity of expression of the NLD syndrome, ranging from disorders that present virtually all the assets and deficits of the NLD syndrome (such as Asperger’s Syndrome), to those that display a majority of the assets and deficits (such as Fetal Alcohol Syndrome...
and Turner’s syndrome), and finally, to those that exhibit only a subset of the assets and deficits of the NLD syndrome (such as autism). Thus, varying numbers of assets/deficits of the NLD syndrome are comorbid manifestations of these disorders caused by damage to the white matter (Rourke, 1995a; Zillmer & Spiers, 2001).

Tsatsanis and Rourke (1995) contended that whereas it may be argued that there is a clear role for white matter functioning in the expression of these childhood disorders, the exact nature of that role is not easily elucidated. Volden (2004) came to a similar conclusion in her literature review of five pediatric neurological conditions that have been associated with NLD, namely agenesis of the corpus callosum, Turner syndrome velocardiofacial syndrome, metachromatic leukodystrophy and periventricular leukomalacia. Overall, she found in several studies, evidence of damage to or dysfunction of cerebral white matter in a variety of conditions that demonstrate deficits in perceptual and cognitive function characteristics of the NLD profile. On the other hand, questions remain about the nature and extent of white matter damage or dysfunction that would give rise to the NLD pattern of deficits. What she found disconcerting was the fact that both verbal and nonverbal difficulties have been documented when white matter damage or dysfunction is specifically related to nonverbal processing difficulties. However, Rourke (1995a) has indicated that it would be expected that significant disruption of white matter within the left hemisphere during the early ontogenetic stages would hamper or even prevent the development of language in the child.

It is noteworthy that Rourke (2000) grouped the first three neurological conditions (corpus callosum, Turner syndrome and velocardiofacial syndrome) investigated by Volden (2004) under “level 1”, indicating that virtually all of the NLD assets and deficits
are manifested. Metachromatic leukodystrophy is a “level 2” classification where a considerable majority of the NLD assets and deficits are evident, while periventricular leukomalacia is not mentioned at all in the hierarchy of classifications. Other neurological disorders considered most like NLD (level 1) by Rourke include Asperger’s Syndrome, Williams syndrome, deLange syndrome, hydrocephalus (early; shunted), and those with significant damage or dysfunction of the right cerebral hemisphere.

Rourke acknowledged that it is very probable that this hierarchy will change and other forms of neurological dysfunction/disease/disorder will be added. It is expected that advances in neuroimaging of white matter functioning, neuropathological findings, and other advances in the specification of the developmental and functional neuroanatomy of myelination will throw considerable light upon the underpinnings of this NLD hierarchy (Rourke, 2000).

Overlap with Other Diagnostic Conditions – Asperger’s Syndrome and High-Functioning Autism

The neurocognitive patterns obtained in Asperger’s Syndrome (AS) appear to follow very closely the cluster of neuropsychological assets and disabilities defining the concept of NLD (Klin, Sparrow, Volkmar, Cicchetti, & Rourke, 1995; Rourke & Tsatsanis, 2000). Rourke (2002) maintained that the neuropsychological profile seen in persons with AS is notably different from that seen in high-functioning autism (HFA), but there is a striking amount of overlap (of AS) with the pattern of assets and deficits seen in the NLD syndrome described by Rourke (1995a).

Currently, controversies arise over whether the two primary representatives of pervasive developmental disorders, autism and AS, are separate disorders, overlapping
subtypes, or one disorder with AS representing individuals with autism who are higher functioning (HFA), both cognitively and adaptively (Zillmer & Spiers, 2001). Ozonoff and Griffith (2000) reviewed years of research for neuropsychological evidence based on motor development, visuospatial functions, theory of mind, and executive functions that hypothetically distinguished AS from higher-functioning forms of autism, but could not find definitive information to make such a distinction. Similarly, Smith (2000) found the issue of the association of clumsiness with AS to be ambiguous after reviewing research intended to differentiate AS from HFA based on their motor functioning. Investigators in the field attribute these inconclusive results contributing to the long-standing diagnostic debate to the inconsistencies across studies with respect to researchers’ definitions of diagnostic criteria, observed behaviors, and control groups (Klin, Volkmar, Sparrow, Cicchetti & Rourke, 1995; Ozonoff & Griffith, 2000; Smith, 2000; Volkmar & Klin, 2000).

More recently, Edgin and Pennington (2005) found spatial processing skills to be intact in autism. They also found no difference between the AS and HFA groups on spatial cognitive and executive function measures, suggesting that AS and autism may not be distinct disorders in terms of these cognitive functions. It is noteworthy that, although the diagnostic criteria (as obtained from the Autism Diagnostic Interview-Revised) for identifying the HFA children was indicated, nothing was mentioned as to how the AS group was assembled except that they were diagnosed by “experienced clinicians independent of this study”.

Given the continuity between NLD and AS, and the controversies over the differentiation of HFA from AS, Volden (2004) questioned whether NLD could be
considered a phenomenon on the autism spectrum. She suggested that if AS is a disorder on the autism spectrum, and if the profile of NLD converges with AS, then NLD could be considered as on the autism spectrum as well. In order “to resolve this issue”, Volden (2004) reviewed research studies to determine if AS is a mild variant of HFA. She found that, although some researchers have indicated that AS and HFA are distinguishable, the bulk of the evidence seems to point to the two conditions as being points on the same continuum. The finding is consistent with Wing’s (1998) that most researchers claim that the distinction between autism and AS is primarily one of severity. For example, Brumback, Harper, and Weinberg (1996) considered AS to be a more severe form or some variant of NLD. This being the case, Volden (2004) suggested that since NLD converges with AS, then NLD could be included on the “borderlands of autism”.

However, Myklebust (1995) informed that in comparing LD and autism, we cannot conclude that because some children with autism have learning disabilities and some learning-disabled children have autistic symptoms that these conditions should be viewed as comprising a single diagnostic category. He added that individuals with NLD and those with autism differ in the neuropsychological constructs of social-perceptual functioning, facial agnosia, and spatial agnosia. On the social-perceptual dimension, Myklebust noted that children with NLD are not out of contact with others as illustrated by their wanting to learn to play games, whereas most children with autism are pervasively limited in social cognition. As for facial agnosia, the researcher noted that some children with NLD are deficient in facial recognition but often recognize others by the color of their hair or clothing, and even by the sound of their voice. Children with autism on the other hand seem to lack awareness of the face, a part of an overall
pervasive limitation in ability to gain meaning from experience. Lastly, children with NLD manifest limitations in spatial perception, but those with autism usually do not.

Besides Myklebust (1975), other investigators too have found evidence suggesting that children with these disorders may be neuropsychologically different. Visuospatial functioning, a primary NLD deficit, has been consistently shown to be an area of strength in children with autism (Ozonoff & Griffith, 2000; Schultz, Romanski, & Tsatsanis, 2000). Furthermore, most studies report higher Performance IQ (PIQ) than Verbal IQ (VIQ) in autism (Ozonoff & Griffith, 2000; Rourke & Tsatsanis, 2000). In contrast, several studies have shown significantly higher VIQ than PIQ in persons with AS, which is also similarly evident in NLD (Volkmar, Klin, Schultz, Rubin, & Bronen, 2000). Bonnet and Gao (1996) compared individuals with AS and HFA and concluded that although they share many similarities, there are sufficient differences to warrant a separate diagnostic entity of AS. For example, they noted that symptoms of AS tend to appear later in development than autism. Furthermore, individuals with AS show more interest in gaining social interaction but are seemingly puzzled by their failure to succeed. Volkmar et al. (2000) indicated that although social disabilities are manifested in both AS and autism, their treatment strategies are different. Verbally mediated treatment programs are most appropriate for individuals with AS, while very structured and problem-oriented psychotherapy and counseling may be indicated in autism.

According to Rourke et. al. (2002), evidence has been accumulating that favors the distinction between AS and HFA despite the continuing disagreement among researchers. In a study by Klin, Volkmar, Sparrow, Cicchetti, & Rourke (1995), 18 of 22 children with AS were found to meet the NLD syndrome criteria, whereas only 1 of the
19 with HFA did. The researchers concluded that the neuropsychological profile of children with HFA seems to suggest that they have greater left than right-hemisphere dysfunction, whereas the NLD syndrome is generally considered a right cerebral hemisphere dysfunction.

Ellis and Gunter (1999) supported Rourke that AS along with NLD are closely associated with dysfunctional right-hemisphere information processing and diminished intercallosal connections centered on incomplete or dysfunctional white matter. Soon after, Gunter, Ghaziuddin, and Ellis (2002) studied individuals who met strictly the diagnostic criteria of DSM-IV and ICD-10 for Asperger’s Syndrome on measures assessing language and communication, verbal and visual memory, and visuospatial abilities. The results suggest that the neuropsychological profile of individuals with AS bears close similarity to that of NLD.

Rourke and Tsatsanis (2000) proposed that the developmental manifestations of NLD can offer an understanding of AS as well as provide a basis from which to distinguish AS from HFA.

Specific NLD Diagnostic Variables

Introduction

Rourke (2000) indicated that the asset of auditory perception and deficits in visual perception, tactile perception, and psychomotor coordination are basic or primary in the development of NLD. In addition, the primary deficits are found to decline relative to age-based norms with advancing years, whereas the primary asset becomes very well developed (B. P. Rourke, Vlugt, & S. B. Rourke, 2002). Although the processing of novel material is considered a primary deficit too, this dimension of NLD has yet to be tested in
a direct manner (Rourke, 2000). Thus for the purpose of this research, the difficulty in handing novelty is treated not as a core neuropsychological deficit, but rather as one of the deficiencies in adaptive behavior.

**Tactile Perception**

*General description.* The world of a young child could be characterized mainly as searching, locating, encountering, and exploring objects in the physical environment through the senses of touch and taste. The knowledge gained through immediate haptic contact, especially during the early phases of development, is thought by researchers to be essential for normal intellectual growth. In the case of children with NLD, during the early phases of development there is little physical exploration of any kind, even for objects that are immediately within reach and could be explored through visual or tactile means (Rourke, 1995a). The basic and early emergent deficits in tactile-perceptual skills of these children are thought to play a very significant role in the eventual manifestations of impaired problem-solving, concept-formation, and related cognitive abilities (Casey & Rourke, 2002). Rourke and his colleagues (Casey, Rourke, & Picard, 1991; Harnadek & Rourke, 1994) have found that children with NLD demonstrate evident bilateral tactile-perceptual deficits which are often more marked on the left side of the body. Deficits in simple tactile imperception and suppression may become less prominent with advancing years, but problems in dealing with complex tactile input tend to persist (Rourke, 2006a).

*Astereognosis.* Complex tactile perceptual deficits (1 SD or more below the norm) are measured by performances on the Reitan-Klove Sensory-Perceptual Exam for finger agnosia, dysgraphesthesia and astereognosis. Sensory information from the primary somatosensory cortex, is integrated at the next level in the secondary somatosensory
cortex which is immediately posterior (Brodmann’s areas 5, 7). Here the individual properties of tactile stimuli such as shape, weight, and texture are combined to form the perception of single and whole percepts such as “pencil” or “coin” that can be recognized by feel. Damage to this area may result in astereognosis, which is the inability to recognize an object by touch even though the child may readily recognize objects by sight (Zillmer & Spiers, 2001). In children with NLD, poor performance with the left hand would support a hypothesis of right parietal lobe dysfunction (Casey & Rourke, 2002).

**Dysgraphesthesia.** Dysgraphesthesia is the difficulty in recognizing letters or numbers drawn by the examiner on skin. The presence of bilateral dysgraphesthesia suggests right cerebral hemisphere dysfunction in children with NLD, the generally accepted basis for this hypothesis being the spatial aspects of the task (Casey & Rourke, 2002).

**Finger agnosia.** Finger agnosia, the inability to recognize or orient to one’s own fingers, is a type of body image disturbance, and deficiencies in body image are attributed to dysfunctions of the non-dominant or right hemisphere (Johnson & Myklebust, 1967). Johnson and Myklebust (1967) observed that a number of children, though competent verbally, have marked deficits in nonverbal learning, including perception of their own body and its relation to the external world.

**Social imperception.** Person- and self-perception, including body image and interpersonal relationships, appear to be highly meaningful aspects of nonverbal experience which children with NLD are commonly deficient in. Their deficiency in *social perception* according to Johnson and Myklebust (1967) includes the perception of
the total social field, perception of oneself in relation to the behavior of others as well as
to events and circumstances that involve others. These children do not perceive the
relationships among nonverbal experiences unless they are appropriately taught and
verbalized for them. They cannot interpret the behaviors of others from observations,
falling to learn the meanings of facial expression, actions, and gestures. Casey and
Rourke (2002) concurred that smooth affective encounters between persons, regardless of
age or stage of development, are greatly enhanced by the presence of intact
somatosensory capacities, and that intimate exchanges between persons would be
impossible without such tactile sensitivity. To be able to make spontaneous adaptations to
novel and rapidly changing social circumstances in interpersonal and group interactions,
a coordinated and integrated sensorimotor functioning system is necessary
(Rourke, 2006m).

*Injury prone.* In addition, many children with NLD given their somatosensory
imperception fail to grasp the significance of hazards in their environment, such as traffic
in parking lots and the streets. They do not perceive danger and hence do not relate
immediate behavior to the future (Johnson & Myklebust, 1965). Moreover, they are more
likely to fall from swings, slides, bicycles, and so on than children whose somatosensory
perception is developing normally. As they grow older, adolescents with NLD are likely
to continue to be at risk for harm and injury given their difficulties in coping with age-
appropriate demands for insights into cause and effect of social interactions, concept
formation, hypothesis testing, and trouble shooting (Rourke, 2006e).

*Tactile perception and cognitive development.* Casey and Rourke (2002) made the
link between tactile perception and cognitive development, citing studies such as the
Florida Longitudinal Project which demonstrated evidence of finger agnosia in preschoolers and their subsequent problems in learning to read. In her sampling of children with low nonverbal abilities aged 5 to 11 years, Badian (1992) found that 41% of them were below average in reading. However, the Florida study also showed that the strength of this association is decreased in older children with reading disabilities. Thus, it appears that the relationship between these two variables is not a direct one, but rather that both are dependent upon other developmental processes. Rourke et al. (2002) indicated that children with NLD have well-developed rote verbal abilities (e.g., single-word reading and spelling), frequently superior to age norms, but show substantial deficit in reading comprehension abilities especially for novel material (particularly so in older children).

It is suggested that the cognitive processes thought to be fundamental to the development of finger recognition (viz., intrasensory differentiation, intersensory integration, and representational/symbolic thinking) play an important role in the development of reading skills as well as the ability to deal with novel or complex information for which there is no preexisting neural code (Casey & Rourke, 2002). Rourke et al. (2002) indicated that individuals with NLD have substantial difficulty in dealing with novel or complex situations because of their over-reliance on rote, memorized reactions and approaches, and failure to learn from feedback. These tendencies appear to remain or worsen with age. Children and adolescents with NLD exhibit impairment on both the Halstead Category Test and Wisconsin Card Sorting Test thought to be measures of rule deduction/concept formation and executive-type functioning respectively (Fisher, DeLuca, & Rourke, 1997). By early adolescence, they
show marked deficits in concept formation, problem solving and hypothesis testing especially in a novel or complex context which are evident in persistent difficulties in academic subjects involving problem-solving and complex concept-formation (e.g., physics). The gap between deficiencies in this type of complex academic endeavor and other, more rote, programmatic academic pursuits widens with age (Rourke, 2006a).

**Visual-Spatial-Organizational Perception**

*General description.* The NLD population is characterized by impaired discrimination and recognition of visual detail and visual relationships, and outstanding deficiencies in visual-spatial-organizational skills. Simple visual discrimination, especially for material that is easily verbalized, usually approaches normal levels with advancing years. Complex visual-spatial-organizational skills, especially when required within a novel framework, tend to worsen relative to age-based norms (Rourke, 2006a). Visuospatial-organizational deficiencies are measured by performance on the Target Test of 1 standard deviation or more below the norm, and where Verbal IQ exceeds Performance IQ by 10 or more standard score points (Casey, Rourke, & Picard, 1991; Harnadek & Rourke, 1994).

*Psychosocial difficulties.* Rourke (2006m) counted the psychosocial difficulties of persons with NLD to be ramifications of their deficits in visual-spatial-organizational skills. For example, they misinterpret visual nonverbal cues in social context by standing too close or too far away from other persons whilst engaged in various forms of social interaction; or they have extreme difficulties in appreciating others' nonverbal "body language".
It has been demonstrated that children with NLD display significant deficits in nonverbal emotion perception. Worling, Humphries, and Tannock (1999) made the connection between problems in interpreting social-emotional content and basic underlying visuospatial deficit when they found that it was only in the NLD group (and not in children with verbal impairments) that difficulties in emotional inferencing about story content were related to their problems in spatial language inferencing. Children with NLD were shown to be less successful than those with verbal deficits in interpreting emotions from facial expressions (Dimitrovsky, Spector, Levy-Shiff, & Vakil, 1998). Another study concurred that they were less accurate than the control group in inferring affect from adult facial expressions or gestures, and were twice as likely as those with verbal learning disabilities to be diagnosed as having an internalized disorder (Petti, Voelker, Shore, & Hayman-Abello, 2003). Rourke et al. (2002) indicated that they have extreme deficits in social perception, judgment and interaction, often leading to eventual social isolation/withdrawal. They are easily overwhelmed in novel situations, with a marked tendency toward extreme anxiety, even panic, in such situations. Furthermore, they have a high likelihood of developing internalized forms of psychopathology (e.g., depression) in later childhood and adolescence.

*Problems with visual imagery.* Children with NLD have problems with visual imagery tasks (Cornoldi, Rigoni, Tressoldi, & Vio, 1999). According to Thompson (1997), visual imagery is the ability to mentally dissect what is seen and then to rearrange or reconfigure those parts in relation to the whole, like manipulating the pieces of an imaginary puzzle in one’s head. Their basic deficits in visual perception and visual imagery cause problems in visual-motor integration, gestalt processing and concept
formation (Thompson, 1997). In turn, these problems give rise to impairment in social judgment that necessitates integrating data from environmental sources and generating reasonable hypotheses in the assessment of social cause-and-effect relationships (Rourke, 2006m).

Children with NLD focus on the details of what they see and often fail to grasp the total picture, an ability that is necessary in hypothesis-testing, concept formation, decision-making and problem-solving. It is the lack of mental capacity to grasp configurations of multiple details, rather than to deal with details as isolates or in linear sequences, which represents impaired thinking or ‘lack of imagination’. This tendency to focus on detail at the expense of the ‘big picture’ may impede academic achievement in literature, history, and social and natural sciences (Denckla, 1991).

*Visual memory deficits.* Liddell and Rasmussen (2005) found that children with NLD perform significantly worse on measures of visual than verbal memory, and with deficits in memory for faces more severe than other measures of nonverbal visual memory. Specifically, the children’s immediate memory for faces was more impaired than delayed memory for faces. The researchers hypothesized that children with NLD may take longer to encode a face, but once it is encoded they may have less difficulty recognizing the face on a delayed memory test. They may also require extra time for memory consolidation. This is consistent with Rourke et al. (2002) who indicated that individuals with NLD have poor attention and memory for tactile and visual input. Relative deficiencies in these areas tend to increase over the course of development, except for material that is programmatic and over-learned (e.g., printed text and spoken natural language). Their deployment of selective and sustained attention is much better
for simple, repetitive verbal material (especially that delivered though the auditory modality) than for complex, novel nonverbal material (especially that delivered through the visual or tactile modalities). They have relatively poor memory for complex, meaningful, and/or novel verbal and nonverbal material if the complex material is not readily coded in a verbal fashion (Thompson, 1997). Of interest is the suggestion that visual-simultaneous and visual-sequential processes in visuospatial working memory of NLD may exist (Mammarella et al., 2006).

Impairment in spatial cognition. Another study showed that children with NLD have difficulties with both the visual and spatial components of visual working memory, and that their deficit with spatial components appears to be more severe (Cornoldi, Rigoni, Tressoldi, & Vio, 1999). According to Denckla (1991), impairment in spatial cognition, i.e. difficulty keeping relationships and simultaneous occurrences in mind, may be the most severe aspect of NLD because of its protracted impact on cognitive development and invasion on the verbal domain. For example, the interpretation of nonliteral usages within language, as in colloquial expressions, proverbs, simile, metaphor and humor, as well as the appreciation of incongruity may become the source of difficulty in the study of language and culture. In athletics, rapid reaction time demand a high level of spatial cognition and the appreciation of a temporospatial matrix (where to be, and when), which may be reasons for failure in team sports even when talent coexists (Denckla, 1991).

Topographagnosia. Particular problems with spatial orientation and visuo-spatial memory cause children with NLD to get lost even in familiar surroundings and be slow to learn their way around a new area (Lezak, Howieson, & Loring, 2004).
Topographagnosia refers to getting lost in space or being spatially disoriented and is seen in children’s adjustment to separation from parents, changing classrooms or schools, and playing in the neighborhood. Getting lost easily can be observed as early as nursery school, when some toddlers cling to adults or to the walls. At play, the spatially disabled child may be ridiculed for running in the wrong direction, scoring in his/her own team’s goal because of failure to reorient at the half-time switch at soccer; and getting lost on hikes or bicycle outings (Denckla, 1991).

**Daily adaptive problems.** Johnson & Myklebust (1965) associate disturbances in spatial orientation with disturbances of body image. Because of faulty body image, or because of an inability to relate themselves to the spatial world, children with NLD bump into things, cannot estimate distance, and lose their way enroute to a destination. These children cannot properly follow directions in regard to pencil and paper routines, in physical education, or in everyday activities due to limitations in awareness of right-left in general. Some preschool children are delayed in grasping the back-to-front orientation of shirts or pants and, even more often, right and left in matching shoes to correct feet (Denckla, 1991). The lack of visual-spatial-organizational skills together with tactile imperceptions render these children at risk for personal injury through their misperception of physical dangers arising from their failure to appreciate the dangers inherent in situations and the consequences of their actions (Rourke, 2006e).

**Visuospatial perceptual deficits and arithmetic failures.** The visuospatial perceptual deficits of children with NLD show up in arithmetic failures requiring written calculations involving spatial organization, and in difficulty copying designs, making constructions, and matching or discriminating patterns or faces (Lezak, Howieson, &
Loring, 2004). Rourke (1993) described their substantial deficit in mechanical arithmetic (such as Wide Range Achievement Test (WRAT) Arithmetic subtest) as persistent and most prevalent errors in spatial organization (misaligning numbers in columns), visual detail, procedure, failure to shift psychological set, graphomotor, memory, and judgment and reasoning. In concurrence, Semrud-Clikeman and Hynd (1990) concluded in their literature review that the early precursors of arithmetic can be significantly impaired by right hemisphere dysfunction. They suggested that nonverbal social-emotional problems and arithmetic difficulties may be related to right hemisphere dysfunction as both involve the manipulation of spatial and visuoperceptual processes. Moreover, it is observed that children with NLD have a distorted sense of time, both in estimating elapsed time over an interval as well as estimating time of day (Rourke et al., 2002). It is expected that the absolute level of mechanical arithmetic performance of adolescents with NLD only rarely exceeds the Grade 5 level, and mathematical reasoning, as opposed to programmatic arithmetic calculation, remains poorly developed (Rourke, 2006a).

Strang and Rourke (1985) indicated that mechanical arithmetic is a very complex academic subject where even seemingly simple mechanical arithmetic calculation involves many steps, rules, and facts about numbers (e.g., there are no less than 33 steps to arriving at the answer to \(62 \times 96 = ?\)). Furthermore, a change in just one digit in a proposed calculation can substantially alter the requirements of the operation. As such, they reasoned that a child with a wide variety of neuropsychological impairments would experience difficulty with acquiring mechanical arithmetic skills.

On the contrary, Denckla (1991) argued that these children may be able to compensate with their verbal-sequential asset in very early counting and single-digit
arithmetic operations which can be mastered with minimal spatial contribution. Place value of number brings in a spatial background but is still compensable by a strong verbal memory for facts and sequential rules. Thus, ‘rote’ learning of arithmetic with little spatial underpinning is within the capacity of the verbal-sequential analytic ability of children with NLD, except for the more demanding levels of mathematics like solid geometry or topology.

Offering yet another perspective, Rourke (1995a) indicated that while they may very well lack the capacity to engage in elementary mathematical thinking, adolescents with NLD perform much better in secondary school mathematics than they did in elementary school arithmetic to the extent that secondary school mathematics require verbatim memory for theorems and corollaries as opposed to adaptive problem solving.

Consistent with his premise, Rourke’s (1997) research review of brain-behavior relationships and mathematics revealed that studies of adults implicated mainly the left cerebral hemisphere, whereas studies of children implicated the right-and left-hemispheral systems. Rourke (1997) reasoned that the cognitive demands of executing learned calculation skills differ considerably from those of initial arithmetic learning in children. The integrative, complex, and novel dimensions of early mathematical learning in children are lateralized to the right hemisphere, whereas in adults, basic arithmetic procedures involving number facts retrieval become sufficiently routinized to be executed primarily by the left hemisphere.

A functional magnetic resonance imaging (fMRI) study by Prabhakaran, Rypma, and Gabrieli (2001) provides further evidence of cerebral hemispheric functions during various mathematical operations. The results of their study indicate that solving
mathematical word problems is dependent on a fronto-temporal network, and that the mathematical reasoning component in solving word problems is largely dependent on bilateral frontal regions. The researchers hypothesized that the right frontal regions make use of spatial working memory resources to construct the conceptual understanding of the problem to be solved, while the left frontal regions make use of nonspatial working memory resources to construct the mathematical formulation of the problem to be solved. In addition, it was shown that simple arithmetic calculations are highly dependent on left parietal areas. However, the 7 subjects of the study were healthy graduate students and these results may not generalize to early elementary school-age children but could explain the stagnation of the mathematical performance of adolescents with NLD at grade 5 or 6 (Rourke, 1995a).

Finally, it should be noted that not all children with NLD have arithmetic disability. Rourke (2006l) indicated that based on the Pelletier, Ahmad, and Byron (2001) study, approximately 65% of children with NLD between the ages of 9 and 15 years also exhibit specific arithmetic disability, whereas an estimated 40% of 7- to 8-year old children with NLD also exhibit specific arithmetic disability according to the investigation of Drummond, Ahmad, and Rourke (2005).

**Psychomotor**

*General description.* Bilateral psychomotor coordination deficiencies are prominent in NLD, and are often more marked on the left side of the body. Except for well-practiced skills (e.g. handwriting) and other simple and repetitive motor skills, these deficits tend to increase in severity with age, especially when they are required within a novel framework (Rourke, 2006a; Rourke et al., 1990). Bilateral psychomotor
deficiencies are measured by performance (either hand) on the Grooved Pegboard Test which are 1 standard deviation or more below the norm (Casey, Rourke, & Picard, 1991; Harnadek & Rourke, 1994).

Problems maintaining bodily balance. Children with NLD have substantial problems maintaining bodily balance, which makes learning to ride a two-wheel bicycle laborious or staying seated at the dinner table or at a desk in school difficult. To remain seated, these children must literally remember a previous experience of equilibrium and then restructure that memory cognitively to achieve a position of bodily balance (Thompson, 1997). If attention is diverted from this cognitively maintained balance, they may fall off the chair, most times on the left side. Thus, they prefer to eat and do homework on the floor.

Poor psychomotor coordination. These children have poor psychomotor coordination, and appear clumsy and slow in motor reaction. Simple athletic skills, such as kicking a soccer ball, jumping up to shoot a basket or jumping jacks, are difficult for them to master. They are not able to just ‘watch and learn’ common nonverbal motor patterns (e.g., jumping rope) and become embarrassed during PE, on the playground, in creative activities and many other social group situations. Furthermore, their fine motor skills (e.g., buttoning, tying shoe laces, cutting with scissors, eating with fork and spoon, etc.) are impaired. In school, writing is slow and arduous because they have difficulty holding a pencil correctly, and they often produce dark and heavy lines in an attempt to control their writing (Thompson, 1997). However, with considerable practice their handwriting often becomes quite good, while some avoid practice and remain deficient in such skills (Rourke, 2006a).
Psychosocial difficulties. Rourke (2006m) indicated that the importance of psychomotor coordination coupled with basic sensory-perceptual competencies for normal psychosocial functioning are often undervalued due to the over emphasis on linguistic proficiency. Psychomotor clumsiness does not facilitate smooth and coordinated interactions or adaptations to the constantly changing demands of social situations, particularly in the development of affectionate or intimate relationships in late adolescence and adulthood. Because of their incoordinated behaviors, persons with NLD may be seen by their peers as idiosyncratic, sloppy, or careless and be excluded from social activities such as team sports or dances. They may even be considered as social misfits and be rejected. With advancing age, their increasing socioemotional problems are expected to lead to a greater likelihood of social withdrawal, social isolation, and depression.

Auditory Perception

General description. After a very early developmental period when such skills appear to be lagging, the auditory-perceptual capacities of children with NLD become very well developed and they are able to benefit from repetitive acts or input of rote material through the auditory modality. In addition, selective and sustained attention for simple, repetitive verbal material (especially auditory), and rote verbal memory and memory for material that is readily coded in a rote verbal fashion become extremely well developed. Their auditory perceptual asset is evident academically in average to above-average single-word reading and spelling skills. Misspellings are almost exclusively of the “phonetically accurate” variety typically seen in normal spellers. Verbatim memory
for oral and written verbal material can be outstanding in the middle to late elementary school years and thereafter (Rourke, 2006a; Rourke & Tsatsanis, 1996).

**Supporting studies.** Adolescents and adults with NLD have been shown to be more likely to spontaneously employ serial verbal learning strategies as opposed to those that are semantically driven, suggesting a passive approach not relying on conceptual and organizational abilities or contextual cues but on well-developed rote skills (Fisher & DeLuca, 1997). These individuals with NLD are not apt to utilize semantic content as a memory aid compared to controls with verbal learning disorder who performed equally well on both the serial and semantic clustering. The serial clustering score refers to the number of instances the subject reports two consecutive items in the same order as they appeared on the word list, while the semantic clustering score refers to reports from the same semantic category.

A recent neuroimaging study of two teenagers with NLD underscores the importance of providing verbally targeted remediation strategies for this population (Tuller, Jantzen, Olvera, Steinberg, & Kelso, 2007). Both NLD participants showed a significant increase in activity within Broca’s area during novel fine-motor sequencing (area of difficulty in NLD) when the task was verbally instructed rather than when tactile instructions were provided. This suggests that they may be using verbal information to rehearse the required sequence silently or using ‘self-talk’ to mediate action. However, they seemed less able to remember and guide the required movement sequence when explicit verbal instruction was unavailable. Nevertheless, verbally mediated strategies were attempted to some extent even with tactile instruction although they were not
sufficient to reduce errors on the tasks. As for the two controls, recruitment of brain areas was unaffected by the instruction mode.

Evidence from daily living. The utilization of verbally mediated strategies is evident in the daily functioning of children with NLD, who overcompensate with their auditory perceptual asset for deficits in psychomotor, tactile and visual-spatial-organizational skills. For example, they want to be told explicitly what is expected of them, what to do, how to do it, because they are unable to figure out things for themselves (Thompson, 1997). Subconsciously they verbally label everything in their environment in order to remember and comprehend things happening around them which are ordinarily recognized and assimilated instantly. Their experiences are stored in memory by their verbal labels and not by visual images. These children constantly talk their way through situations and problem-solving as a means of verbally compensating for their deficiencies. For example, counting and labeling environmental markers; and through self-talk, recounting a sequence of details which they have taken pains to label and commit to verbal memory in order to find their way around in the neighborhood or shopping mall (Thompson, 1997). As such, they develop a remarkable rote memory for details as a coping technique which, however, breaks down under novel or highly complex situations and generate increased anxiety. It is therefore no surprise that they prefer the security of familiar and predictable situations and resist attempts at modifying their circumstances through the introduction of a new substitute teacher.

NLD and Auditory Processing Disorder (APD). It has been postulated by Keller, Tillery and McFadden (2006) that children with NLD may be at risk for Auditory Processing Disorder (APD), which may be defined as “an observed deficiency in auditory
discrimination, pattern recognition, sound localization, temporal ordering and integration, and the correct interpretation of speech signals within the context of competing or other forms of degraded signals”. Four subtypes of APD have been delineated – decoding, tolerance-fading memory (TFM), organization and integration – of which children with TFM profile have been described as strikingly similar to children with NLD. Whereas articulation skills with isolated words are often satisfactory, children with TFM demonstrate a reduced ability to make inferences, are impulsive, display poor reading comprehension, and have weak handwriting. Furthermore, the performance of individuals with TFM profile on the Staggered Spondaic Word (SSW) test is characterized by a greater number of errors on the left ear competing condition, which is consistent with right hemispheric imperceptions typical of NLD. The researchers found in their sample of 18 children diagnosed with NLD that 11 of them (61%) met the criteria for APD, of which 10 of them (90%) manifested the TFM subtype of APD.

The findings of the present investigation appear to support the common observation that children with NLD have difficulties noticing or distinguishing changes in tone or pitch of voice or emphasis of delivery in others’ or their own speech (Thompson, 1997). Moreover, Myklebust (1975) has indicated that although NLD involves mainly visual cognitive processing, minor auditory deficits giving rise to indirect secondary effect may be present with the exception of severe auditory nonverbal deficits.

Compared to the NLD group, the NLD +APD group had significantly lower scores on Digit Span, Block Design, Sentence Memory, and Speech Sounds Perception tests. Contrary to expectation, both groups performed significantly low on the Speech
Sounds Perception test which is typically used to determine auditory perception and is considered a relative strength in NLD (Harnadek & Rourke, 1994; Rourke & Finlayson, 1978).

In concluding, Keller et al. (2006) noted that APD has been criticized as a diagnostic entity given the lack of data relating APD to specific learning disorders. Moreover, their present investigation did not include a control group. Thus, the reliability of these findings needs to be further examined in future studies where comparisons are made with a control group, given that auditory perceptual ability is a well-established primary neuropsychological asset of children with NLD (Rourke, 1991, 1994, 1995; Rourke et al., 1990, 1991, 2002; Harnadek & Rourke, 1994; Rourke & Tsatsanis, 1996). Nevertheless, the findings of Keller et al. (2006) highlight that one should expect similarities and dissimilarities in children with NLD, and their individual differences must be emphasized (Myklebust, 1975).

Combination of NLD Diagnostic Variables

*Principal Identifying Features of NLD*

For clinical and experimental purposes, Rourke and his colleagues saw the need to establish the most discriminating features that differentiate children with NLD. Three investigations were conducted and the principal classification rules or criteria for NLD obtained. However, these studies, according to Harnadek and Rourke (1994), were limited by the statistical methods employed: 1) the selection of control groups very different from NLD (Harnadek & Rourke, 1994); 2) utilization of original tests that have since been revised (Pelletier, Ahmad & Rourke, 2001; Drummond, Ahmad & Rourke, 2004); 3) sample selection bias (Pelletier, Ahmad & Rourke, 2001); and 4) small sample
size (Drummond, Ahmad & Rourke, 2004) restrict the extent to which these NLD criteria can be generalized. At best, the studies serve as one source of information to assist the clinician in deciding whether a comprehensive neurological assessment is necessary for a NLD diagnosis. The researchers strongly recommend further investigations into these tentative rules.

*First empirical study.* To determine the relative discriminative power of various dimensions thought to be typical of children with NLD, Harnadek and Rourke (1994) selected children who exhibited the NLD syndrome, those who matched the R-S (reading-spelling deficient) academic achievement test profile, and a non-clinical control (NC) group. The R-S subjects were selected solely on their Wide Range Achievement Test (WRAT) Reading and Spelling subtest scores which were at least 1.8 years below their Arithmetic subtest grade-equivalent score. The three groups were administered two sets of tests that statistically differentiated them. The first set of four neuropsychological tests (Target Test; the Trail making Test, Part B; the Tactual Performance Test; and the Grooved Pegboard Test) assesses visual-spatial organization, tactile-perception, and psychomotor skills, and the second set of tests (WRAT and Speech Sounds Perception Test) is sensitive to academic (reading) and auditory-perceptual skills. These two sets of measures accurately classified the NLD cases with 95% accuracy and all of the R-S and NC children.

Compared to the R-S and NC groups, the NLD group performed more poorly on tests of visual-spatial-organizational skills, psychomotor coordination, complex tactile-perceptual skills, and conceptual and problem-solving skills. Furthermore, on tests of the more rote aspects of verbal and psycholinguistic skills, the NLD group performed within
normal range and did not differ significantly from the non-clinical (NC) group. Therefore, when considering a NLD diagnosis, Harnadek and Rourke (1994) suggested focusing on children’s performance on visual-spatial-organizational ability, psychomotor coordination skill, and complex tactile-perception ability since these appear to be most characteristic of the syndrome. However, further investigations are required to determine whether the six measures are sufficiently sensitive to be employed for individual diagnosis, thus reducing the need for the full battery (Zillmer & Spiers, 2001).

Second empirical study. Pelletier, Ahmad and Rourke (2001) attempted to elucidate rules to classify the two subtypes of LD, namely, Basic Phonological Processing Disabilities (BPPD) and NLD exhibited in children of ages 9 to 15 years old. The BPPD group refers to the R-S children who have very poor single-word reading and spelling skills and significantly better, but still impaired mechanical arithmetic skills. The results of the investigation produced 10 rules/criteria for the classifications of BPPD and 8 for NLD which were ranked hierarchically according to the actual incidence of these rules in children.

A notable finding of the investigation concerns the NLD criterion, VIQ > PIQ by at least 10 points (i.e. verbal skills are superior to visual-spatial-organizational skills), that was evident in only 25% of the time, implying that the exclusive use of this rule would cause 70% of the definite and probable NLD population to be missed. It would appear that dropping it as a criterion would, in all likelihood, have no appreciable effect on ‘diagnostic’ accuracy.

This present finding, as well as that of the later investigation with younger children by Drummond, Ahmad and Rourke (2005), support Denckla’s (1991) contention
that the PIQ scale is not to be interpreted as a test of either spatial ability or nonverbal ability as the scale taps other factors too. In the same way, the VIQ is not free of nonverbal configurational, simultaneous cognitive processes. Denckla (1991) elaborated that right hemispheric simultaneous processing skills seen in developing children and adolescents follow the acquisition of basic linguistic skills in a sequence of emergent abilities that become part of verbal intelligence. Increasing age brings with it greater expectations on the tests, and adolescents with significant nonverbal disabilities may experience decreases in both scales of the intelligence test. Thus, the discrepancy between VIQ and PIQ is expected to be greater in younger than older children, and this appears to be supported by Drummond’s et al. (2005) study.

Pelletier et. al. (2001) indicated that the strict application of the remaining first seven tests should result in very few false positives and false negatives. These are as follows, with the percentages of cases for which each feature/rule applied indicated in parenthesis (%) (Rourke, 2006j):

(1) Less than two errors on simple tactile perception and suppression vs. finger agnosia, finger dysgraphesthesia, and astereognosis composite greater than 1 SD below the mean (90%), i.e., simple tactile-perceptual skills are superior to complex tactile-perceptual skills.

(2) Wide Range Achievement Test (WRAT) standard score for Reading is at least 8 points greater than Arithmetic (85%), i.e., single-word reading is superior to mechanical arithmetic.

(3) Two of Wechsler Intelligence Scale for Children (WISC) Vocabulary, Similarities, and Information are highest of the Verbal scale (75%), i.e., straightforward and/or rote
verbal skills are superior to those involving more complex processing (e.g., comprehension).

(4) Two of WISC Block Design, Object Assembly, and Coding subtests are the lowest of the Performance scale (75%), i.e., complex visual-spatial-organizational skills and speeded eye-hand coordination are impaired.

(5) Target Test at least 1 SD below the mean (60%), i.e., memory for visual sequences is impaired.

(6) Grip strength within one standard deviation of the mean or above vs. Grooved Pegboard Test greater than one standard deviation below the mean (60%), i.e., simple motor skills are superior to those involving complex eye-hand coordination, especially under speeded conditions.

(7) Tactual Performance Test Right, Left, and Both hands; time taken for the tests becomes progressively worse relative to the norms (60%), i.e., complex tactile-perceptual and problem-solving skills under novel conditions are impaired.

(8) WISC/WISC-R VIQ > PIQ by at least 10 points (27%)

Rourke (2006j) summarized the above NLD identification criteria as follows:

First 5 features: Definite NLD; 7 or 8 of these features: Definite NLD; 5 or 6 of these features: Probable NLD; 3 or 4 of these features: Questionable NLD; and 1 or 2 of these features: Low Probability of NLD. Pelletier et. al. (2001) emphasized that these rules/criteria are not intended to substitute for a comprehensive neuropsychological evaluation but are meant to serve as one source of information that would assist the clinician in deciding whether a comprehensive neuropsychological evaluation is warranted when considering a diagnosis of NLD. In addition, Rourke (2006j) cautioned
that these rules are very much in need of refinement, even after the rather impressive results of their first concurrent validity study.

*Third empirical study.* Following the Pelletier’s et al. (2001) investigation, Drummond, Ahmad and Rourke (2005) purposed to evaluate the applicability of the resulting criteria for a younger population with NLD and BPPD, and to make revisions if necessary. The participants were 114 BPPD and 10 NLD of ages 7 and 8 years. The children not only had to meet the hierarchical criteria for definite or probable NLD/BPPD according to Pelletier et. al. (2001), but also had to receive an LD classification from the neuropsychologist to be included in the study. The tests used to generate the rules for classification fell into seven categories: Academic achievement, psychomotor, tactile perceptual, visual-spatial, auditory perception, language, and problem solving.

The results of the study indicated that Pelletier’s et. al. (2001) rules for classification of BPPD and NLD differ somewhat in the percentages to which they applied to older and younger children, and a revision of these rules were necessary. The rules arranged in a hierarchical frequency according to the order in which they applied (i.e., %) are as follows (Rourke, 2006j):

1. Target Test at least 1 SD below the mean (90.0%), i.e., memory for visual sequences is impaired.
2. Two of Wechsler Intelligence Scale for Children (WISC) Block Design, Object Assembly, and Coding subtests are the lowest of the Performance scale (90.0%), i.e., complex visual-spatial-organizational skills and speeded eye-hand coordination are impaired.
3. Two of WISC Vocabulary, Similarities, and Information are the highest of the Verbal
scale (80.0%), i.e., straightforward and/or rote verbal skills are superior to those involving more complex processing (e.g., Comprehension).

(4) Tactual Performance Test Right, Left, and Both hand times become progressively worse vis-a-vis the norms (77.8%), i.e., complex tactile-perceptual and problem-solving skills under novel conditions are impaired.

(5) Grip Strength within one standard deviation of the mean or above versus Grooved Pegboard Test greater than one standard deviation below the mean (70.0%), i.e., simple motor skills are superior to those involving complex eye-hand coordination, especially under speeded conditions.

(6) WISC VIQ > PIQ by at least 10 points (70.0%), i.e., verbal skills are superior to visual-spatial-organizational skills.

(7) Wide Range Achievement Test (WRAT) standard score for Reading is at least 8 points higher than Arithmetic (60.0%), i.e., single-word reading is superior to mechanical arithmetic.

(8) Less than two errors are made on simple tactile perception and suppression versus finger agnosia, finger dysgraphesthesia, and astereognosis composite greater than one standard deviation below the mean (10.0%), i.e., simple tactile-perceptual skills are superior to complex tactile-perceptual skills.

The above hierarchy of criteria indicates that rules related to visual-spatial perception (rules 1 and 2) applied to the highest percentage of children (90%). The researchers suggest that strict application of criteria #1 through 3 should result in very few false positives or false negatives. Interestingly, the NLD rule that most discriminate younger from older children was rule 8, the tactile perception test (i.e., less than 2 errors
on simple tactile perception and suppression versus finger agnosia, finger
dysgraphesthesia and astereognosis composite greater than 1 SD below the mean).
Whereas the rule applied to nearly 90% of older children with NLD, its incidence was
only 10% in the younger population. It would appear that dropping #8 as a criterion
would, in all likelihood, have no appreciable effect on classification/diagnostic accuracy
in younger children with NLD.

As in the Pelletier’s et. al. (2001) study, Drummond et. al. (2005) stressed that
these rules are very much in need of refinement, and should not substitute a
comprehensive neuropsychological evaluation. In addition, the generalizability of these
criteria is limited by the small number of NLD subjects. On a final note, Drummond et.
al. (2005) asserted the continuing applicability of the rules despite differences between
the WISC-III used in their study and the latest revised version, WISC-IV.

Summary of the three investigations. The objective of these three investigations
was to elucidate the most salient features of NLD for the purpose of deriving a set of
brief diagnostic criteria. The researchers concluded that the results were tentative and
were to be applied with caution in view of the limitations of these studies. In the case of
Harnadek and Rourke (1994), the nature of the clinical group selected to serve as a
contrast to the NLD sample was very different, thus contributing to the high accuracy of
classification. Harnadek and Rourke (1994) recommended further comparisons using
children with other clinical disorders that have commonality with the NLD syndrome. As
for Pelletier, Ahmad and Rourke (2001) study, the major limitation was sample selection
bias through the use of clinically referred subjects, selection criteria employed, and the
use of a profile-matching program. The third investigation (Drummond, Ahmad, &
Rourke, 2005) is severely limited by the small number of NLD subjects \( n = 10 \). Rourke (2006j) emphasized that further investigations are needed to clarify the relationship between the number of criteria or features and the degree of probability of NLD diagnosis.

Nevertheless for the purpose of future empirical investigations, Rourke et al. (2002) proposed adopting the diagnostic criteria set out in Table 2.1 in the identification of the sample with NLD. Furthermore, they redefined the age limits for the younger (i.e., up to 6 years) and older (7 years and above) groups (see Table 2.2), also presumably for the purpose of streamlining the NLD sample in empirical research. The importance of utilizing a stringent and operational definition of subjects studied has been highlighted by Rourke’s investigations, given the difficulty of building upon the findings of researchers if they individually chose different diagnostic criteria such as in studies on the validity of Asperger syndrome (Klin, Volkmar, Sparrow, Cicchetti, & Rourke, 1995).

Table 2.1

<table>
<thead>
<tr>
<th>Diagnostic criteria for research in nonverbal learning disabilities (Rourke et al. (2002))</th>
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<tbody>
<tr>
<td>1. Bilateral deficits in tactile perception, usually more marked on the left side of the body. Simple tactile perception may reach normal levels as the child ages, but interpreting complex tactile stimulation remains impaired.</td>
</tr>
<tr>
<td>2. Bilateral deficits in psychomotor coordination, usually more marked on the left side of the body. Simple repetitive motor skills may reach normal levels with age, but complex motor skills remain impaired or worsen relative to age norms.</td>
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<tr>
<td>3. Extremely impaired visual-spatial-organizational abilities. Simple visual discrimination can reach normal levels with age, particularly when stimuli are simple. Compared to age norms, complex visual-spatial-organizational abilities worsen with advancing years.</td>
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<tr>
<td>4. Substantial difficulty in dealing with novel or complex information or situations. A strong tendency to rely on rote memorized reactions, approaches, and responses (often inappropriate for the situation), and failure to learn or adjust responses according to informational feedback. Also, especially frequent use of verbal responses in spite of the requirements of the novel situation. These tendencies remain or worsen with age.</td>
</tr>
<tr>
<td>5. Notable impairments in nonverbal problem-solving, concept-formation. And hypothesis-testing.</td>
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<tr>
<td>6. Distorted sense of time. Estimating elapsed time over an interval and estimating time of day are both notably impaired.</td>
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Table 2.1 (continued)

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<tr>
<th>Diagnostic criteria for research in nonverbal learning disabilities (Rourke et al. (2002))</th>
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<tr>
<td>7. Well-developed rote verbal abilities (e.g., single-word reading and spelling), frequently superior to age norms, in the context of notably poor reading comprehension abilities (particularly so in older children).</td>
</tr>
<tr>
<td>8. High verbosity that is rote and repetitive, with content disorders of language and deficits in functional/pragmatic aspects of language.</td>
</tr>
<tr>
<td>9. Substantial deficits in mechanical arithmetic and reading comprehension relative to strengths in single-word reading and spelling.</td>
</tr>
<tr>
<td>10. Extreme deficits in social perception, judgment, and interaction, often leading to eventual social isolation/withdrawal. Easily overwhelmed in novel situations, with a marked tendency toward extreme anxiety, even panic, in such situations. High likelihood of developing internalized forms of psychopathology (e.g., depression) in later childhood and adolescence.</td>
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Table 2.2

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<thead>
<tr>
<th>Nonverbal learning disabilities characteristics at younger and older age levels (Rourke et al., 2002)</th>
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</table>

**Characteristics particularly evident in younger children (up to 6 years)**

1. Delays in reaching all developmental milestones, including speech, followed by a late but rapid development of speech and some other verbal abilities, usually to above-average levels.
2. Below-normal amount of exploratory behavior.
3. Impaired development of complex psychomotor skills (e.g., climbing, walking).
4. Avoidance of novelty, and preference for highly familiar objects, stimulation, and information.
5. Preference for receiving information in verbal as opposed to visual format.
6. Strengths in simple, repetitive motor activities and in rote verbal memory.
7. Deficits in perception and attention in both the visual and tactile domains.
8. Notably better auditory-verbal memory than visual or tactile memory.
9. Initial problems in oral-motor praxis, and longstanding, mild difficulties in pronouncing complex, multi-syllabic words.

**Characteristics particularly evident in older children (7 years and above)**

1. Impaired abilities to analyze, organize, and synthesize information, with associated impairments in problem-solving and concept-formation.
2. Very evident and significant impairments in language prosody, content, and pragmatics, despite high levels of verbosity. This is often manifest in the form of “cocktail-party” speech patterns, with high volume of verbal output but relatively little content (meaning) and exceedingly poor psycholinguistic function/pragmatics.
3. Strengths in single-word reading/recognition and spelling, but substantially worse performance in reading comprehension and mechanical arithmetic.
4. Very poor handwriting in early school years, often improving to normal levels but only with considerable practice.
5. Spelling errors predominantly – even almost exclusively – of the phonetically accurate variety.
### Table 2.2 (continued)

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<tr>
<th>Nonverbal learning disabilities characteristics at younger and older age levels (Rourke et al., 2002)</th>
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<tr>
<td>6. Deficient social perception, social judgment, and social interaction.</td>
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<tr>
<td>7. Poor perception and comprehension of facial expressions of emotion, as well as in reading, interpreting, and providing nonverbal communication signals.</td>
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<tr>
<td>8. Preschoolers and those in early school years are frequently described as “hyperactive”; however, they tend to become normoactive and then hypoactive with advancing years.</td>
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**Developmental Profile of NLD**

*Infant and Toddler Years (0-2).* Parents of children with NLD appear to know relatively early that ‘something was wrong’ when their babies did not respond to the cuddling and ‘cooing’ as much as their siblings (Johnson, 1987). These babies do not automatically assume a position of balance when set down after being held, and they cling to objects and other people for balance (Thompson, 1997). In infancy, these children are often suspected to be ‘hard of hearing’ and their developmental milestones, including speech, are clearly delayed (Rourke, 1995a). They remain essentially sedentary, exploring the world not through vision or locomotion, but rather through receiving verbal answers to their questions about the immediate environment. Indeed, the more often and more elaborate parents’ answers are to these children’s questions, the more passive their behaviors. This in turn further reduces their exposure to novel stimuli with negative repercussions for an already diminished capacity to handle novel situations (Rourke, 1995a).

Given their neuropsychological deficits in tactile and visual-spatial perceptions, and psychomotor skills, children with NLD do not understand the world like the normal child who learns the name of an object *after* many of its physical features have been encountered. Rather than investigate objects in the environment through a variety of
different sensory inputs (tactile, visual and kinesthetic) they are content to ask questions and rely on verbal inputs. They do not learn the weight of a vase, they do not learn that if you pick something up that is too heavy it drops and shatters on the floor. The consequences of their lack of physical exploratory experience are that they do not make the cause and effect connections between objects in the environment and the social-emotional responses most children learn in their daily lives (Whitney, 2002). Thus, the child with NLD is unable to comprehend the significance of many aspects of his/her environment (Johnson & Myklebust, 1967).

*Preschool Years (3-5).* When their children enter nursery school programs, parents often observed problems in self-help skills including eating, dressing and learning to climb stairs (Johnson, 1987). They have problems learning to play or use typical toddler toys such as blocks and puzzles, nor do they enjoy coloring or drawing. These children are apprehensive of novel situations and have difficulty adjusting to a preschool setting away from home (Thomson, 1997).

However, given their primary neuropsychological capacity to deal with information delivered through the auditory modality, children with NLD soon ‘catch up’ and progress through the various stages of speech and language development at what seems to be an above-normal rate of speed (Rourke, 1995a). Typically, these children overcompensate verbally and some begin to read during the preschool years (Johnson, 1987). They have remarkable rote verbatim memory and are extremely verbose, speaking “like an adult”. Some begin to read at this age. As such, these children may even be considered “gifted” by parents and teachers (Thomson, 1997).
Other developmental milestones, especially locomotor and manipulative skills, still do not make normal progress (Rourke, 1995a). These children’s visual-spatial-motor deficits result in awkward and clumsy behavior (Johnson, 1987), and caregivers must watch them closely because they bump into furniture, are unsteady on their feet, breaks toys and endanger themselves (Palombo, 1996). Severe balance and coordination problems are evidenced in their great difficulty in learning to ride a tricycle, kick a ball, skip, and mastering other simple athletic skills (Thompson, 1997). All these difficulties dissuade them from physical exploration of the environment, and they will come to prefer to hear about the environment rather than to see or to touch it (Rourke, 1995a). Hence, they prefer to eat and play on the floor (Thompson, 1997).

Usually rules and routines must be rehearsed verbally because of their poor observational skills (Johnson, 1987). These children have to be taught explicitly to explore, play and participate in nonverbal activities since they have difficulty comprehending nonverbal tasks just by watching to “get the idea”. Given that they have the strong tendency to engage in what they do well (i.e., auditory analysis) and avoid what they do poorly (i.e., visual-spatial, tactile and psychomotor tasks), interventions are necessary to retard the widening gap between their neuropsychological asset and deficits as they grow older.

Because of their constant bumping into people and objects, and their difficulty staying seated without falling off their chairs, such children at this age are typically perceived as hyperactive. Furthermore, given their problems in attending to visual and tactile stimuli which are predominantly present in preschool lessons, they may also be viewed as inattentive in spite of their relative proficiency in auditory attention and
memory. The combined perceptions of hyperactivity and inattention often lead to the unwarranted classification of these children as having Attention Deficit Disorder (ADD), with or without Hyperactivity (Rourke, 2006b).

Elementary Years (6-10). Upon entering elementary school, children with NLD are often placed in gifted or accelerated programs because of their strong verbal skills (Thompson, 1997). They exhibit remarkable gains in word decoding, and it is not uncommon for such children to be rated on single-word reading at the grade 6 level when they are in grade 3 (Rourke, 1995a). Similarly, their spelling ability exceeds their grade level, which is predictable in view of their basic neuropsychological assets in phonemic hearing, segmentation, and blending. Misspellings are almost exclusively of the phonetically accurate variety (e.g., “nacher” for nature; “okupie” for occupy) (Rourke, 1995a). In written spelling it is necessary to engage in graphomotor activity which involves basic NLD neuropsychological deficits in the areas of tactile-perceptual, visual-perceptual, and complex psychomotor skills. Thus, these children write slowly and laboriously, and have great difficulty copying text from chalkboard or book and have trouble completing tasks on time. Their nonverbal deficits are evident in the greater difficulty these children have on reading comprehension tests which require matching words and pictures than when matching words to synonyms. In addition, they frequently miss the point on filmstrips and television programs (Johnson, 1987).

Mechanical arithmetic poses considerable difficulty for these children (Rourke, 1995a). They may memorize facts and rules but fail to access them when it would be appropriate to do so, that is, they cannot generalize what is learned to new situations. They are further hampered by difficulty in lining up columns, “carrying” and
“borrowing” and writing answers on paper. In addition, most have difficulty in extracurricular activities such as physical education and art (Johnson, 1987).

Daily adaptive skills are still lacking, such as tying shoelaces or using a key in a lock (Thompson, 1997). Difficulties comprehending environmental and nonverbal cues coupled with their inclination to make very literal translations lead such children to make continuous misjudgments and misinterpretations of what they see and hear. The more difficulty they have interpreting others’ vocal emotional cues, the more social avoidance and distress these children (ages 8 to 10 years) experience (McClure & Nowicki, Jr., 2001). Johnson (1987) cited an instance of a 9-year old who could not cross the road by himself despite above average verbal ability. He could not use environmental cues to estimate the speed of oncoming traffic, and occasionally was unable to determine whether the cars were moving toward or away from him. Such children access information of the surrounding environment by binding themselves to others by talking all the time through continuous dialogue. They over compensate their neuropsychological deficits with auditory perceptual and verbal assets, and may be labeled annoying (Thompson, 1997).

Adolescence (11-15). With increasing age children with NLD develop age-appropriate verbal, simple tactile, and simple motor skills that coincide with similar gains in academic skills of word recognition and spelling (Casey, Rourke, & Picard, 1991). As early as grade 5 or 6, they develop smooth, coordinated handwriting, which attests to their capacity to routinize this activity completely although it involves the most basic neuropsychological deficits of the syndrome (Rourke, 1995a). Such rote learning and
stereotypic application is thought to be a specialized process of the left hemisphere which is presumed to be intact in these children.

In marked contrast, adolescents with NLD are expected to encounter increasing difficulty on tasks that are more novel or complex in nature and that stress problem-solving abilities (Casey, Rourke & Picard, 1991). They exhibit problems with executive functions, which include a) forming concepts, b) solving complex problems, c) discerning cause-effect relationships, and d) initiating, planning, directing, managing, and orchestrating behavior (Rourke, 2006n). They have difficulty with abstract concepts and often misinterpret information when conveyed through analogies, idioms or figurative speech because they still think in concrete and literal terms (Thompson, 1997). While most are excellent decoders they often have difficulty with higher level comprehension and inferential questions. In literature they may be unable to perceive another person’s point of view (Johnson, 1987). Consequently their grades go down in middle school compared to elementary school (Thompson, 1997). The prospects of adolescents with NLD are even bleaker as they are unlikely to be able to meet age-appropriate expectations to do with less external structure to perform in an adaptive manner. Thus with the passage of time, the impact of deficits in executive functions during adolescence becomes more significant (Rourke, 2006n).

Moreover with advancing age, their mechanical arithmetic skills fall further behind their normally achieving age-peers (Casey, Rourke & Picard, 1991). Rarely do the arithmetic abilities of adolescents or adults with NLD progress beyond grade 5 or 6 (Rourke, 1995a). Many are unable to estimate size or visualize distance even though they can recite facts such as the number of inches in a foot or yard. Johnson (1987) mentioned
a 12-year old who thought that one-half foot and one-half mile would look the same because they were both halves.

Perhaps the most debilitating deficit for adolescents with NLD is in the area of socioemotional functioning. Close and affectionate personal interactions are largely functions of smooth, coordinated, and integrated sensorimotor functioning as well as spontaneous adaptations to novel and changing social circumstances (Rourke, 2006m). The lack of complex psychomotor and tactile perceptual skills in social situations can cause these young people to be rejected and isolated because they are viewed as clumsy, careless, or awkward. Furthermore they often make wrong social judgments due to difficulties in gathering and integrating salient features of the environment, forming concepts, and testing hypotheses.

The social problems of adolescents with NLD are compounded by deficits in visual-spatial-organizational skills and prosody. They fail to observe the negative reactions from others because they cannot attend to multiple facial expressions, body language, vocal inflection, and proxemic (distance) features that convey nonverbal meaning (Johnson, 1987). They stand too close or too far away from other persons during social interactions, and fail to appreciate subtle and even obvious visual details and others’ nonverbal body language with consequent misinterpretation of them (Rourke, 2006m). These adolescents cannot tell when someone is surprised, angry or embarrassed unless someone tells them. Nor do they know when people are teasing or being sarcastic. Many do not appreciate humor either. Some have additional social problems because of facial recognition difficulty, such as not being able to recognize family, relatives or friends until they spoke (Johnson, 1987).
Furthermore, their propensity to verbalize and their high volume of verbal output coupled with the lack of prosody tend to alienate them from others, who view their speech as boring, colorless and drab (Rourke, 2006m). In addition, these individuals may sound discourteous or ill-mannered without being aware of being so because of deficits in prosody (Thompson, 1997). They may also make rude and disrespectful statements without intending to do so. Rourke (2006c) attributes their “rude” behavior to their struggle in taking another person’s perspective; difficulty empathizing and understanding that others may think and feel differently; and their difficulty understanding social conventions and acting appropriately with respect to various situations and persons in certain key roles.

Their problems are clearly evident in novel situations that necessitate dealing flexibly with changing patterns of social interactions. It is quite probable for them to attempt to apply previously over-learned strategies to such situations in a stereotyped, rigid fashion. It becomes even worse when they deal with such situations in a verbal fashion although some other mode of interaction (e.g., touching, psychomotor expression, appropriate gesturing) is called for (Rourke, 2006m). The difficulty of individuals with NLD in dealing with or adapting to novel circumstances causes them to be particularly prone to the experience of threat with consequent anxiety or even a panic attack (Rourke, 2006g). They may react to these novel and extremely anxiety-provoking situations by performing a single behavior repeatedly (i.e., a ritual) in a compulsive manner and thereby obtain relief. Unlike obsessive compulsive disorder (OCD), the triggering factor for the behavior in NLD is a novel encounter rather than obsessive thoughts (Rourke, 2006h).
The combination of consistent experiences of social failures and ostracism by peers is likely to cause the adolescent with NLD to gravitate towards solitary activities and to choose much younger persons or adults for friends. These moves further decrease the opportunities for interacting and learning from age-peers for growth-engendering psychosocial experiences which are important in the formation of identity in adolescence (Rourke, 2006i). In view of their numerous problems, adolescents with NLD are particularly prone to the development of depression (Rourke, 2006i).

Language Development

*Language form, verbal associations, and language output.* Children with NLD are seen to be highly verbal, fluent speakers, capable of using sophisticated vocabulary and appropriate sentence structure. Typically they rely heavily on language as a principal means for social relating, information gathering, and relief from anxiety. They demonstrate little difficulty with the structure of language or language form which includes the dimensions of phonology, morphology and syntax. These children exhibit good auditory perception and excellent phonemic hearing, segmentation, blending, and repetition. Because they have strong verbal memory skills, these children are often able to recall a plethora of facts and details, and to repeat verbatim segments of prose with little difficulty. They are observed to have a large store of verbal material and verbal associations. In general, children with NLD are inclined to automatize language and are likely to experience less difficulty with dimensions of language that are structured or easily routinized (Rourke, 2006k; Rourke & Tsatsanis, 1996). Volden (2004) noted that there is empirical evidence supporting the phonological processing skills of individuals
with NLD from the studies of Rourke and his colleagues but not their morphological or syntactic competence which appear to be based on clinical observations.

Language content or semantics. Because more than 65% of the intent of an average conversation is conveyed nonverbally, children with nonverbal learning disabilities struggle to piece together the meaning of a conversation. They employ their strong verbal skills and memory to make sense of material from the 35% of verbal language they actually perceive and process. Consequently, they miss the majority of relevant content that is conveyed nonverbally and much of their conversational responses sound inappropriate, for example in tone and mood (Thompson, 1997). Although they are verbose, there is relatively little in the way of meaningful content in their linguistic output which tends to be straightforward, repetitive and rote. They struggle with the semantic and conceptual characteristics of words and compensate by over-reliance on their strength in phonological processing at the expense of attending to the semantics of speech (Rourke & Tsatsanis, 1996).

As mentioned earlier, Fisher and DeLuca (1997) reported that participants with NLD relied more on rote memory rather than semantic categories as a strategy to recall items on memory tasks. Worling, Humphries, and Tannock (1999) also found that these children have difficulties drawing inferences from vignettes, particularly when the inference depended on interpreting spatial or emotional relationships. A study on the narrative abilities of children with NLD also concluded that making inferences appears to pose a greater challenge than factual understanding in comprehension (Humphries, Cardy, Worling & Peets, 2004). In their story retell, instead of reporting original factual information they have comprehended, these children produce a lot of detail when
speaking, using more scripted and sometime meaningless language that is difficult to follow.

Children with NLD are also observed to experience difficulty with the connotative or metaphoric aspects of word meanings and make very literal translations, which frequently create misjudgments and misinterpretations. They usually fail to appreciate humor, irony, idioms or metaphors, which meanings are typically to be understood in context (Rourke & Tsatsanis, 1996). However, as reported by Fisher and DeLuca (1997), these children are not inclined to make use of contextual cues. A neuroimaging study of participants with prefrontal damage on their ability to understand sarcasm (one form of irony) implicated the right ventromedial regions as opposed to dorsolateral regions (Shamay-Tsoory, Tomer & Aharon-Peretz, 2005). The researchers suggest that the right frontal lobe mediates understanding of sarcasm by integrating affective processing in the right hemisphere with perspective taking associated with the prefrontal area. Similarly, the most severe deficit in empathy in patients with prefrontal damage was noted among those whose lesion involved the right ventromedial region (Shamay-Tsoory, Tomer, Berger, & Aharon-Peretz, 2003). These findings are consistent with Rourke’s white matter model explaining the difficulties of children with NLD in the area of language content and pragmatics, which are thought to reflect limitations in the functioning of, or ‘access’ to, right hemisphere intermodal systems (Rourke & Tsatsanis, 1996). In concordance, Shammi and Stuss’s (1999) neuroimaging study of the appreciation of humor specified where in the right hemisphere the greatest deficit occurs, that is right frontal pathology is critical in producing a deficit in humor appreciation and
specifically, the right anterior (somewhat more superior) region within the right frontal lobe.

*Language use or pragmatics.* Children with NLD are especially deficient in pragmatics, which includes an appreciation of the rules of social discourse, the speaker’s purpose/intent for communication, and how language is modified to fit different situations (Rourke & Tsatsanis, 1996). Pragmatics refers to the appropriate social use of language and includes the ability to use language to accomplish a wide variety of social purposes (e.g., requesting objects, requesting information, commenting, greeting) as well as the ability to manage conversations successfully (e.g., initiating interactions and introducing topics, taking turns, maintaining and building on topics, recognizing and repairing conversational breakdowns) (Volden, 2004).

The discourse of children with NLD is seriously impaired, not only because so little content is expressed in their utterances, but also because they appear to pay so little attention to how appropriate their language is within a particular situation (e.g., concerning whether what is being said is relevant, being in tune with the listener’s cues, communicating intent) (Rourke & Tsatsanis, 1996). These children display limited comprehension and processing of contextual information (whether physical, interpersonal, affective, situational or linguistic), which impairs their capacity to adapt to novel contexts by incorporating past and salient features of the present experience. As noted earlier, Petti, Voelker, Shore, and Hayman-Abello (2003) showed that children with NLD demonstrate a failure to attend to and interpret correctly nonverbal cues, such as facial expression and gestures. The overall outcome is that they are unable to determine which contextual cues to utilize in order to convey or understand the meaning
of an exchange. As such, they usually rely on routinized or automatized or programmatic exchanges and their speech becomes rambling, marked by minimal structure, organization and cohesion. It tends to be tangential, repetitive, monotonous and straightforward nature, containing little conceptual content. Their verbalizations are often loose and characterized by intrusions, embellishments and confabulations (Rourke & Tsatsanis, 1996).

In another aspect of pragmatics, children with NLD often display limited expression and comprehension of prosody which cause their speech to be rather monotonic and lacking in affective modulation. Speech prosody or intonation involves the ‘musical’ aspects of language – variations in the pitch, length and loudness of spoken utterances. Intonation conveys grammatical, pragmatic and emotional information which contributes to the meaning of utterances (Snow, 2000). Thus, children with NLD often demonstrate a failure to relate and appreciate fully both the meaning and sentiment of an interchange. Consequently, both the meaning and emotional (communicated by facial expression, gestures, or prosody) content of their speech tend to be inappropriate (Rourke & Tsatsanis, 1996).

**Diagnostic Differentiation of NLD and Asperger’s Syndrome**

Although Rourke and his colleagues have found strong evidence to suggest that individuals with Asperger’s Syndrome (AS) present with virtually all the characteristics of NLD, they do not appear to have made attempts to show how the two disorders are different. This is not surprising given that since 1971, Rourke and his colleagues have typically investigated intensively two subtypes of children with LD (while acknowledging there are several subtypes of LD), namely NLD and those with relatively
poor psycholinguistic skills (Group R-S, deficits in Reading and Spelling). Harnadek and Rourke (1994) acknowledged the lack of studies employing clinical groups other than an R-S LD subtype to derive constellations of neuropsychological assets and deficits that would distinguish children with NLD from those with other clinical disorders.

Rourke et. al., (2002) have indicated that there is a striking amount of overlap between the characteristics of NLD and AS. At the same time, the researchers maintained the separateness of the two disorders, emphasizing that while many individuals with AS fulfill the criteria for NLD, it is also clear there are many individuals with NLD profile who do not exhibit the full clinical syndrome of AS (Klin, Sparrow, Volkmar, Cicchetti, & Rourke, 1995). Rourke referred to the NLD phenotype as the “final common pathway” for a variety of neurological disorders, including AS (Rourke & Tsatsanis, 2000). Rourke’s white model hypothesized that NLD characteristics will be manifest to the extent that white matter (long myelinated fibres) in the brain is underdeveloped, damaged, or dysfunctional. While significant dysfunction within the right hemisphere is sufficient for NLD manifestation, significant perturbations of white matter in many or most regions of the brain is necessary to produce the NLD syndrome (Rourke et al., 2002). Drawing from the white matter model, it may be that AS and NLD differ in the location of perturbations of white matter in the brain. However, this speculation does little to inform on their differing behavior(s), and anyhow, the white matter hypothesis has yet to be supported by any direct histological evidence (Ellis & Gunter, 1999).

Rourke et al. posit that the two disorders should not be dissociated (Volden, 2004). It is also apparent that Klin et al. (1995) are not able to resolve where AS and NLD may diverge, although Rourke and Tsatsanis (2000) have mentioned that there are
observable differences in terms of manifestations of social disabilities between these two disorders. The researchers suggested that individuals with NLD do not commonly have social disability as severe as that seen in AS (Rourke & Tsatsanis, 2000). Fast (2004) considers the main difference between AS and NLD to be the highly restricted interests peculiar to children with AS. She includes in addition another difference between AS and NLD, which is the absence of visual spatial deficits in children with AS who apparently respond well to visuals and diagrams, and are visual learners in contrast with children with NLD who have difficulties learning by watching and need everything explained in words. However, some data have suggested that visuospatial functions may be specifically impaired in AS and this is likely related to the finding of greater Verbal IQ than Performance IQ scores in AS (Klin, Volkmar, Sparrow, Cicchetti, & Rourke, 1995; Schultz, Romanski, & Tsatsanis, 2000). A third difference between AS and NLD which Fast (2004) mentioned appears to support the notion that AS is a more severe form of NLD. She indicated that children with NLD have normal emotions but are inept in expressing them and in recognizing them in others, whereas children with AS do not feel the normal range of emotions, have a flat affect, and have difficulty initiating or experiencing normal social relationships. Although Brumback, Harper, & Weinberg (1996) also perceived AS to be a more severe form of NLD, they indicated that the basic problem of children with AS is expressive hyper-dysprosodia and hyper-emotionality. The complex relationship between NLD and AS may be an example of how categorizing too rigidly can confuse, rather than clarify, our thinking (Dinklage, 2001).

Indeed, there are rarely reported attempts at distinguishing the two conditions, one of which is a clinical case conferencing by Stein, Klin, and Miller (2004) who reviewed
similarities of and differences between NLD and AS. As reported by Wodrich and Schmitt (2006), both disorders include well-developed verbal skills but impairments in motor and social skills. Furthermore, both have pragmatic language deficits that interfere with social interactions (e.g., impaired eye contact and uses of facial expression, body postures, and gestures to regulate social interaction), failure to form developmentally appropriate friendships, and lack of social reciprocity. In addition, aversion to novelty and adherence to routines are found in both. According to Stein et. al. (2004), the crucial difference is that AS mandates the presence of unusual, restricted, repetitive and stereotyped patterns of behavior, interests and activities that typically are not seen in NLD. The most conspicuous symptoms of AS appear to be verbosity and circumscribed areas of interest (Volkmar & Klin, 1998). A child with Asperger’s Syndrome is typically the “little professor” who talks endlessly on arcane topics of his or her own selection (Wodrich & Schmitt, 2006).

In their conferencing of the case of “an 8-year old boy with school difficulties and odd behavior”, Stein, Perrin et al. (2004), considered the diagnosis of Asperger’s Syndrome based on his limited social interaction and some repetitive behaviors. The child was described as “overfocussed”, which is characteristic of children who tend to become overly involved in their very specific interests and have difficulty moving on. From his clinical experience, Snyder (Stein, Perrin et. al., 2004) found these observations to be extremely common in AS.

There appears to be sufficient reasons to support the presence of “unusual, restricted, repetitive and stereotyped patterns of behavior, interests and activities” that typically are seen in AS but not seen in NLD as one probable differentiating factor (Stein
et. al., 2004). Hans Asperger’s original behavioral description of children exhibiting the disorder described them as displaying poor social skills, odd and eccentric behaviors and restrictive patterns of interests and activities, without significant delays in cognitive or language abilities (Zillmer & Spiers, 2001). Bonnet and Gao (1996) described the characteristic features of AS to be fine or gross motor dyspraxia, distinct restricted focal interests, and perceptual integration and social interaction disturbances. Schultz Romanski, & Tsatsanis (2000) added that any attempt to devise neurofunctional models of AS must include these two domains of dysfunction: social interactions and restricted, repetitive patterns of interests, and behavior. In addition, Little (2002) noted in her literature review that unlike children with NLD, children with AS also exhibit restricted, unusual and repetitive patterns of interests and behavior. Based on his clinical experience, Palombo (2006) indicated that the features, “encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus” stipulated as one of DSM-IV criteria for Asperger’s Disorder, are uncommon in children with NLD. Furthermore, Thomson (1997) indicated the “restrictive, repetitive and stereotypical patterns of behavior coupled with an all-absorbing, narrow and unusual area of interest” as the deciding factor rather than a significant difference between PIQ and VIQ for the diagnosis of AS and not NLD. Thus, the common factor found in all these observations in AS (but not often observed in NLD) appears to be “restrictive patterns of interests and activities” or “an all-absorbing, narrow and unusual area of interest”.

In congruence, the World Health Organization’s (1993) tenth revision of the *International Classification of Disease* (ICD-10) and the American Psychiatric
Association’s (1994) fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV) ‘officially’ defined Asperger’s Syndrome as a cluster of cognitive and social signs including normal verbal development, abnormal social interactions and unusually intense interests (Ellis & Gunter, 1999). In addition, clinician Kanner (besides Asperger) who first observed the disorder included similar characteristics of AS, namely social impairment as well as restricted, repetitive behaviors and idiosyncratic, narrow interests (Ozonoff & Griffith, 2000).

Moreover, the criteria for AS set out in the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM-IV-TR; American Psychiatric Association, 2000) indicated that restrictive/repetitive/stereotyped pattern of behavior, interests/activities is not the distinguishing criterion between AS and Autistic Disorder. Rather, it is the social-emotional indifference and clinically significant delays in language/cognitive/adaptive skills that set children with autism apart from those with AS. Concurrently ICD-10 stipulates that a diagnosis of AS has to meet the criteria for restricted, repetitive, and stereotyped patterns of behavior, interests, and activities of the type observed in autism (Volkmar & Klin, 1998). In other words, children with AS seem to behave more like children with autism than children with NLD in terms of the manifestations of restrictive interests and repetitive behaviors.

The ‘bottom line’ posited by Rourke (2007, August 21) is that the NLD syndrome appears to constitute a "final common pathway" for AS as it does for many types of neurological disorder, such as Williams syndrome, early shunted hydrocephalus, etc. The implication is that these disorders, including AS, would have other phenotypical characteristics in addition to the set of neuropsychological assets and deficits that
constitute the NLD syndrome. The “other phenotypical characteristics” of AS that distinguish the disorder from NLD is hypothesized to be the restricted idiosyncratic interests and repetitive stereotypical patterns of behavior of children with AS.

According to the American Psychiatric Association’s (2000) DSM-IV-TR diagnostic criteria for Asperger’s Disorder, “restricted repetitive and stereotyped patterns of behavior, interests, and activities” are defined as:

1. encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus
2. apparently inflexible adherence to specific, nonfunctional routines or rituals
3. stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements)
4. persistent preoccupation with parts of objects

Ehlers, Gillberg, and Wing (1999) designed the High-Functioning Autism Spectrum Screening Questionnaire (ASSQ) to assess for AS particularly and HFA in children and adolescents. Included in the Gillberg criteria for AS are “an all-absorbing, circumscribed interest in a subject”, and “a stereotyped way of trying to introduce and impose routines or the particular interest in all or almost all aspects of ordinary life” (Ehlers & Gillberg, 1993).

As Klin, Sparrow, Volkmar, Cicchetti, and Rourke (1995) pointed out, the neuropsychological profiles of individuals with NLD and AS coincide closely. The overlap, however, is not perfect and more research is required to explore any residual differences between the two conditions (Ellis & Gunter, 1999).
Summary

The Validity and Reliability of NLD

Individuals diagnosed with nonverbal learning disabilities (NLD), as the name suggests, have a variety of nonverbal cognitive deficits and they exhibit marked difficulty processing nonverbal information despite their average intellectual capacity particularly in verbal abilities. Presently, the NLD syndrome is synonymously associated with scientist-practitioner Byron Rourke who, together with his colleagues at the University of Windsor and Child Study Centre at Yale University, delineated, defined, and validated the syndrome as a reliable LD subtype in connection with their research program during the last 40 years (Rourke, 2005). The profusion of empirical studies and data delivered from Windsor and Yale over the years has led to the current wide acceptance, among the community of researchers in the field and clinicians, of the NLD syndrome as conceptualized by Rourke. Researchers recognize that the reliability and external validity of NLD is well documented (Greenham, Stelmack, & Vlugt, 2003).

Denckla (1991) indicated that Rourke’s studies were the only ones from neuropsychology then equipped with a control group, while Myklebust (1995) mentioned the “scientific clarification” of LD subtypes shown by Rourke. Moreover, Denckla (1991) lent support for Rourke’s proposed white matter etiology for nonverbal learning disabilities and his hierarchical conceptualization of NLD neuropsychological assets and deficits, which she considered were “valuable antidotes to rigid cortical…thinking” in associating nonverbal learning disabilities with solely right-hemisphere dysfunction. More recently, McDonald (2002) reported the applications of Rourke’s cognitive profile of NLD and white matter model as a heuristic device for understanding the potential
neuropsychological sequelae of various medical, neurologic, and psychiatric diagnoses. In the area of research, Volden (2004) found that most reports on NLD have relied on anecdotal evidence gathered from clinical observation or on Rourke’s published reports, rather than on original empirical data. It appears that Rourke and his colleagues have monopolized the empirical investigation of NLD, as is also evident in this literature review on NLD.

*Original Work of Johnson and Myklebust*

Rourke et. al. (2002) indicated in deference that the content of the NLD syndrome began with the seminal work of Myklebust (1975) and what they were able to do was to “flesh out this content”. It is noteworthy that the disability developed from more than fifteen years of work by Johnson and Myklebust (1967) at the Institute of Language Disorders (Northwestern University) with many children who presented problems developmentally. From questions raised by parents and from clinical observations, they realized that most of these disturbances involved the inability of the children to learn from everyday experience and behaviors not deliberately taught by parents or teachers (Myklebust, 1995). These children needed help in learning to interpret nonverbal aspects of their environment, such as body parts and body orientation; to make left-right distinctions; the meaning of the actions of others, facial expression and gesture; the meaning and concepts of time and direction; reading maps; performing arithmetic calculations; and the relative meanings of size, weight, height, and speed. These impairments were theorized to underlie the abnormalities in social perception and interaction apparent in individuals with NLD (McDonald, 2002). They were thus, unable to acquire the significance of basic nonverbal aspects of daily living (Johnson and
Myklebust, 1967). However, their primary cognitive system is auditory and they learn well when instructions are verbally mediated (Myklebust, 1975).

**Content and Dynamics of NLD as conceived by Rourke**

Since the original work of Johnson and Myklebust, the concept of NLD has been expanded and developed notably in the work of Rourke. A salient feature of Rourke’s model is the hierarchical conception of the content and dynamics of the NLD syndrome. The primary or core constructs of NLD are deficits in tactile perception, visual perception, complex psychomotor skills, and in dealing with novelty. Primary assets include auditory perception, simple motor skills, and proficiency in rote verbal material. These primary neuropsychological assets and deficits lead to secondary, tertiary, and linguistic assets and deficits that eventuate directly in a particular pattern of academic assets and deficits and to a particular pattern of psychosocial disturbance (Rourke & Tsatsanis, 2000). The usefulness of this model apparently lies in its reliability, given that the associated academic, psychosocial, and adaptive abilities and deficiencies are the expected sequelae of the neuropsychological assets and deficits displayed by persons with NLD (Rourke & Tsatsanis, 2000).

**The White Matter Model as conceived by Rourke**

Models of etiology of NLD linked to the right cerebral hemisphere have similarly undergone significant development over time. Rourke’s white matter model hypothesized that NLD will be manifest to the extent that the systems of long myelinated fibers, either confined to the right hemisphere or spread more diffusely throughout the brain, are underdeveloped or dysfunctional and affecting cognitive abilities primarily subserved by the right cerebral hemisphere. The white matter hypothesis is based on Goldberg and
Costa’s (1981) formulations that the right hemisphere is characterized by larger areas of multimodal association cortex and contains relatively more white matter than the left hemisphere. Rourke theorized that the social problems and higher-order cognitive deficits (e.g. dealing with novelty) exhibited by persons with NLD stem from impaired intermodal integration systems. Since intermodal integration is dependent on intact white matter connections between primary and association cortex, and there is a predominance of white matter in the right hemisphere relative to the left, Rourke attributes the NLD syndrome to white matter perturbations and, thus, implicate the right more than the left hemisphere (McDonald, 2000). Rourke proposed that although the right hemisphere white matter perturbation is sufficient condition to produce NLD syndrome, it is the destruction of the white matter that is necessary for producing the disorder (Rourke, 1995a). He sees the NLD syndrome as a “final common pathway” for various neurological disorders, including Asperger’s Syndrome, which would have other phenotypical characteristics as well.

**Direction for Future Research**

According to Schultz, Romanski, and Tsatsanis (2000), Rourke’s white matter model remains largely untested and heuristic. Ellis and Gunter (1999) likewise indicated that the white matter hypothesis has yet to be supported by any direct histological evidence. However, researchers recognize that any alternative model must equally be capable of explaining the pattern of academic, psychosocial and adaptive difficulties experienced by persons with NLD as a direct result of the interaction of the primary, secondary, tertiary, and linguistic neuropsychological assets and deficits that typify NLD.
The white matter model moreover is superior to the “strict localizationist theory” because the NLD outcome is conceptualized more broadly in terms of the functional organization of systems within the brain (Rourke & Tsatsanis, 2000). In this regard, Schultz, Romanski, and Tsatsanis (2000) have proposed that future neuroimaging studies on individuals with Asperger’s Syndrome should proceed with mapping systems rather than being too “enamored with the localization of function” as “brain modules in isolation never do much of anything of practical significance”. Nevertheless, Rourke and Tsatsanis (2000) suggested neuroimaging studies for future research to explore further the brain maturational factors involved in NLD. This approach appears to be the right sequential order of successful research on dyslexia i.e., beginning with empirical studies and followed later by investigations into “lateralization and localization within the brain” (Denckla (1991).

Conclusions

Presently there is strong theoretical and empirical evidence in support of the concept of nonverbal learning disabilities (NLD), beginning with the clinical work of Johnson and Myklebust (1967). Rourke developed over the last four decades empirical and theoretical work based on Myklebust’s (1975) clinical ground work and original conception of NLD. More evidently, Rourke’s white matter model has been used in recent years to frame the pattern of cognitive and behavioral dysfunction noted in a wide range of neurologic, genetic, and neurodevelopmental disorders (McDonald, 2002). Given these positive developments surrounding Rourke’s conceptualization of the NLD syndrome, one can proceed with confidence to the construction of a valid and reliable
parent rating scale to screen for the NLD syndrome as conceived by Rourke. In this respect, the behavioral manifestations in the areas of language, academics, adaptive and socioemotional functioning of Rourke’s model are deduced to be reasonable NLD constructs for the parent rating scale.
CHAPTER 3

METHODOLOGY

Statement of Purpose

The purpose of this research is to construct and validate a parent rating scale that could be used by school psychologists as one of the preliminary screening procedures prior to making a referral for a diagnostic evaluation of nonverbal learning disabilities (NLD).

Description of Participants

*General Description of Participants*

The participants were parents of 130 children who were identified for each of three sample groups: Asperger’s Syndrome (AS), Nonverbal Learning Disabilities (NLD) and non-learning disabled or Control (C). There were 19 subjects in the AS group, 55 in NLD and 56 in the Control group. The participants’ children included 9 preschoolers, 53 children aged 6 to 10 years old, and 64 children aged 11 to 15 years old.

Children of the participants included both sexes – 83 male and 46 female (one respondent did not indicate gender). All the participants’ children in the NLD and AS groups were assessed by clinicians and given the clinical diagnosis of either NLD or AS. The NLD and AS children frequently had comorbid disorders, which were mostly ADHD and some anxiety and depression. About 40% of the participants’ children or around 70% of those with NLD or AS had received or were receiving special education services in the areas of speech (42%), academics (51%), social skills (54%) and counseling (61%). The control group of children had never been evaluated for special education services by the school system or diagnosed by an outside clinic, nor have they ever received special
education services. The final count per group was 14 AS, 43 NLD and 46 Control making a total of 103 participants, because by default, SPSS deleted incomplete or spoilt responses during statistical analyses.

Selection of Participants

The NLD and AS participants were drawn from across the U.S. and were those able to gain internet access to the NLDline website via [http://www.nldline.com/](http://www.nldline.com/) and the asperger syndrome education network (aspen) via [http://www.aspennj.org/](http://www.aspennj.org/). Contacts were made with the managers of these websites (see email letters in Appendix C) who agreed to post on their websites the link 

[http://inquisitor bsu.edu/inqsit/inqsit.cgi/lee7?Nonverbal+Learning+Disabilities-+A+Parent+Rating+Scale](http://inquisitor bsu.edu/inqsit/inqsit.cgi/lee7?Nonverbal+Learning+Disabilities-+A+Parent+Rating+Scale) to the NLD parent rating scale on Ball State University inQsit. The managers also sent emails to their pool of contacts with parents of children with NLD/AS. There were more than 2,000 hits out of which about 260 responded and of which 50% had other diagnoses. Those who had NLD/AS comorbid with PDDNOS, autism, bipolar or auditory processing disorder were not included in the research.

The control group participants were parents of students in Burris Laboratory School (K-12) affiliated to Ball State University in Muncie, Indiana. Permission was sought from Burris research committee and the principal who contacted and provided the inQsit link to parents of the school PTO (see Appendix D).

Characteristics of Participants

About 88% of the participants of the three sample groups were White Americans while 2% were Blacks, 2% Asians and 1.5% Hispanics. They were likely to be internet savvy with computer access from the middle/upper-middle class with similar socio-economic background from across the nation. Parents of children with NLD/AS were
likely to be educated and well-informed, having had their children clinically diagnosed outside school or privately, and who might be in parent support groups and be strong advocates for their children. Around 70% of these children had received or were receiving special education services in schools, and could possibly be getting additional interventions outside schools in private settings. Participants of children in the three sample groups were 70% mothers who would have substantial opportunities to observe their children and would be able to respond with reasonable accuracy to the parent rating scale.

**Sampling Biases**

Although random sampling was preferred over non-probable ones, it was not feasible, practical or theoretically sensible to do random sampling for the purposes of this research. Purposive expert sampling was very useful for this study to reach the targeted samples quickly and where sampling for proportionality was not the primary concern. Parents of children with NLD/AS constitute a sample of persons with high probability of possessing experience and expertise in the disorders. With a purposive expert sampling, one was likely to get to the target population i.e., individuals with NLD and AS, by capitalizing on the internet and informal social networks to identify specific respondents who were hard to locate. The downside, however, was the likelihood of overweighing subgroups in the target population that were more readily accessible and self-selective. As mentioned earlier, these parent participants were likely to be educated, internet savvy and of middle/high social economic status (SES), the impact of which was to limit the generalizability of research findings.
Confounds of Study

One confound of this study may be the impact of interventions or therapies and special education services, which 70% of the children with NLD/AS in this research sampling had received or were receiving. However, given that NLD and AS are both syndromes and life-long pervasive disorders, the impact of interventions is likely to be mitigating and not extinguishing. Other extraneous confounding variables arise from the number of different etiologies of NLD which are correlated with the varying extent of white matter perturbations, and the presence of comorbid disorders.

Human Participants Consideration and Clearance from IRB

These procedures were employed for the protection of the participants:

- Full disclosure of the purpose of the dissertation and the tasks required for the development of the parent rating scale.
- Communicate the benefits of the rating scale as a screening instrument for NLD.
- Assure confidentiality and anonymity
- Agree to share the research findings upon completion of the dissertation
- Convey that survey is completely voluntary and without penalty
- Convey that the monetary compensation is in support of the activities of parent associations/support groups, and is a token of appreciation for their assistance

Description of Instrumentation Procedures

The parent rating scale was constructed through extensive literature review on NLD for the purpose of discriminating individuals with NLD from AS and control groups
on these outcome constructs, namely language assets and deficits, academic assets and deficits, adaptive deficits, socioemotional deficits, and restricted interests and repetitive behavior. No other instrument was employed.

*Defining the Constructs of NLD*

According to Rourke’s model of the NLD syndrome, language assets and deficits, academic assets and deficits, adaptive deficits, and socioemotional deficits are the behavioral manifestations resulting from the interactions of the primary, secondary and tertiary neuropsychological assets and deficits of NLD. The core or primary neuropsychological asset is auditory perception, and the primary deficits are tactile perception, visuospatial perception and psychomotor coordination. Although the processing of novel material is considered a primary deficit too, this dimension of NLD has yet to be tested in a direct manner (Rourke, 2000). Thus for the purpose of the construction the parent rating scale, the deficit in dealing with novelty was perceived as one of the outcomes rather than as a primary deficit of NLD and it (processing of novel material) was included under adaptive deficits. The NLD constructs of the parent rating scale as such were defined as language assets and deficits, academic assets and deficits, adaptive deficits and socioemotional deficits.

*Defining the Constructs of Asperger’s Syndrome (AS)*

As concluded in the section *Diagnostic Differentiation of NLD and Asperger’s Syndrome* of the literature review (pp. 104-110), the neuropsychological profiles of individuals with NLD and AS coincide closely. The overlap, however, is not perfect. The NLD syndrome appears to constitute a "final common pathway" for AS, as it does for many types of neurological disorders. The implication is that these disorders, including
AS, would have other phenotypical characteristics in addition to the set of neuropsychological assets and deficits that constitute the NLD syndrome. The “other phenotypical characteristics” of AS that distinguish the disorder from NLD are hypothesized to be the restricted idiosyncratic interests and repetitive stereotypical patterns of behavior manifested by children with AS. In the design of the parent rating scale, these two dimensions were combined and hypothesized to be the construct (restricted interests and repetitive behavior) defining AS that could distinguish it from NLD.

Construction of Scale

The parent rating scale is a Likert scale designed with five agreement response options: Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree, and given the values 1, 2, 3, 4 and 5 respectively (see Appendix B).

Items of the parent rating scale were written for five constructs or subscales: 1) Language Assets and Deficits, 2) Academic Assets and Deficits, 3) Adaptive Deficits, 4) Socioemotional Deficits, and 5) Restricted Interests and Repetitive Behavior. Language was further subdivided into language form, language content and language use (see Appendix A). The first 64 ‘NLD items’ largely reflected Rourke’s et al. (2002) NLD diagnostic criteria set out in Table 2.1 of Chapter 2 and the characteristics of NLD observed in the younger (i.e., up to 6 years) and older (7 years and above) groups (see Table 2.2 of Chapter 2).

The six items hypothesized to differentiate individuals with NLD from those with Asperger’s Syndrome (AS) were items 65 to 70 of the scale (see Appendices A and B), the latent variable being Restricted Interests and Repetitive Behavior. The items reflected
closely the behavioral manifestations of the definition of “restricted repetitive and stereotyped patterns of behavior, interests, and activities” according to the American Psychiatric Association’s (2000) DSM-IV-TR diagnostic criteria for Asperger’s Disorder.

Twenty five out of the total of 70 items required reverse scoring as they were worded in the opposite direction for the purpose of minimizing bias produced by response sets i.e., the tendency of some people to respond to questions on a basis that is unrelated to the question content. One example is a response set of acquiescence, or yea saying. This is the tendency to mark agree or strongly agree in responding to the questionnaire items, regardless of the content of those items.

In sum, the parent rating scale provided 5 subscale scores for Language, Academics, Adaptive Functioning, Socioemotional Functioning, and Restricted Interests and Repetitive Behavior. The total score for Nonverbal Learning Disabilities (NLD) is the sum of 4 subscale scores for Language, Academics, Adaptive Functioning, and Socioemotional Functioning.

Description of Procedures

Defining the Constructs

The conceptual task of defining the constructs of NLD was made possible through an extensive literature review of the syndrome. The constructs of the parent rating scale were derived from Rourke’s model of the NLD syndrome, specifically that language assets and deficits, academic assets and deficits, adaptive deficits, and socioemotional deficits are the outcome of the interactions of primary, secondary and tertiary neuropsychological assets and deficits of NLD. The fifth construct, restricted interests
and repetitive behavior, was hypothesized to be able to differentiate the NLD group from the AS group.

*Designing the Scale*

The constructs of the parent rating scale were behavioral characteristics of children with NLD/AS. Thus, it seemed most appropriate for the scale to contain statements with which respondents could indicate agreement. A five-point scale was chosen, with two response choices on the disagree end, two on the agree end, and one (neutral) in between. An agreement response choice is one where respondents are asked to indicate if they agree or disagree with each item, as well as the magnitude of their agreement or disagreement i.e., if they *strongly disagree, disagree, neutral, agree*, or *strongly agree*. The response choices are chosen so that they could be ordered along a measurement continuum from low to high. Numbers assigned to each choice ranged from 1 to 5 for strong disagreement to strong agreement. Items that did not reflect NLD behaviors had scaling reversed (i.e., 5=1, 4=2, 3=3, 2=4, and 1=5). Twenty five such items out of a total of 70 required reverse scoring as they were worded in the opposite direction to minimize bias produced by response tendencies such as acquiescence. If there were an equal number of positively and negatively worded items, acquiescent respondents will tend to get middle scores. Their scores will do far less damage to estimates of means and results of statistical tests.

The second step in scale design was writing the item stems. Agreement items were declarative statements that one could agree with or not. Five considerations were taken into account when writing the items: 1) each item expressed one and only one idea; 2) both positively and negatively worded items were used; 3) colloquialisms, expressions,
and jargon were avoided; 4) the reading level of the respondents was considered; and 5) the use of negatives to reverse the wording of an item was avoided. In addition, the rating scale asked participants for information on demographics, diagnosis, who provided the diagnosis, and the nature and extent of interventions.

Scale Validation

Content validity. Content validity concerns item sampling adequacy i.e., the extent to which a specific set of items reflects a content domain. To establish content validity i.e., the extent to which the items of the parent rating scale reflect NLD, experts in the field were asked to review the initial list of items of the parent rating scale. It may be that content areas that have been omitted should be included, or content areas that have been included should be excluded. Upon the recommendations of the experts, items were added to or omitted from the parent rating scale accordingly.

Collection of data. Data collected via BSU inQsit was exported into an Excel file. Each response was identified as belonging to one of 4 groups – AS, NLD, Control and Others. Only data from the first 3 groups of 130 participants were analyzed using SPSS to determine the reliability and validity of the scale. By default, SPSS deleted a total of 27 incomplete or spoilt responses. The final count of subjects was reduced by SPSS to 14 in the AS group, 45 in NLD, and 46 in the Control group. The following statistical procedures were deemed necessary for the validation of the parent rating scale:

Internal consistency reliability. Internal consistency reliability is an indicator of how well the individual items of a scale reflect a common, underlying construct. Measurement theory suggests that the relationships among items are logically connected to the relationships of items to the latent variable. A scale is internally consistent to the
extent that its items are highly intercorrelated. High interitem correlations suggest that the items are all measuring the same construct. Internal consistency is typically equated with Cronbach’s (1951) coefficient alpha which is provided by conducting reliability analysis in SPSS. The larger this value, the more consistent the scale is believed to be. Nunnally (1978) provided a widely accepted rule of thumb that alpha should be at least .70 for a scale to demonstrate internal consistency.

Construct validity. Construct validity is directly concerned with the theoretical relationship of observed variables with the latent variables of interest. Some evidence of construct validity of the parent rating scale was provided to the extent that empirical correlations matched the predicted or hypothesized pattern. The NLD behavioral characteristics (outcome of the interactions of primary, secondary and tertiary NLD neuropsychological assets and deficits) as reflected in the parent rating scale items were hypothesized to tap these four latent variables: Language Assets and Deficits, Academic Assets and Deficits, Adaptive Deficits, and Socioemotional Deficits. The fifth latent variable, Restricted Interests and Repetitive Behavior, was hypothesized to reflect the differentiating characteristic of AS. Thus, in theory a 5-factor solution was hypothesized. Factor analysis is the most common way to determine construct validity. Exploratory Factor Analysis (EFA) allowed for the statistical testing of the factor structure hypothesized in theory i.e., how well the set of real data fit the hypothesized structure or model. Two major questions addressed with factor analysis were: a) the number of factors that best represent the items and b) the interpretation of the factors.

Discriminant groups validity. Discriminant groups validity addressed the question of whether groups that theoretically should differ from one another on the instrument
(parent rating scale) did actually differ in the population i.e., could a differential
diagnosis among the AS, NLD and Control groups be made reliably from a set of factor
scores?

*Multivariate Analysis of Variance (MANOVA).* The Multivariate Analysis of
Variance (MANOVA) is a statistical technique that can be used to test for differences
among groups on a set or linear combination of dependent variables. In performing this
linear combination, the MANOVA test weights each dependent variable or DV (i.e.,
language assets and deficits, academic assets and deficits, adaptive deficits,
socioemotional deficits, and restricted interests and repetitive behavior) in order to
achieve maximal group separation. The groups or IVs (AS, NLD and Control) are then
tested to determine whether they differ significantly on the linear function. This was
answered by conducting MANOVA in SPSS. Pillai’s Trace and Wilks’ Lambda appear to
be the best multivariate test statistics for significance.

*Discriminant Analysis (DA).* Discriminant analysis (DA) tests whether pairs of
groups differ significantly on the discriminant function, which is a combination of DVs
such that the two groups will differ as much as possible. More importantly, DA is a
useful procedure that allows one to identify the DVs (constructs or subscales) that best
discriminate members of two or more groups from one another. DA allows for
multivariate comparisons by finding a combination of variables such that the dependent
variables (AS, NLD and Control groups) will differ as much as possible on this combined
variable or discriminant function. Wilks’ Lambda is the multivariate statistical test
provided by conducting DA in SPSS to indicate if groups differ significantly on the
independent variables (constructs or subscales).
However, knowing merely that the groups differ was not sufficient. SPSS provided the structure matrix that showed the structure coefficients or correlations between the discriminant function values and the individual subscale scores that indicated specifically how the groups differ from one another i.e., what was the primary cause(s) or latent variable implicated for the difference. In general, the larger the value the more important the variable (subscale/factor) is in differentiating the groups. The rule of thumb is that any variable with a structure coefficient greater than 0.3 is to some degree related to the difference between groups. Thus, in discriminant analysis there is an attempt to understand the dimensions along which groups differ. Another way of ascertaining how the groups differ was to examine the group statistics, specifically the means of the groups on each subscale/factor.
CHAPTER 4
RESULTS AND DISCUSSION

Validation of the Parent Rating Scale

Content Validity

To establish content validity i.e., the extent to which the items of the parent rating scale reflect NLD, experts in the field were asked to review the initial list of items of the parent rating scale. Of the several experts who were approached, two responded, namely Joseph Palombo, M.A. LCSW and Kathryn Stewart, Ph.D. Mr. Palombo is the author of Nonverbal Learning Disabilities: A clinical perspective (2006), and in his private practice, he evaluates and treats children and adolescents with learning disabilities. He is a Clinical Social Work Founding Dean and faculty member of the Institute for Clinical Social Work in Chicago and on the staff of Rush Neurobehavioral Center. Dr Stewart is a clinical psychologist and founder of Orion Academy in Moraga, California, dedicated to the education of high school students who have NLD or Asperger’s syndrome. She is also the author of Helping Children with NLD or Asperger’s Syndrome: A Parents Guide.

Upon the recommendations of Mr Palombo and Dr Stewart, items were reworded for clarity and specificity. Mr Palombo’s suggestion to add more items tapping emotional functioning was also taken. Although the experts did not recommend removing any items, nearly 30 items were omitted from the final version of the parent rating scale of 70 items for the purpose of reducing incomplete responses. Even so, about 20% of the data collected were incomplete responses and were excluded from analyses.
Internal consistency reliability

Internal consistency is typically equated with Cronbach’s (1951) coefficient alpha. Nunnally (1978) provided a widely accepted rule of thumb that alpha should be at least .70 for a scale to demonstrate internal consistency. Reliability statistics of the 70-item NLD parent rating scale was very high as reported by Cronbach’s Alpha of .963.

Construct Validity

Exploratory Factor Analysis (EFA) was conducted to test the factor structure hypothesized in theory i.e., how well the set of real data fit the hypothesized structure. The KMO statistic is .744, indicating that a reasonable factor solution could be obtained from the data set. The Bartlett’s test of sphericity was significant at .001, indicating that there are significant correlations among variables and that factor analysis would be appropriate. The scree plot indicated a high probability of a 4- or 5-factor solution. The total variance explained by a 4- and 5-factor solution was 50.7% and 53.8% respectively. The factor correlation matrix (see Table 4.1) indicated that some factors were correlated with one another calling for the oblique rotation, and so Promax rotation was appropriate.

Table 4.1

Factor Correlation Matrix

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The extraction methods used with Promax were Principal Component Analysis, Unweighted Least Squares, Principal Axis Factoring, Alpha Factoring, Generalised Least Squares, Maximum Likelihood and Image Factoring. Both 4- and 5-factor solutions were attempted. A comparison of results indicated that the most interpretable and elegant solution appeared to be a 5-factor one extracted with Principal Component Analysis and Promax rotation (see Table 4.2). The pattern of loadings of variables could be meaningfully interpreted as these factors: Asperger’s Syndrome features (12 variables), adaptive deficits (17 variables), socio-conceptual deficits (13 variables), academics (7 variables) and learning style (4 variables). The rule of thumb applied to determine the loading of a variable was .4 and larger. There were 7 cross-loadings mostly with Asperger’s features, indicating the syndrome’s considerable overlap with NLD characteristics. The rest of the 10 items/variables did not load (< .4) on any one factor, and variations of their loadings appeared to be random depending more on the extraction method used rather than due to their redundancy or ambiguity.

Asperger’s Syndrome features factor. The Asperger’s factor included 4 of the 6 restricted interests and repetitive behaviors hypothesized to differentiate Asperger’s Syndrome (AS) from NLD i.e., pursuing idiosyncratic interest with intensity; unusual concentration on interest; frustrated that others do not share the interest; and having large amount of information on unusual topics. The item that described the child with AS as a ‘little professor’ because of his/her intellectual interests clearly loaded on this Asperger’s associative factor (.732); however, it was cross-loaded on the academics factor (.461) too. The 6th item (i.e., My child has many and varied interests) hypothesized to differentiate Asperger’s syndrome (AS) from NLD clearly did not load on the Asperger’s associative
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Table 4.2 (continued)

Pattern Matrix of Correlations between Item Variables and Factors (Item-Loadings)

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Item Cross-Loadings

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Low Item-Loadings (<.4)

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Note: Extraction Method: Principal Component Analysis  
Rotation Method: Promax with Kaiser Normalization  
Significant item-factor correlations are >.4  
factor (.100) but on the NLD socio-conceptual deficits factor (.624). Thus, it may be
concluded that all 5 items hypothesized to tap Asperger’s Syndrome in fact did so except for the aforementioned 6th item which could be poorly worded and ambiguous.

In addition, other NLD features commonly associated with AS loaded on the factor i.e., need for step-by-step verbal directions on simple tasks; difficulty understanding and using appropriate gestures in communication; difficulty understanding when things are going out of control; being perceived by others as having Asperger’s Syndrome; and exhibiting acting-out behaviors like arguing, being irritable, and having melt-downs. Thus, this pattern of loading suggests that, besides restricted interests and repetitive behavior, socio-emotional problems are highly associated with Asperger’s Syndrome (AS).

Adaptive deficits factor. Items or variables that loaded on the adaptive behavior factor were learning to do simple tasks by talking through; memorizing environmental markers to find the way around; talking incessantly to gather environmental information; difficulty understanding and expressing the gist of information; using excessive verbiage when communicating; talking like adults but having difficulty understanding what adults mean to say; sounding rude because of difficulty with tone of voice; missing the main point of story; difficulty with visual-spatial activity/thinking; tendency to lose the way; prone to injury; clumsy; difficulty with understanding concept of time; difficulty understanding personal space; and naively trusting others. It is noted that language is used by individuals with NLD in a maladaptive way to solve problems in daily living.

Socio-Conceptual deficits factor. Items that loaded on the socio-conceptual factor were social deficits items namely, misunderstanding what others say; difficulty adjusting to novel situations (e.g., substitute teacher); difficulty understanding others; being unable
to detect hidden meanings in social interaction; disliking large group gatherings; and having few same-aged friends. The conceptual deficits items were difficulties with learning to play with others by watching; and problems with understanding concepts, gestalt formation, visual-spatial dimensions, and the relative meaning of speed. Unexpectedly, two items associated with psychomotor and somatosensory/tactile impairment loaded on the socio-conceptual factor that are, nevertheless, consistent with the literature review on NLD. The two items were difficulties with tying shoes and with cutting and pasting activities.

The connection between tactile imperception and social and conceptual skills deficits was reported in the literature review (p. 64-68). Casey and Rourke (2002) indicated that smooth affective encounters between persons, regardless of age or stage of development, are greatly enhanced by the presence of intact somatosensory capacities, and intimate exchanges between persons would be impossible without tactile sensitivity. Rourke (2006m) reported that a coordinated and integrated sensorimotor functioning system is necessary for individuals to be able to make spontaneous adaptations to novel and rapidly changing social circumstances in interpersonal and group interactions. In addition, Casey and Rourke (2002) reported that the basic and early emergent deficits in tactile-perceptual skills of children with NLD play a very significant role in the eventual manifestations of impaired problem-solving, concept-formation, and related cognitive abilities.

Finally as mentioned earlier, item *My child has many and varied interests* which was hypothesized to be an AS differential item loaded instead on the NLD socio-
conceptual deficits factor (.624), possibly indicating that the item is more associated with NLD than AS.

*Academics factor.* The NLD academic assets that loaded on this factor were reading, word decoding skills, spelling and large/advanced vocabulary. The NLD academic deficits that loaded on this factor were reading comprehension, understanding spatial relationships and math.

*Learning Style factor.* Factor analysis of the data revealed a new construct that was not hypothesized. The learning style factor emerged consistently in both 4- or 5-factor solutions with 5 and 4 items loading on the factor respectively. In the 5-factor solution, the variables were the hypothesized academic items, namely learning best through direct verbal instruction, and difficulty with learning by watching. The other two items pertained to difficulties with learning activities that required intact visual-spatial-motor coordination skills, namely writing and manipulating construction toys. The emergence of the learning style factor suggests that the unique and salient feature of NLD is the severe impairment of such individuals in their ability to interpret environmental nonverbal cues and their resultant over reliance on the verbal modality to compensate for the disability.

*Conclusions.* It may be concluded the set of real data fitted the hypothesized factor structure to a large extent with the emergence of the Asperger’s Syndrome features, adaptive behavior, academics and socio-conceptual functioning constructs.

The hypothesized language factor, however, was absent. Practically all the language items were found to load on the adaptive construct which, nevertheless, were found to be consistent with the literature review. According to Rourke’s NLD model, the
primary neuropsychological assets and deficits lead to secondary, tertiary, and linguistic assets and deficits that eventuate directly in a particular pattern of academic assets and deficits and to a particular pattern of psychosocial disturbance (Rourke & Tsatsanis, 2000). The associated academic, psychosocial, and adaptive abilities and deficiencies are the expected sequela of the neuropsychological assets and deficits displayed by persons with NLD (Rourke & Tsatsanis, 2000). Thus, the literature review indicated that the language component predisposed children with NLD to manifest the academic, psychosocial, and adaptive abilities and deficiencies. In other words, these eventual manifestations of behaviors are the sequela of the higher hierarchically ordered language and other neuropsychological dysfunctioning in Rourke’s model of the NLD syndrome.

Besides the hypothesized 5 variables, the Asperger’s factor included several NLD features, particularly the emotional variables. This suggests that, besides restricted interests and repetitive behavior, socio-emotional problems feature prominently in individuals with Asperger’s Syndrome. Rourke and Tsatsanis (2000) mentioned that there are observable differences in terms of manifestations of social disabilities between NLD and AS, and suggested that individuals with NLD do not commonly have social disability as severe as that seen in AS. Schultz, Romanski, & Tsatsanis (2000) reported that any attempt to devise neurofunctional models of Asperger’s Syndrome must include these two domains of dysfunction: social interactions and restricted, repetitive patterns of interests, and behavior. Brumback, Harper, & Weinberg (1996) perceived AS to be a more severe form of NLD and indicated that the basic problem of children with AS is expressive hyper-dysprosodia and hyper-emotionality.
Most interesting of all is the emergence of the new construct, learning style, which appeared consistently in the factor analyses. It may be concluded that the construct highlights the distinctive characteristic of individuals with NLD i.e., the significant difficulty with interpreting and learning visual-spatial-organizational material requiring psychomotor coordination. The emergence of the learning style factor suggests that the unique and salient feature of NLD is the severe impairment of such individuals in their ability to interpret environmental nonverbal cues and their resultant over reliance on the verbal modality to compensate for the disability. In contrast, the literature review yielded equivocal evidence for visuospatial impairment in children with Asperger’s Syndrome (AS). The difference between AS and NLD according to Fast (2004) was the absence of visual spatial deficits in children with AS who apparently respond well to visuals and diagrams, and are visual learners in contrast with children with NLD who have difficulties learning by watching and need everything explained in words. However, some data have suggested that visuospatial functions may be specifically impaired in AS and this is likely related to the finding of greater Verbal IQ than Performance IQ scores in AS (Klin, Volkmar, Sparrow, Cicchetti, & Rourke, 1995; Schultz, Romanski, & Tsatsanis, 2000). Furthermore, Thomson (1997) indicated the “restrictive, repetitive and stereotypical patterns of behavior coupled with an all-absorbing, narrow and unusual area of interest” as the deciding factor rather than a significant difference between Performance IQ and Verbal IQ for the diagnosis of AS and not NLD.

Clearly, in this study when only 4 variables loaded on this factor (learning style), the results and interpretation thereof will be tentative until more studies are conducted, particularly with a larger AS sample size.
Discriminant groups validity. Although the set of real data fitted the hypothesized factor structure to a large extent, the Box’s Test indicated that the group variances of the hypothesized model were not equal (.010) while the same multivariate test indicated that the group variances of the real data set were equal (.123). Thus, discriminant group analyses were not performed for the hypothesized model but with the real data set.

The discriminant groups validity test as indicated by Wilks’ Lambda reported that functions 1 and 2 were significant and that the three groups (AS, NLD and Control) were significantly different from one another at the .001 level on the extracted factors (see Table 4.3). Pillai’s Trace multivariate test statistic was also significant at .001. Partial eta squared indicated that the proportion of variance in the dependent variables that could be explained by the groups was approximately 30% (see Table 4.4).

### Table 4.3

Wilks’ Lambda

<table>
<thead>
<tr>
<th>Test of Functions</th>
<th>Wilks’ Lambda</th>
<th>Chi-square</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 through 2</td>
<td>.440</td>
<td>82.073</td>
<td>.000</td>
</tr>
<tr>
<td>2</td>
<td>.875</td>
<td>13.327</td>
<td>.010</td>
</tr>
</tbody>
</table>

### Table 4.4

Multivariate Tests

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROUP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pillai’s Trace</td>
<td>.622</td>
<td>8.936</td>
<td>.000</td>
<td>.311</td>
</tr>
<tr>
<td>Wilks’ Lambda</td>
<td>.440</td>
<td>9.944</td>
<td>.000</td>
<td>.337</td>
</tr>
</tbody>
</table>
The structure matrix indicates correlations between predictor variables and discriminant functions (see Table 4.5). The first discriminant function correlates most highly with Socio-Conceptual (.930), followed by Asperger’s Syndrome (.546) and Adaptive (.535). The second function correlates most highly with Learning Style (.693), followed by Asperger’s Syndrome (.439). The groups were not significantly different on the basis of the Academics factor.

Table 4.5
Structure Matrix of Correlations between Factors and Discriminant Functions

<table>
<thead>
<tr>
<th></th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Socio-Conceptual</td>
<td>.930</td>
</tr>
<tr>
<td>Asperger’s Syndrome</td>
<td>.546</td>
</tr>
<tr>
<td>Adaptive</td>
<td>.535</td>
</tr>
<tr>
<td>Learning Style</td>
<td>.353</td>
</tr>
<tr>
<td>Academics</td>
<td>.052</td>
</tr>
</tbody>
</table>

An examination of group means on these variables revealed that AS and NLD groups had similar values for Asperger’s Syndrome features, Adaptive deficits and Socio-Conceptual deficits, while the Control group had lower means on the 3 variables than the others (see Table 4.6). It would appear that the Socio-Conceptual variable is most discriminating in differentiating AS and NLD groups from the Control group. In terms of Learning Style, AS and Control groups had similar mean values while NLD group had a higher mean. Thus, Learning Style is the most discriminating variable differentiating the
NLD group from AS and Control groups. All 3 groups had similar mean values for the Academics factor, indicating that groups could not be separated based on that variable alone. Moreover, the correlations between Academics and the discriminant functions were very low at .052 and .104 (see Table 4.5).

Table 4.6
Mean Values of AS, NLD and Control Groups

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Group</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asperger’s Syndrome Features</td>
<td>AS</td>
<td>41.0</td>
</tr>
<tr>
<td></td>
<td>NLD</td>
<td>38.3</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>33.8</td>
</tr>
<tr>
<td>Adaptive Deficits</td>
<td>AS</td>
<td>60.6</td>
</tr>
<tr>
<td></td>
<td>NLD</td>
<td>60.7</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>46.2</td>
</tr>
<tr>
<td>Socio-Conceptual Deficits</td>
<td>AS</td>
<td>51.1</td>
</tr>
<tr>
<td></td>
<td>NLD</td>
<td>49.4</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>34.5</td>
</tr>
<tr>
<td>Academics</td>
<td>AS</td>
<td>24.5</td>
</tr>
<tr>
<td></td>
<td>NLD</td>
<td>24.9</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>24.4</td>
</tr>
<tr>
<td>Learning Style</td>
<td>AS</td>
<td>11.6</td>
</tr>
<tr>
<td></td>
<td>NLD</td>
<td>13.9</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>11.2</td>
</tr>
</tbody>
</table>
CHAPTER 5
SUMMARY AND CONCLUSIONS

Summary

Given the absence of a suitable screening scale for identifying children with nonverbal learning disabilities (NLD) in schools today, this study attempted to construct and validate a parent rating scale that could be used by school psychologists as one of the preliminary screening procedures prior to making a referral for a diagnostic assessment of NLD. Individuals diagnosed with NLD, as the name suggests, have a variety of nonverbal cognitive deficits and they exhibit marked difficulty processing nonverbal information despite their average intellectual capacity particularly in verbal abilities. The NLD syndrome represents between 0.1% and 1.0% of the entire general population of the U.S, with an overall ratio of male to female of approximately 1.2 to 1.0 (Pennington, 1991; Zillmer & Spiers, 2001). More recently, Rourke (2006n) increased the prevalence estimate of NLD from between 5% to 10% (Rourke, 1989) to 18% within the LD (learning disability) clinic population.

The construction of the NLD parent rating scale began with an extensive literature review and concluded with the adoption of Rourke’s conceptualization of the NLD syndrome (Rourke et. al., 2002; Rourke & Tsatsanis, 2000). The behavioral manifestations in the areas of language, academics, adaptive and socioemotional functioning of Rourke’s model were deduced to be reasonable NLD constructs for the parent rating scale (see Figure 1). Instead of an experimental group with verbal learning disabilities or phonological dyslexia as found in practically all studies on NLD by Rourke, an Asperger’s Syndrome (AS) group was used to test the sensitivity of the parent
rating scale in differentiating NLD from Asperger’s Syndrome (AS) in view of their several shared characteristics (Klin, Sparrow, Volkmar, Cicchetti, & Rourke, 1995). The reason for choosing Asperger’s Syndrome (AS) over a verbal learning disabled group was a very practical one, since it was more likely in school for a child with NLD to be misdiagnosed with Asperger’s Syndrome (AS) than with a verbal learning disability. The literature suggested that there were sufficient reasons, in spite of their substantial overlapping characteristics, to support the presence of “unusual, restricted, repetitive and stereotyped patterns of behavior, interests and activities” that typically are seen in AS but not seen in NLD as one probable differentiating factor (Stein et. al., 2004). Hence, Likert scale items were written for 5 constructs - Language Assets and Deficits, Academic Assets and Deficits, Adaptive Deficits, Socioemotional Deficits, and the fifth, Restricted Interests and Repetitive Behavior (see Appendix A).

Validation of the NLD parent rating scale began with data collection from the AS, NLD and Control groups. The NLD and AS groups consisted of parents of children who had been diagnosed in a clinical setting. The Control group children had never been evaluated for special education services by the school system or diagnosed by an outside clinic, nor had they ever received special education services. The NLD and AS participants were drawn from across the U.S. who were able to gain internet access to the NLDline website via http://www.nldline.com/ and the asperger syndrome education network (aspen) via http://www.aspennj.org/ respectively. Contacts were made with the managers of these websites who agreed to post on their websites the link to the NLD parent rating scale on the Ball State University inQsit. The Control group participants were PTO parents of students in Burris Laboratory School (K-12) affiliated to Ball State
University in Muncie, Indiana, who were provided the *inQsit* link to the NLD parent rating scale (see Appendix B). The participants’ children included both males and females in the ratio of nearly 2 to 1. They were 9 preschoolers, 53 children aged 6 to 10 years old, and 64 children aged 11 to 15 years old. The final count of subjects was reduced by SPSS to 14 in the AS group, 45 in NLD, and 46 in the Control group. The NLD and AS children frequently had comorbid disorders, mostly ADHD, and some anxiety and depression. Around 70% of the children with NLD/AS had received or were receiving special education services in the areas of speech (42%), academics (51%), social skills (54%) and counseling (61%).

The collection and analyses of data for the validation of the parent rating scale answered the following research questions:

1. Is the nonverbal learning disabilities (NLD) group significantly different from the non-learning disabled control groups on the parent rating scale? If so, what construct(s) on the parent rating scale most differentiate(s) the NLD group from the control group?

2. Is the NLD group significantly different from the Asperger’s Syndrome (AS) group? If so, what construct(s) on the parent rating scale most differentiate(s) the NLD group from the AS group?

Conclusions

*Summary of Results and Conclusions*

The results and conclusions of the study may be summarized as follows:

1. Content validity of the NLD parent rating scale was obtained when two experts in the theoretical and clinical knowledge of NLD, Joseph Palombo, M.A. LCSW and
Kathryn Stewart, Ph.D, reviewed the scale and gave feedback which was acted upon in scale revision.

2. The internal consistency reliability of the 70-item NLD parent rating scale was very high at Cronbach’s Alpha of .963.

3. Exploratory Factor Analysis (EFA) results indicated that the most interpretable and elegant solution was 5-factor (see Table 4.2). The pattern of variable loadings could be meaningfully interpreted as converging on these factors: Asperger’s Syndrome associative features, Adaptive deficits, Socio-Conceptual deficits, Academics and Learning Style. It may be concluded that the set of real data fit the hypothesized 5-factor structure to a large extent.

4. The hypothesized language factor, however, was absent. The language items were found to load mostly on the adaptive construct, which nevertheless was found to be consistent with the literature review.

5. Excepting one, all 5 items hypothesized to tap Asperger’s Syndrome (AS) in fact did so. The AS factor included several NLD features, particularly the hypothesized socioemotional variables. Congruent with literature review, this suggests that, besides restricted interests and repetitive behavior, socioemotional problems are highly associated with Asperger’s Syndrome (AS).

6. Most interesting of all is the emergence of the new construct, learning style, which appeared consistently in the factor analyses. It may be concluded that the construct highlights the distinctive characteristic of individuals with NLD i.e., the extreme difficulty with interpreting and learning visual-spatial-organizational material requiring psychomotor coordination. The emergence of the learning
style factor suggests that the unique and salient feature of NLD is the severe impairment of such individuals in their ability to interpret environmental nonverbal cues and their resultant over reliance on the verbal modality to compensate for their disability.

7. The Box’s Test indicated that the group variances of the hypothesized model were not equal while the same multivariate test indicated that the group variances of the real data set were equal. Thus, discriminant group analyses were not performed for the hypothesized model but with the real data set.

8. The discriminant groups validity test indicated that the three groups (AS, NLD and Control) were significantly different from one another at the .001 level on the 4 extracted factors i.e., Socio-Conceptual, Asperger’s Syndrome, Adaptive and Learning Style. The proportion of variance in the dependent variables that could be explained by the groups was approximately 30%. Thus, it may be concluded that the parent rating scale is discriminating and useful in screening for individuals with NLD.

9. The first discriminant function correlates most highly with Socio-Conceptual (.930) and is thus the most discriminating factor in differentiating AS and NLD groups from the Control group (see Table 4.5). The Asperger’s Syndrome features and Adaptive deficits factors are also significant in discriminating AS and NLD groups from the Control group. Thus, in addressing the first research question, it may be concluded that the construct that most differentiates the NLD group from the Control group is the Socio-Conceptual deficits factor, which demonstrates the
significant difficulty of individuals with NLD in interpreting the subtleties and nuances in social interactions and in understanding concepts.

10. The second function correlates most highly with Learning Style (.693), and is thus the most discriminating variable differentiating the NLD group from AS and Control groups (see Table 4.5). Thus, it may be concluded with reference to the second research question that the construct that differentiates the NLD group from the AS group is the Learning Style factor. The NLD and AS groups could not be differentiated on the other three factors, thus supporting current literature that individuals with NLD and those with AS have characteristics that overlap to a large extent and yet are distinctive disorders.

11. All 3 groups (AS, NLD and Control) had similar mean values for the Academics factor, indicating that groups could not be separated based on that variable alone (see Table 4.6). Moreover, the correlations between Academics and the discriminant functions were very low. It may be concluded that although the academic assets and deficits of children with NLD or AS may be very different from those of their typically functioning peers, the success of academic interventions in schools may have blurred this difference.

Implications of Results

The results of this study indicated that although the real data set fitted the hypothesized model to a large extent, revisions to the parent rating scale are needed before it can be used. With scale revisions along the line of the real data set extracted-factors model, the parent rating scale can be used with confidence to screen for individuals with NLD from those with AS and from typically functioning peers. Scale
revisions would involve retaining all factors (i.e., Socio-Conceptual, Asperger’s Syndrome, Adaptive and Learning Style) and dropping the Academics factor, making it a 4-factor model. Furthermore, given that Learning Style is the only factor that differentiates individuals with NLD from those with AS, addition to the parent rating scale of items that capture the construct should be explored.

This study supports Rourke’s NLD model and the notion that there is considerable overlap of features between AS and NLD. It is unclear from the study if the hypothesized variable of restricted interests and repetitive behavior could be the distinguishing factor between NLD and AS, given that the variable converged with socioemotional deficits on the Asperger’s Syndrome features, which factor mean values for the two syndromes did not show significant difference. However, the learning style factor which was identified in this study is unique to individuals with NLD and distinguishes them from individuals with AS. This finding adds fodder to the continuing debate on the nonverbal abilities (i.e., visual-spatial-organizational and psychomotor coordination) of individuals with AS. It would appear that if AS is recognized as a disorder on the autism spectrum, their nonverbal abilities are less likely to be impaired. If, on the other hand, AS is perceived as more similar to NLD than autism as proposed by Rourke, nonverbal learning disabilities are likely to feature prominently in AS. Nevertheless, the results of this study clearly demonstrate that NLD and AS are two distinguishing disorders with implications for the inclusion of NLD in the DSM formally.

Lastly, the power of the academics factor in differentiating the groups might have been confounded and diminished by special education services received by about 70% of NLD and AS students in this study. These results suggest that early diagnosis is
imperative as interventions are highly effective in helping students with NLD or AS experience academic success and thereby in mitigating their socio-emotional problems.

Recommendations for Future Research

This study provides a number of possibilities for future research, one of which is to continue the validation process of the parent rating scale. The parent rating scale may be revised based on the findings of this research, and a new data set collected to replicate the study with the goal of obtaining a larger AS group that is roughly equivalent to the NLD and Control groups since the AS group in the present study was disproportionately smaller.

Future research could include an Autism group which could reveal similarities and differences with NLD and AS. The findings of such a study might throw light on how the learning styles of the three disorders are different or similar (and indirectly their nonverbal abilities/disabilities), which could aid in differential diagnosis.

Differential Item Functioning is a statistical method that can be used to investigate further the potential of the hypothesized variable Restricted Interests and Repetitive Behavior in differentiating NLD from AS. The method involves holding all other items of the parent rating scale constant except for the 6 items of Restricted Interests and Repetitive Behavior to determine if there is a difference between groups. To tap the factor more accurately, the 6th item, My child has many and varied interests, should be reworded or deleted from the rating scale. In addition, to increase the power of differentiation between NLD and AS, more AS items that reflect American Psychiatric Association’s (2000) DSM-IV-TR diagnostic criteria for Asperger’s Disorder and definition of “restricted repetitive and stereotyped patterns of behavior, interests, and
activities” should be included i.e., inflexible adherence to specific, nonfunctional routines or rituals; stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements); and persistent preoccupation with parts of objects.
References


APPENDIX A

PARENT RATING SCALE ITEMS

LANGUAGE ASSETS AND DEFICITS

A. Language Form
1. My child learns by talking his/her way through even when doing simple tasks (Rourke, 1995b, 2006k, May 7; Thompson, 1997).

2. To find his/her way around in the neighborhood or shopping mall, my child verbally labels and memorizes environmental markers (Rourke, 2006e, February 12; Thompson, 1997).

3. My child talks nonstop when other children are trying to play (Rourke, 1995a; Thompson, 1997).

4. When my child speaks, it sounds like he/she is reporting word for word rather than telling the story (Rourke & Tsatsanis, 1996b).

B. Language Content
5. My child uses many words but makes few points (Rourke & Tsatsanis, 1996b).

6. My child talks like an adult, but has difficulty understanding what adults mean to say (Humphries, Cardy, Worling & Peets, 2004; Rourke & Tsatsanis, 1996b; Thompson, 1997; Worling, Humphries & Tannock, 1999).

7. My child understands when someone is being sarcastic (Rourke & Tsatsanis, 1996b; Shamay-Tsoory, Tomer & Aharon-Peretz, 2005; Thompson, 1997; Whitney, 2002).


9. My child tends to misinterpret, misunderstand or misjudge what others say (Petti, Voelker, Shore & Hayman-Abello, 2003; Rourke, 2006k, May 7; Thompson, 1997).

C. Language Use
10. My child easily interprets the meaning conveyed by other people’s tone of voice (Rourke & Tsatsanis, 1996b; Snow, 2000; Thompson, 1997; Volden, 2004).

11. My child’s tone of voice makes him/her sound rude to others although he/she does not mean to be rude (Rourke, 2006c, February 12; Thompson, 1997).

12. My child understands or uses appropriate gestures when interacting with others (Johnson & Myklebust, 1967; Palombo, 2006)
ACADEMIC ASSETS AND DEFICITS

13. My child learns best by watching (e.g., dance movements, riding a bike, legos) (Johnson & Myklebust, 1967; Rourke, 1995b; Rourke & Tsatsanis, 1996b; Thompson, 1997).

14. My child learns best through direct verbal instruction (Rourke, 1995b; Tuller, Jantzen, Olvera, Steinberg, & Kelso, 2007).

15. My child excels in reading (Rourke, 1995a; Rourke & Tsatsanis, 1996b).

16. My child has excellent phonological decoding skills (Rourke & Tsatsanis, 1996b).

17. My child easily understands what he/she reads, even age-appropriate complex text (Casey & Rourke, 2002; Rourke, 1995a; Rourke, Ahmad, Collins, et al., 2002).

18. When reading, my child understands language on relationships between objects in space (Worling, Humphries, & Tannock, 1999).

19. When retelling a story, my child focuses on the details and misses the main point of the story (Humphries, Cardy, Worling & Peets, 2004).

20. My child gets poor spelling scores (Rourke, 1995a; Rourke & Tsatsanis, 1996b).

21. My child has little difficulty with handwriting, even in the early school years (Rourke, 1995a; Rourke, 2006a, February 12).

22. My child has a larger/more advanced vocabulary than other children his/her age (Rourke & Tsatsanis, 1996b).

23. My child’s reading skills are much worse than his/her math abilities (Rourke, 1995a; Rourke, Ahmad, Collins et al., 2002).


25. My child’s favorite subjects are art and physical education (PE) (Johnson, 1987).

26. My child can easily remember and recall facts and details, like a ‘walking encyclopedia’ (Rourke & Tsatsanis, 1996b).

27. My child easily understands concepts (Casey & Rourke, 2002; Fisher, DeLuca & Rourke, 1997; Rourke, 1995a, 1995b).
ADAPTIVE DEFICITS

28. My child loses his/her way easily, even in familiar places he/she has visited frequently (Cornoldi, Rigoni, Tressoldi & Vio, 1999; Denckla, 1991; Johnson & Myklebust, 1967; Lezak, Howieson & Loring, 2004).

29. My child is more prone to physical injury than other children his/her age (Rourke, 2006e, February 12).

30. My child easily learned to ride a bike (Johnson & Myklebust, 1967; Rourke, 2006e, February 12; Thompson, 1997).

31. My child enjoys jigsaw puzzles (Johnson & Myklebust, 1967; Thompson, 1997).

32. My child quickly learned to tie his/her shoe laces without much difficulty (Johnson & Myklebust, 1967; Thompson, 1997).

33. My child bumps into things and people more than usual for no good reason (Johnson & Myklebust, 1967).

34. My child trips over things or drops things more so than others in the family (Thompson, 1997).


36. My child has trouble lining up the columns on his/her math papers (Cornoldi, Rigoni, Tressoldi & Vio, 1999; Johnson & Myklebust, 1967; Lezak, Howieson & Loring, 2004; Rourke, 1993; Thompson, 1997).

37. My child enjoys cutting and pasting (Thompson, 1997).

38. My child has a distorted sense of time, both in estimating elapsed time and time of day (Rourke, 2006a, February 12; Rourke, Ahmad, Collins, et al., 2002).

39. My child has little difficulty copying material from the chalkboard (Cornoldi, Rigoni, Tressoldi & Vio, 1999; Thompson, 1997).

40. My child has no trouble learning to kick a soccer ball (Johnson & Myklebust, 1967; Thompson, 1997).

41. My child misses recess at school and drops out of after-school activities in order to keep up with school work (Rourke, 1995a; Thompson, 1997).

42. My child needs me to explain each step even when doing simple tasks (Johnson & Myklebust, 1967; Rourke, 1995b; Thompson, 1997).
43. My child easily watches and learns to play games with other children (Cornoldi, Rigoni, Tressoldi & Vio, 1999; Johnson & Myklebust, 1967; Thompson, 1997).

44. My child has a much better memory for pictures than words (Johnson & Myklebust, 1967; Liddell & Rasmussen, 2005).

45. My child enjoys building or construction toys (Cornoldi, Rigoni, Tressoldi & Vio, 1999; Rourke, 2006a, February 12; Thompson, 1997).

46. My child tends to focus on the details of what he/she sees and often misses the big picture (Cornoldi, Rigoni, Tressoldi & Vio, 1999; Denckla, 1991; Thompson, 1997).

47. My child easily understands the relative meanings of size, weight, height, and speed (Myklebust, 1975).

48. My child tends to have difficulty adjusting to a substitute or new teacher (Casey & Rourke, 2002; Rourke, Ahmad, Collins, et al., 2002; Thompson, 1997).

49. My child enjoys large birthday parties with friends (Rourke, 2006g, February 12; Rourke, Ahmad, Collins, et al., 2002; Thompson, 1997).

50. My child is easily overwhelmed in new situations, such as when his/her routine is changed (Ehlers & Gillberg, 1993; Ehlers, Gillberg, & Wing, 1999; Rourke, 2006h, February 12; Rourke, Ahmad, Collins, et al., 2002).

**SOCIOEMOTIONAL DEFICITS**

51. My child has difficulty understanding people (Casey & Rourke, 2002; Dimitrovsky, Spector, Levy-Shiff & Vakil, 1998; Rourke, 2006m, May 6; Rourke, Ahmad, Collins, et al., 2002; Rourke, 2006i, February 12; Worling, Humphries & Tannock, 1999).

52. My child has many friends his/her age (Casey & Rourke, 2002; Rourke, 2006m, May 6; Rourke, Ahmad, Collins, et al., 2002).

53. My child is easily picked on or bullied by his/her peers (Palombo, 2006).

54. My child tends to argue and be oppositional (Palombo, 2006).

55. It has been suggested that my child may have Attention Deficit Disorder (ADD) with or without Hyperactivity (ADHD) (Rourke, 1995a; Rourke, 2006b, February 12).
56. It has been suggested that my child may have Asperger’s syndrome or High-Functioning Autism (Rourke & Tsatsanis, 2000).

57. My child tends to misinterpret facial expressions, gestures or body language (Dimitrovsky, Spector, Levy-Shiff & Vakil, 1998; Petti, Voelker, Shore & Hayman-Abello, 2003; Rourke, 2006m, May 7).

58. My child stands too far or too close to the person he/she is talking to (Rourke, 2006m, May 7).

59. My child is naively trusting, taking everyone at face value (Rourke, 2006e, February 12; Thompson, 1997).

60. My child does not detect hidden meanings in language and social interactions (Rourke, Ahmad, Collins, et al., 2002; Thompson, 1997).

61. My child has difficulty understanding when things are going out of control or gone ‘far enough’. (Thompson, 1997).

62. My child tends to be anxious, even panicky, in new or novel situations (Petti, Voelker, Shore & Hayman-Abello, 2003; Rourke, 2006g, February 12; Rourke, Ahmad, Collins, et al., 2002).

63. My child often has “melt-downs” (Palombo, 2006).

64. My child is often irritable (Palombo, 2006).

**RESTRICTED INTERESTS (ASPERGER’S SYNDROME)**

65. My child has been described as a “little professor” because of his/her self-absorbing restricted intellectual interests (Ehlers & Gillberg, 1993; Ehlers, Gillberg, & Wing, 1999; Klin, Sparrow, Volkmar, Cicchetti & Rourke, 1995; Wodrich & Schmitt, 2006).


67. When something catches my child’s interest, he/she begins to focus with unusual concentration for his/her age (Klin, McPartland & Volkmar, 2005; Wallace, 2000).

68. My child has expressed frustration that his/her peers are unable to share his/her skills or interests (Klin, Sparrow, Volkmar, Cicchetti & Rourke, 1995; Wallace, 2000).

70. My child has an extraordinary large amount of factual information about some unusual topics, such as letters and numbers, astronomy, nuclear fission, transportation system and mortgages (Klin, McPartland & Volkmar, 2005; Klin, Sparrow, Volkmar, Cicchetti & Rourke, 1995).
Nonverbal Learning Disabilities - A Parent Rating Scale

Important Information:
- Your responses will not be recorded until you click the button at the end of this page.

Nonverbal Learning Disabilities (NLD) Screening Questionnaire: A Parent Rating Scale

*Instructions to parent or primary care-giver: Please provide information about your child.*

1. Date of birth:

2. Gender:
   - [ ] A. Male
   - [ ] B. Female

3. Age:
   - [ ] A. Up to 5 years old
   - [ ] B. 6 – 10 years old
   - [ ] C. 11 – 15 years old

4. Grade:

5. Ethnicity:
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<th>6. Relationship to child:</th>
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<td>7. Date of rating:</td>
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<td>8. Has your child ever been evaluated for special education services by his/her school?</td>
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<tr>
<td></td>
<td>Yes</td>
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<tr>
<td></td>
<td>Diagnoses and dates diagnosed:</td>
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<tr>
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<td>At a private clinic?</td>
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<tr>
<td></td>
<td>Yes</td>
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<tr>
<td></td>
<td>Diagnoses and dates diagnosed</td>
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<tr>
<td></td>
<td>9. Has your child ever received special education services?</td>
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<td>Yes</td>
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</table>

What kind of special education services has your child received or is receiving in
school and/or outside school?

10. Speech/Language
    Yes  No  For how long? __ months
    Academic
    Yes  No  For how long? __ months
    Social Skills
    Yes  No  For how long? __ months
    Counseling
    Yes  No  For how long? __ months
    Others
    Yes  No  For how long? __ months

11. Date when my child first started receiving special education services in school:

12. How long has your child been receiving special education services? __ months

13. Please provide any additional information or comments as you wish here.

Instructions: Please choose the option that best fits your child's description.

14. | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
   |------------------|---------|--------|------|---------------|
   My child learns by talking his/her way through even when doing simple tasks. |   |   |   |   |   |
   To find his/her way around in the neighborhood or shopping mall, my child verbally labels and memorizes environmental markers. |   |   |   |   |   |
   My child talks nonstop when other children are trying to play. |   |   |   |   |   |
   When my child speaks, it sounds like he/she is reporting word for word rather than telling the story. |   |   |   |   |   |
   My child uses many words but makes only a few points. |   |   |   |   |   |
   My child talks like an adult, but has difficulty understanding what adults mean to say. |   |   |   |   |   |
   My child understands when someone is being sarcastic. |   |   |   |   |   |
   My child understands language literally. |   |   |   |   |   |
| My child tends to misinterpret, misunderstand or misjudge what others say. |   |   |   |   |   |
| My child easily interprets the meaning conveyed by other people's tone of voice. |   |   |   |   |   |
| My child's tone of voice makes him/her sound rude to others although he/she does not mean to be rude. |   |   |   |   |   |

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<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
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<tbody>
<tr>
<td>My child understands or uses appropriate gestures when interacting with others.</td>
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<tr>
<td>My child learns best by watching (e.g., dance movements, riding a bike, legos).</td>
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<tr>
<td>My child learns best through direct verbal instruction.</td>
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<tr>
<td>My child excels in reading.</td>
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<tr>
<td>My child has excellent word decoding skills.</td>
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<tr>
<td>My child easily understands what he/she reads, even grade-equivalent complex text.</td>
<td></td>
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<tr>
<td>When reading, my child understands language on relationships between objects in space.</td>
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<tr>
<td>When retelling a story, my child focuses on the details and misses the main point of the story.</td>
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<tr>
<td>My child gets poor spelling scores.</td>
<td></td>
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<tr>
<td>My child has little difficulty with printing and cursive script, especially during the early school years.</td>
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<tr>
<td>My child has a larger/more advanced vocabulary than other children his/her age.</td>
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<tr>
<td>My child's reading skills are</td>
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</table>
much worse than his/her math abilities.

<table>
<thead>
<tr>
<th>16.</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>My child finds geometry harder than other math.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>My child's favorite subjects are art and physical education (PE).</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>My child can easily remember and recall facts and details, like a 'walking encyclopedia'.</td>
<td>0</td>
<td>0</td>
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<tr>
<td>My child easily understands concepts.</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>My child loses his/her way easily, even in familiar places he/she has visited frequently.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>My child is more prone to physical injury than other children his/her age.</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>My child easily learned to ride a bike.</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>My child enjoys jigsaw puzzles.</td>
<td>0</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>My child learned to tie his/her shoe laces without much difficulty.</td>
<td>0</td>
<td>0</td>
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<tr>
<td>My child bumps into things and people more than usual for no good reason.</td>
<td>0</td>
<td>0</td>
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<tr>
<td>My child trips over things or drops things more so than others in the family.</td>
<td>0</td>
<td>0</td>
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<thead>
<tr>
<th>17.</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>My child does well in team sports.</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>My child has trouble lining up the columns on his/her math papers.</td>
<td>0</td>
<td>0</td>
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<tr>
<td>My child enjoys cutting and pasting.</td>
<td>0</td>
<td>0</td>
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<tr>
<td>My child has a poor sense of</td>
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</table>
time, both in estimating elapsed time and time of day.

| My child has little difficulty copying material from the chalkboard. | | | | |
| My child has no trouble learning to kick a soccer ball. | | | | |
| My child misses recess at school and drops out of after-school activities in order to keep up with schoolwork. | | | | |
| My child needs me to explain each step even when doing simple tasks. | | | | |
| My child easily watches and learns to play games with other children. | | | | |
| My child has a much better memory for pictures than words. | | | | |
| My child enjoys building or construction toys. | | | | |
| My child tends to focus on the details of what he/she sees and often misses the big picture. | | | | |
| My child easily understands the relative meanings of size, weight, height, and speed. | | | | |

18.

<p>| My child tends to have difficulty adjusting to a substitute or new teacher. | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
| My child enjoys large birthday parties with friends. | | | | | |
| My child is easily overwhelmed in new situations, such as when his/her routine is changed. | | | | | |
| My child has difficulty understanding people. | | | | | |
| My child has many friends his/her age. | | | | | |
| My child is easily picked-on or bullied by his/her peers. | | | | | |</p>
<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>My child tends to argue and be oppositional.</td>
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<tr>
<td>It has been suggested that my child may have Attention Deficit Disorder (ADD) with or without Hyperactivity (ADHD).</td>
<td></td>
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<tr>
<td>It has been suggested that my child may have Asperger's syndrome or High-Functioning Autism.</td>
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<tr>
<td>My child tends to misinterpret facial expressions, gestures or body language.</td>
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<tr>
<td>My child stands too far or too close to the person he/she is talking to.</td>
<td></td>
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<tr>
<td>My child is naively trusting, taking everyone at face value.</td>
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<td>My child does not detect hidden meanings in language and social interactions.</td>
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<td>My child has difficulty understanding when things are going out of control or gone 'far enough'.</td>
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<td>My child tends to be anxious, even panicky, in new or novel situations</td>
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<tr>
<td>My child often has &quot;melt-downs&quot;.</td>
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<tr>
<td>My child is often irritable.</td>
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<tr>
<td>My child has been described as a 'little professor' because of his/her unusual intellectual interests.</td>
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<tr>
<td>My child pursues his/her idiosyncratic interest with such intensity that it interferes with completing simple daily living activities.</td>
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When something catches my child's interest, he/she begins to focus with concentration unusual for his/her age.

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My child has expressed frustration that others are unable to share his/her interests.

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My child has many and varied interests.

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My child has an extraordinary large amount of factual information about some unusual topics (e.g., letters and numbers, astronomy, geography).

<p>| | | | | |</p>
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Have you responded to all the items? Please complete the rating scale and inform your parent support group facilitator /NLD/ASPEN/PTA in order to be counted towards a monetary compensation as a token of appreciation for your time and assistance.

**SUBMIT**
APPENDIX C

Email letter to Asperger Syndrome Education Network (ASPEN)

December 29th, 2008

Dear

I am a doctoral student of the School Psychology program at Ball State University, Indiana, conducting a research study in partial fulfillment of the PhD dissertation requirements of the University.

The purpose of the study is to construct and validate a parent rating scale as a preliminary screening procedure for the identification of students with nonverbal learning disabilities (NLD) in schools. Students with learning difficulties are expected to benefit from such a brief and inexpensive screening procedure that will facilitate early diagnosis and intervention.

Children with Asperger's Disorder have many overlapping NLD characteristics, thus, it's imperative to have a sensitive instrument that would differentially diagnose these two disabilities. Parents are an invaluable source of information for educational psychological assessment, and the participation of ASPEN parents in this study is very much needed.

Should ASPEN decides to participate, parents shall be asked to click on a link to complete the rating scale online. They shall be asked respond to statements in the parent rating scale with respect to their child’s behaviors by indicating the option that best describe him/her. It will take approximately 20 to 25 minutes to complete the rating scale. There are no known risks from participating in this research. Anonymity and confidentiality of data is maintained since parents are not required to provide any identifying information of themselves or their children on the rating scale.

My IRB ID# is 83936-2, should you wish to contact the Coordinator of Research Compliance, Office of Academic Research and Sponsored Programs, Ball State University, Muncie, IN 47306, (765) 285-5070, irb@bsu.edu.

As mentioned on the telephone, I shall be please to donate $5/- to ASPEN for every completed rating scale submitted as a token of appreciation for your time, participation and assistance.

Thank you so much for your interest in the study.

Yours sincerely,
Ms Tzu Min Lee, EdS, NCSP
Doctoral Intern
School Psychology
Department of Educational Psychology
Ball State University
Muncie, IN 47306
Tel: 765-285-8500
APPENDIX D

Email letter to NLDCoaching Connection (NLDline)

December 31\textsuperscript{st}, 2008

Dear

I am a doctoral student of the School Psychology program at Ball State University, Indiana, conducting a research study in partial fulfillment of the PhD dissertation requirements of the University.

The purpose of the study is to construct and validate a parent rating scale as a preliminary screening procedure for the identification of students with nonverbal learning disabilities (NLD) in schools. Students with learning difficulties are expected to benefit from such a brief and inexpensive screening procedure that will facilitate early diagnosis and intervention. Parents are an invaluable source of information for educational psychological assessment, and the participation of parents of children with NLD in this study is very much needed.

Should NLDA or NLDConnection or NLDLine decides to participate, parents shall be asked to click on a link to complete the rating scale online. They shall be asked respond to statements in the parent rating scale with respect to their child’s behaviors by indicating the option that best describe him/her. It will take approximately 20 to 25 minutes to complete the rating scale. There are no known risks from participating in this research. Anonymity and confidentiality of data is maintained since parents are not required to provide any identifying information of themselves or their children on the rating scale.

My IRB ID# is 83936-2, should you wish to contact the Coordinator of Research Compliance, Office of Academic Research and Sponsored Programs, Ball State University, Muncie, IN 47306, (765) 285-5070, irb@bsu.edu.

I shall be pleased to donate $5/- to NLDA/NLDConnection/NLDline for every completed rating scale submitted as a token of appreciation for your time, participation and assistance. I shall require around 30 responses.

Thank you so much for your interest in the study.

Yours sincerely,
Ms Tzu Min Lee, EdS, NCSP
Doctoral Intern
School Psychology
Department of Educational Psychology
Ball State University
Muncie, IN 47306
Tel: 765-285-8500
APPENDIX E

January 6th, 2009

Dear Parent/Primary caregiver of Burris Laboratory School,

Validation of a Preliminary Screening Procedure for the Identification of Nonverbal Learning Disabilities (NLD) in Schools: A Parent Rating Scale

I am a doctoral student of the School Psychology program at Ball State University conducting a research study in partial fulfillment of the PhD dissertation requirements of the University.

I wish to invite you to participate in my study concerning the identification of students with nonverbal learning disabilities (NLD). The purpose of this research is to construct and validate a parent rating scale that could be used by school psychologists as a preliminary screening procedure for NLD diagnosis. Currently, the NLD parent form is unavailable in the educational system. Students with learning difficulties are expected to benefit from such a brief and inexpensive screening procedure that will facilitate early diagnosis and intervention.

Parents are an invaluable source of information for educational psychological assessment. Your participation in this study is very much needed as the control group of parents of children aged up to 15 years who are not receiving special education services or have not been diagnosed with a learning disability.

Should you decide to participate, you shall be asked to respond to statements in the parent rating scale with respect to your child's behaviors by indicating the options that best describe him/her. It will take you approximately 20 minutes to complete the rating scale. There are no known risks from participating in this research.

Anonymity and confidentiality of data is maintained since you are not required to provide any identifying information of yourself or your child on the rating scale. For questions on your rights as a research participant, please contact Coordinator of Research Compliance, Office of Academic Research and Sponsored Programs, Ball State University, Muncie, IN 47306, (765) 285-5070, irb@bsu.edu.

Your participation in this study is completely voluntary and you are free to withdraw from the research at anytime without prejudice from the investigator. Please contact the investigator or faculty supervisor mentioned below if you have any questions regarding the research.

Please access the parent rating scale by clicking on this link:

Thank you for your participation and assistance.

*******************************

Principal Investigator
Tzu Min Lee, Doctoral Student
School Psychology
Ball State University
Muncie, IN 47306
Telephone: (765) 285-8500

Faculty Supervisor
Dr. Raymond S. Dean, Director of Doctoral Programs
School Psychology
Ball State University
Muncie, IN 47306
Telephone: (765) 285-2289