Nonverbal Learning Disabilities: An understanding of inferential competencies

by

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Abstract

Although subtle linguistic deficits have been postulated for children identified with Nonverbal Learning Disabilities (NLD) (e.g., Rourke & Tsatanis, 1996), there is little empirical evidence to support this contention. Two experimental language inferencing measures that have been demonstrated to be problematic for individuals with right hemisphere brain damage (RHBD) and one norm-referenced inferencing task (Test of Language Competency: Making Inferences subtest), were examined with three groups of children between the ages of 9-13: 1) children with NLD (n=14), 2) children with verbal-impairments (VI) (n=14), and 3) children without learning disabilities who served as controls (C) (n=19). The NLD and VI groups did not differ from one another on any of the three measures, indicating a generalized language inferencing deficit in the NLD group. Relative to the C group, however, the NLD group experienced a unique pattern of difficulties with spatial and emotional inferencing capabilities. The implications of right hemisphere involvement in the NLD profile are examined in relation to the effects of working memory on inferential abilities.
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Introduction

Since the inception of the term learning disabilities (LD) over thirty years ago (Kirk, 1963), efforts have been made to describe what has generally been accepted as a heterogeneous population (Fletcher, 1985). The partitioning of learning disabilities into subtypes has received considerable attention (e.g., Fletcher, 1985; Fuerst, Fisk & Rourke, 1989; Hooper & Willis, 1989; Keogh, 1986; Morrison & Siegel, 1991; Porter & Rourke, 1985) and, although the reliability of discrete subtypes remains equivocal, there are several prominent subtypes that have emerged from the literature.

One learning disability subtype that has been identified is Nonverbal Learning Disability (NLD). Nonverbal learning disability was first described by Johnson and Myklebust (1967) and then expanded by Rourke and his colleagues (Casey, Rourke, Picard, 1991; Fisk & Rourke, 1983; Fuerst et al., 1989; Harnadek & Rourke, 1994; Ozols & Rourke, 1985; Porter & Rourke, 1985; Rourke, 1982, 1985, 1987, 1988a, 1988b, 1989, 1993; Rourke & Fuerst, 1992; Rourke, Fisk, & Strang, 1986; Rourke, Young, & Leenaars, 1989; Rourke, Young, Strang, & Russell, 1985; Strang & Rourke, 1985). According to these authors, individuals who have been diagnosed as NLD present with a myriad of difficulties that are thought primarily to affect the individual's visual-spatial functioning. Although the etiology of these difficulties is not clear, they are assumed to be pervasive and associated with the right hemisphere (RH) and lead to secondary deficits in mathematics and social skills. The NLD profile is similar to other developmental profiles involving the right hemisphere and some authors have argued for a more generalized right hemisphere disability (e.g., Brumback & Staton, 1982; Glosser & Koppell, 1987;
The language functioning of individuals with NLD is currently unclear as it has been reported that their automatic language functioning is as good as those without learning disabilities (Casey & Strang, 1994; Rourke, 1989). At the same time though, Rourke (1989; Rourke & Tsatanis, 1996) has noted that individuals with NLD may have somewhat delayed language development and problems with semantics, prosody, and pragmatics. Some investigators (e.g., Foss, 1991; Johnson, 1987; Johnson and Myklebust, 1971; Moss Thompson, 1985) have also observed a connection between the visual-spatial problems of individuals with NLD and certain confusions in their spatial language. The connection between NLD and linguistic difficulties, however, remains speculative as there are currently no data to support this contention. Although Rourke (1989) has suggested that the rote verbal capacities of NLD individuals are often adequate, there is a dearth of research examining the ability of individuals with NLD to understand and interpret the subtleties of language.

If the visual-spatial difficulties found in NLD are as pervasive and comprehensive as some researchers suggest (e.g., Humphries, Krekewich, & Snider, 1996; Rourke, 1989), their pattern of neurological deficits may be similar to those of individuals with right hemisphere brain damage (RHBD) who have well-documented severe visual-spatial problems and related difficulties with some forms of language. If the pattern of NLD visual-spatial deficits is analogous to that found in RHBD, it is likely that these deficits will be reflected in aspects of the language functioning of these individuals with NLD. Examples of linguistic difficulties that have been associated with RHBD include problems
with inferencing, narrative and emotional discourse, and spatial language (Moya et al., 1986; Myers & Brookshire, 1996; Richards & Chiarello, 1997; Rivers & Love, 1980; Van Lancker, 1997).

The purpose of the present study was to characterize the language inferencing abilities of children with NLD. The ability of children with NLD to understand inferences was examined using two methodologies that have been used to assess inferencing skills of RHBD participants: 1) an inferencing paradigm (Paris & Carter, 1973), and 2) a narrative discourse paradigm (Moya, Benowitz, Levine, & Finklestein, 1986). A standardized inferencing measure, The Making Inferences subtest from the Test of Language Competence-Expanded Edition (TLC-E) (Wiig & Secord, 1989), was included to provide data from an existing normed test.

Children with NLD were compared to a group of children with a pattern of verbal impairments (VI) and a group of children without learning disabilities who served as controls (C) to determine if a) NLD children have difficulty interpreting oral language when this requires making a spatial inference compared to a nonspatial inference, b) whether this difficulty is more severe for children with NLD than those with VI and c) if this problem is correlated with greater difficulty for NLD children in interpreting the content of stories, in particular the emotional content, as has been found with individuals with RHBD (Bloom, Borod, Obler, & Gerstman, 1992).

By examining the more subtle linguistic abilities of NLD children, it was proposed that the relationship between visual-spatial deficits and linguistic functioning may be more clearly delineated. If the NLD pattern of linguistic weakness is analogous to that of individuals with RHBD, inferencing, interpreting visual-spatial language, and predicting
emotional content should be the aspects of performance most affected. If, however, children with NLD are indistinguishable from the VI group, there will not be support for the uniqueness of these factors in defining the NLD profile. By providing data on linguistic competencies, this study will help to provide a unique understanding of NLD language features and, in doing so, further clarify the nature of the NLD profile.
2.1 Introduction to NLD

Researchers have investigated the heterogeneity of the LD population through the application of statistical analyses to a battery of tests to determine subtypes (Torgesen, 1991). Multivariate classifications are believed to provide objective support for discrete subtypes within the heterogeneous LD population (Fisk & Rourke, 1983). Empirically derived LD subtype models based on neuropsychological test battery performance profiles have recently been utilized to identify emerging subtypes (Fletcher & Satz, 1985; Hooper & Willis, 1989; Rourke & Fisk, 1988). One subtype that has consistently emerged from multivariate analyses is a relative weakness in nonverbal skills (Fletcher, 1985; Ozols & Rourke, 1988; Rourke, 1989; Rourke et al., 1989; Torgesen, 1991; Van der Vlugt, 1991). Individuals identified within this subtype present with a series of core factors including weak visual-spatial skills, poor mathematical achievement, and difficulties with abstract nonverbal problems (Little, 1993). Additional factors that have been associated with this subtype are disturbances in interpersonal skills and left-sided neurological findings (Gross-Tsur et al., 1995; Spafford & Grosser, 1993).

A number of researchers (e.g., Glosser & Koppell, 1987; Gross-Tsur et al., 1995; Johnson & Myklebust, 1967; Rourke, 1989; Semrud-Clikeman & Hynd, 1990, 1991; Voeller, 1986, 1995; Weintraub & Mesulam, 1983) have argued for a right hemisphere involvement in this nonverbal disability. Although the names given to this disability differ (e.g., developmental right hemisphere syndrome, right hemisphere deficit
syndrome, developmental learning disability of the right hemisphere, right hemispheric dysfunction, nonverbal learning disability syndrome), the criteria for inclusion appear to be similar.

2.2 Right Hemisphere Dysfunction (RHD) in NLD:

In their seminal book on learning disabilities, Johnson and Myklebust (1967) introduced a novel classification or subtype of disability: nonverbal learning disabilities. Although the majority of educators and researchers at the time were concerned with the language and academic deficits of individuals with LD, Johnson and Myklebust recognized that some individuals presented with an entirely different set of difficulties that centred on the nonverbal aspects of functioning. Originally, Johnson and Myklebust (1967), and later Myklebust (1975) and Johnson (1987), identified individuals who presented with NLD as demonstrating, to some degree, an inability to comprehend the importance of many of the rudimentary aspects of daily living. These individuals were seen as encountering difficulty with pretend play, understanding the intention of others', body image, left-right-discrimination, time, orientation, and spatial abilities.

The difficulties associated with NLD were thought to stem from deficits in the cerebral systems that controlled nonverbal information and because these individuals were able to accurately distinguish separate elements of a task, they were not seen as having problems in perception (Myklebust, 1975). Rather, their problems were considered to be related more to memory and the individual's inability to encode and
store the percept. Information was seen as being taken in correctly yet stored incorrectly; therefore, the ensuing action was based on inaccurate information.

Johnson and Myklebust (1967), citing clinical and theoretical evidence, implied a strong right hemisphere involvement in the nonverbal domain. These authors delineated a theoretical model that identified semi-autonomous systems of brain functioning. Within this framework, each hemisphere is primarily responsible for a specific domain: the left for language and the right for mediating nonverbal skills. Research demonstrating neural plasticity and the transfer of function following brain injury led Johnson and Myklebust to move away from a theory of exclusive functioning and incorporate the semi-autonomous classification. For individuals who presented with NLD it was assumed that "the neurological systems, predominant in the right hemisphere, have been developmentally disrupted by endogenous or exogenous involvement in the same manner as detriments occur for verbal learning" (Johnson & Myklebust, 1967, p. 45-46).

The writings of Johnson and Myklebust (1967), and later Myklebust (1975), are important for two reasons. First, they introduced the concept of NLD and alerted educators, clinicians, and researchers to the critical importance of disorders in the nonverbal aspects of functioning. Second, they are the first set of researchers to have described social perception difficulties in individuals with learning disabilities (Spafford & Grosser, 1993). Difficulties with nonverbal functioning and social perception have since received considerable attention in the LD literature.

Although Johnson and Myklebust (1967) were able to focus attention on this little-known disability, their pioneering attempts centred on symptomatology rather
than classification. Weaknesses associated with NLD were outlined and several case examples were provided for illustration (Johnson, 1987; Myklebust, 1975). Because the authors failed to include the research outlining the defining criteria associated with NLD, the reader is left unclear as to the degree of impairment necessary to distinguish the NLD group from other types of LD and/or brain injury.

As a result of the dearth of specifics regarding the NLD profile, several researchers (Glosser & Koppell, 1987; Gross-Tsur et al., 1995; Rourke, 1989; Semrud-Clikeman, 1990; Spaford & Grosser, 1993; Voeller, 1986, 1995; Weintraub & Mesulam, 1983) have made an effort to outline the NLD profile in more detail. A common theme found among these outlines is the assumption that the right hemisphere plays a critical role in the difficulties of the NLD population. The core deficits found within the NLD population appear to centre on visual-spatial or perceptual dysfunction (Humphries et al. 1996; Rourke, 1989). Although certain spatial processing disorders have been observed in individuals with left hemisphere damage and/or bilateral impairments, the right hemisphere has been implicated as the dominant hemisphere for acquisition and execution of visual-spatial skills (Kolb & Whishaw, 1985). Given Johnson and Myklebust's (1967) interpretation of the skill deficits of individuals with NLD, and the implication of right hemisphere involvement, researchers have been interested in further defining this potential relationship.

2.21 Neuropsychological Evidence for RHD in NLD:

Rourke together with his colleagues has been the most prolific researcher in the area of NLD neuropsychological profiling (e.g., Casey, et al, 1991; Fisk & Rourke,

Within the NLD syndrome framework, neuropsychological strengths and weaknesses are differentiated and further categorized into four dimensions: primary, secondary, tertiary, and verbal. All four categories are thought to impact on the academic and social functioning of the individual. Causality within this model is explicit so that deficiencies in social and/or academic functioning are the direct result of the pattern of neurological strengths and weaknesses found within this profile. More specifically, the primary neurological characteristics lead to secondary characteristics, and are found across strengths and weaknesses.

i) NLD Deficits:

According to Rourke (1989), primary neuropsychological deficits associated with NLD centre on four areas of perception and psychomotor abilities. First, if difficulties with bilateral tactile-perception are present they are usually more discernible on the left side of the body. Second, marked visual-spatial-organizational difficulties are evident. Third, these individuals exhibit bilateral psychomotor coordination deficiencies that are often more pronounced on the left side of the body. Finally, there
are significant difficulties in adapting to novel situations and/or incorporating novel information into existing schema.

The secondary neuropsychological deficits outlined in the NLD model involve attention and exploratory behaviours. Attention to tactile and visual input is described as weak, particularly for complex verbal material delivered through the haptic or visual modalities. Exploratory behaviour in infants is described as limited and continues to be restricted into adulthood with the pursuit of sedentary and often physically limited experiences.

Tertiary neuropsychological deficits are characterized by difficulties with concept formation, problem solving, and memory. Nonverbal problem solving and hypothesis testing are considered to be areas of difficulty, particularly when the information or concept is novel and/or complex. Memory for tactile or visual input is weak. More specifically, memory for nonverbal, complex, or novel material is problematic unless it can easily be coded verbally.

The fourth dimension of neuropsychological deficit focuses on verbal competence. Although verbal skills are considered to be a relative strength for this profile, specific verbal deficits remain. Primary linguistic difficulties centre on what Bloom (1988) has termed the content of language and include semantics, humour, and metaphoric use of language. The specifics of these language deficits are discussed in more detail in a later section (see page 37).

As mentioned above, the NLD model outlined a causative relationship between the four dimensions of neuropsychological deficits and the ensuing social and academic deficits. Academically, three areas are considered problematic: reading comprehension,
mechanical arithmetic/mathematics, and science. Socially, individuals with NLD may demonstrate significant deficits in the areas of social judgment, social perception, and social interaction skills. Behaviourally, there may be an inability to adapt to novel situations and a reliance on using overly scripted, and often inappropriate, behaviours. Socioemotional pathologies may exist and present as a form of internalized (e.g., depression, suicide) disturbance (Rourke et al. 1989).

The pattern of neuropsychological deficits outlined by Rourke (1989) is relatively detailed and lists a number of specific areas of weakness. There are, however, some common elements represented throughout the list of deficits. Information that is presented in the visual-spatial modality is apparently difficult for individuals with NLD to incorporate into their thinking. In addition, these individuals have difficulty using their existing schema to interpret information or situations when faced with new material or when the material is overly complex.

ii) NLD Assets:

In addition to examining deficits, Rourke (1989) also outlined the relative strengths of the NLD profile for each of the four dimensions and the resulting academic and social skills. Primary assets fall in the areas of simple or repetitive motoric skills; a generally well-developed ability to learn material through rote or repetitious input; and relatively strong auditory perceptual skills. Secondary assets include well-developed selective and sustained attention for rudimentary, rote verbal material. Tertiary assets are found in memory for simple auditory and verbal material. The verbal assets of the NLD profile are characterized by a high volume of speech
output that relies heavily on rote material and associations. In addition, receptive language skills are described as good. Academic assets are evident in single-word reading (or decoding) and verbatim recall of oral and written verbal material. Rourke (1989) does not outline or speculate on social assets for the NLD profile.

iii) Theoretical Model

Rourke and his colleagues have outlined a strong theoretical argument for right hemisphere involvement in the processing difficulties associated with NLD. In an attempt to explain the development and/or etiology of the NLD syndrome, Rourke provided a theoretical model (Rourke, 1982, 1987, 1989) that examined the neurological aspects of the syndrome. The Rourke "Right--Left, Down--Up, Back--Front Model" attempts to explicate the development of abilities and deficits in the NLD profile, while at the same time "encompass a relatively broad range of the neuropsychological dimensions of human development and their ramifications in aspects of personal, academic, and social functioning" (Rourke, 1989, p.111).

The Rourke Right--Left, Down--Up, Back--Front Model (hereinafter labeled the "NLD model") is based on the premise that subcortical injury and/or dysfunction is responsible for cognitive and learning disorders of development. More important, the organizational properties of the hemispheres plays an integral role in the development and acquisition of basic personal, social, and academic skills.

The NLD model is supported by the work of Goldberg and Costa (1981) who found that differential organization of the hemispheres may account for their dissimilar processing abilities. More specifically, the right hemisphere has a better
ability to process novel stimuli and perform intermodal integration; the left hemisphere is better suited to store compact codes and perform unimodal and motor processing. The right hemisphere's proclivity for assembling novel information is functional only if the novel stimuli can be incorporated into a meaningful repertoire of behaviour and become a more automatic process.

To account for the automaticity and/or assimilation of meaning, Goldberg and Costa (1981) included the concept of a right-to-left shift in the relative hemispheric control of cognitive skills over the course of their ontological development. In this paradigm, the previously novel stimuli, having been "assembled" by the right hemisphere, are then transferred to the left hemisphere where they are dealt with in a more routinized, unimodal, and stereotypic fashion. The authors submit that this theory accounts for a gradation, or continuum, of relative hemispheric control over cognitive skills in the course of their development that reflects the degree of routinization.

Rourke (1982; 1989) hypothesized that if children with NLD were somehow deficient in right hemisphere abilities they should exhibit some of the intermodal integration difficulties proposed by Goldberg and Costa (1981). Upon closer examination, Rourke found that the NLD group did indeed demonstrate deficiencies in intermodal integration, problem solving, concept formation in novel situations, and difficulties benefiting from experiences that do not already exist in their behavioural repertoires. Conversely, examination of the skills and modalities of the left hemisphere (e.g., modality-specific, intramodal, routinized, and stereotypic) for this group were found to be well formed.
In an effort to further his contention that the NLD syndrome is a reflection of RHD, Rourke (1989; 1995) cites similarities between NLD and other neurological impairments (e.g., head injuries, hydrocephalous, and children with either absence of the corpus callosum or significant tissue removal). In all of these cases, the individuals had suffered from either right hemisphere damage and/or complete absence of the commissural fibers. According to Rourke, (1987, 1989) the fact that these individuals share some of the same behavioural, academic, and intellectual characteristics as the NLD group argues for a correlation between NLD and RHD.

iv) Criticisms of the NLD Syndrome Model:

Rourke and his colleagues have produced enormous volumes of writing on the NLD model over the past two decades. Although the sheer volume and breadth of the experimental and theoretical writings are impressive, there are several methodological concerns relating to the manner in which the NLD profile is classified in addition to a lack of specificity regarding several key factors.

First, Rourke (1989) used several of the selection variables as dependent measures. For example, he utilized a minimum 10 point standard score discrepancy on the WISC-R in favour of the Verbal IQ (VIQ) to select his NLD group and then proceeded to use individual WISC-R subtest scores as dependent measures. Clearly, individuals who are selected into a group as a result of their good verbal skills will undoubtedly have high verbal scores on the dependent measures. Similarly, participants were selected on their academic profiles on the WRAT and then academic measures were used as outcome measures.
A second criticism centres on the two-step inclusion process that was used by Casey et al. (1991) and Harnadek and Rourke (1994). The first step screened for potential NLD participants by utilizing nine criteria (e.g., good verbal capacity, psychomotor deficiencies, etc.). Once all of the potential participants (42) were selected from a database of over 5,000 children, the authors then independently reviewed each case file to "determine if the child in question exhibited the behavioural consequences of the NLD syndrome" (Harnadek & Rourke, 1994, p.147). At this phase, eight potential participants were rejected based a) on behavioural criteria such as difficulty testing, hyperactivity, and language impairment, or b) because they "exhibited features not consistent with NLD" (Harnadek & Rourke, 1994, p.148). Unfortunately, the authors failed to define what the inconsistent features were and excluded participants who met all of the academic and neuropsychological selection criteria for the NLD profile. A quick examination of the numbers of participants originally meeting NLD criteria reveals that approximately 19% of the children identified by the first stage of screening presented with a different behavioural pattern and/or inconsistent features and, as a consequence, were excluded from further investigation. It is unfortunate that the authors chose to exclude these participants and failed to include some descriptive data that may have helped to define a more broad-based NLD profile.

An additional criticism concerns the small sample of NLD participants in conjunction with the large number of classification variables used to identify the NLD group. Harnadek and Rourke (1994) utilized no fewer than 22 classification variables from a variety of neuropsychological and language measures. Fletcher (1985), in
discussing the external validation of LD subtypes, suggested that external validation can be hindered in studies that utilize large numbers of classification variables. According to Fletcher, better designed research utilizes a small number of classification variables thus both reducing the likelihood of redundant measures and making it easier to identify new participants. Even though Harnadek and Rourke utilized composite scores to maximize power and reduce alpha biases, it is clear that the utility of such a large number of classification variables with a small sample size is questionable.

The high number of classification variables in concert with the vague exclusion criteria call into question the generalizability of the Rourke model of NLD. Indeed, the ratio of the number of children with NLD that Harnadek and Rourke (1994) found in their “clinical data base of over 5,000 children who had received neuropsychological assessment because of suspected learning or perceptual difficulties” (p.147, italics added) is 29/5000. It appears, therefore, that the incidence rate of NLD in a suspected LD sample is approximately 0.006%, which is considerably lower than Ozols and Rourke's (1988) prior prediction of 10% of the LD population.

A final criticism of the Harnadek and Rourke (1994) methodology centres on the lack of specificity for IQ data. Although the VIQ had to exceed 79 and there had to be a 10 point discrepancy between the VIQ and the lower Performance IQ (PIQ), there was no limit or ceiling score for the PIQ score. Consequently, a member of the NLD group could have a PIQ of 105 and a Verbal IQ of 115 and qualify as NLD. If this was indeed the case, Rourke's descriptive term “poor” perceptual skills should be changed to “relatively” poor.
The work of Rourke and his colleagues has contributed significantly to the understanding of the neuropsychological theory and developmental profile of NLD. The specificity with which the NLD profile is outlined, however, is based on a small sample of children who met highly specific inclusion criteria. Unfortunately, in an attempt to specify the NLD profile in detail, Rourke has limited the generalizability of the diagnostic criteria and made the likelihood of replication difficult. In an effort to broaden the criteria, some researchers have utilized a descriptive approach to provide detail on the NLD profile.

2.22 Descriptive Evidence for RHD in NLD:

Weintraub and Mesulam (1983) examined 14 participants with histories of nondyslexic learning disabilities and difficulties in interpersonal skills and collected data on their neurological and academic functioning. The authors described a behavioural syndrome termed "Developmental learning disabilities of the right hemisphere" (DLD-RH). In the study, the age of the participants ranged from 11 to 42 years. Several neurological variables were measured: handedness, family history, motor signs, posture/gait, hemiplegia, perinatal stress, and seizures. Due to the descriptive nature of the study (i.e., no defining criteria for DLD-RH), the 14 participants differed widely on the results of the measures having anywhere from one to nine of the possible indicators. The most common indicator was asymmetrical left arm posturing during complex gait (12/14) and the least common was evidence of left infantile hemiplegia (2/14).
Weintraub and Mesulam (1983) examined the VIQ-PIQ discrepancies and found an average 20 point VIQ advantage; however, the discrepancies ranged from 6 to 36 standard score points. Weintraub and Mesulam also collected descriptive data on the academic profile of the DLD-RH participants and found that arithmetic was the most common area of difficulty. One half of the participants scored lower on a mathematics subtest than a reading subtest and five of these discrepancies were more than 17 standard score points. Two measures of attention (one verbal and the other nonverbal) were also utilized with the DLD-RH participants and their performance on these measures was also variable. The DLD-RH participants performed more poorly on the story recall and nonverbal/spatial measures than on the paired associate learning task. The authors suggested attentional factors may have accounted for these discrepancies.

Although Weintraub and Mesulam (1983) did not include any “hard” neurological data, the pattern of low PIQ, left-sided neurologic signs, and poor visual-spatial functioning are all characteristic of RHD. In a summary of their study, these authors state that DLD-RH “is a syndrome of early RHD that may be genetically determined and that is associated with introversion, poor social perception, chronic emotional difficulties, inability to display affect, and impairments in visual-spatial representation” (p.468).

In an effort to further delineate the right hemisphere disability population Voeller (1986), examined 15 children aged 5 to 13 with “Right hemisphere Deficit Syndrome” (RH-DS) who exhibited some form of right hemisphere lesion and/or dysfunction. Neurologically, all of the children were deemed to have RHD following a
neurological examination and/or a CAT scan. Fourteen of the 15 participants exhibited left-sided motor delays manifested by gait asymmetries, motor weakness, and poor left hand performance on the Grooved Pegboard test.

Intelligence testing data from the Voeller (1986) study showed an overall mean difference between the VIQ and PIQ scores in favour of the VIQ, with 64% of the differences reaching significance (i.e., a greater than 15 point difference). The range of the 15 participants’ scores was considerable with one participant showing a discrepancy of 50 points and another with no discrepancy. Group means from the Wide Range Achievement Test-Revised (WRAT-R) (Jastak & Wilkinson, 1984) suggested that this group performed significantly better in reading decoding than arithmetic; however, three of the participants showed no difference or had better performance on the Arithmetic subtest. In addition, emotional expression as measured by prosody, gesturing, shyness, insensitivity, and peer relations were all considered to be problematic for the majority of this group. Finally, Voeller found that performance on two experimental affective recognition measures was poorer compared to age-matched norms.

From the data provided in this descriptive study, Voeller (1986) was able to highlight several behavioural, neurological, academic, and social sequelae that appear to correspond to those proposed by Weintraub and Mesulam (1983). Overall, Voeller concluded that RHD was characterized by reduced visual-spatial, emotional, and arithmetic abilities. More importantly, the affective recognition limitations in concert with the poor social interaction skills are likely to have a deleterious impact on these children’s ability to interact in an “affectively appropriate fashion” (p.1008).
In a later publication, Voeller (1995) elaborated on the clinical neurologic aspects of the RH-DS. In an effort to provide a more detailed comparison to the 16 children in this study with RH-DS, Voeller included three control groups: 1) a neuropsychiatric group with six children meeting criteria for Asperger’s Syndrome, 2) a neuropsychiatric group of three adults diagnosed with schizophrenia, and 3) 20 normal control children.

Voeller (1995) compared the four groups on a series of physical examination features including: handedness, facial asymmetry, left-sided neurologic signs, and voluntary or mimetic smiling. Although 40% of the normal control group demonstrated evidence of left-sided signs, 88% of the children with RH-DS had left-sided signs. According to Voeller, one “can be reasonably sure” (p.82) a child fits the diagnosis of RH-DS if there are two or more subtle signs of RHD in conjunction with chronic social difficulties. It is important to note that Voeller emphasized the heterogeneity of RH-DS and the need to be aware of the differential effects of specific lesion sites.

Gross-Tsur et al. (1995) attempted to further clarify the diagnostic picture of children with NLD by providing a descriptive study of what they termed “Developmental right hemisphere syndrome” (DRHS). According to these authors "Although the neuropsychological, verbal, academic, and psychosocial/adaptive features of NLD and DRHS have been reported, there are no clearly defined clinical criteria for diagnosing these syndromes" (p.80). Gross-Tsur et al. utilized five criteria for selection: 1) emotional and interpersonal behaviour disorders, 2) paralinguistic communication problems, 3) VIQ of 85 or higher and greater than the PIQ, 4) dyscalculia, and 5) neurological (motor) signs on the left side of the body. Twenty
participants were selected using these criteria and LD, attention deficit hyperactivity disorder (ADHD), and dyscalculia, were evident, to some degree, in the majority of participants with DRHS. These authors suggested that DRHS is predicated on deductive data sources and that the existence of a specific lesion site does not necessarily follow. They did suggest, however, that from the available data, the behavioural and neuropsychological profile of DRHS appeared to conform to established profiles of RHD.

Although the nomenclature found in the studies by Weintraub and Mesulam (1983), Voeller (1986, 1995), and Gross-Tsur et al. (1995) differ (e.g., Developmental learning disabilities of the right hemisphere (DLD-RH), Right hemisphere deficit syndrome (RH-DS), and Developmental right hemisphere syndrome (DRHS), respectively), the core features of each of these corresponding designations appear to be similar. These symptoms include: abnormal obstetrical and/or postnatal history, motor signs, PIQ and arithmetic weaknesses, inattention, atypical prosody, gesturing deficits, shyness, and poor peer relations. Each of these difficulties has, as its neuropsychological underpinning, a common thread of RHD.

The descriptive studies by Weintraub and Mesulam (1983), Voeller, (1986, 1995), and Gross-Tsur et al. (1995) utilized a common methodology that has several limitations. First, generalizability is reduced due to the differential criteria selection for the participants and the considerable variation found in the participant demographics (e.g., age, handedness, gender). For example, the age of the participants in the Weintraub and Mesulam (1983) study spanned childhood to adulthood with a 31 year age difference. Second, the data collected from the participants contained a high
degree of variability. Although the mean IQ discrepancies in each of these studies favoured the VIQ, for example, the individual discrepancy scores found within the data had considerably large ranges, and the relative PIQ weakness was not evident in some of the participants. Third, the capacity to assess the relative degree of dysfunction in these studies is compromised by the lack of normative data available on a number of the measures utilized for the descriptive measures, such as shyness, prosody, and peer relations, and by the fact that Gross-Tsur et al. (1995), Weintraub & Mesulam (1983), and Voeller, (1986) failed to include control and/or comparison groups.

2.23 Pharmacological Evidence for RHD and NLD:

Brumback and Staton (1982) proposed a theoretical argument for the commonality of right hemisphere involvement in learning disabilities, ADHD, and childhood depression. Children with what the authors termed “right-hemispheric learning disability” (RHLD) demonstrate weaknesses in areas traditionally thought to be executed by the right hemisphere: spatial orientation, telling time, sequencing, musical appreciation and left-body sensorimotor dysfunction.

According to Brumback and Staton (1982), children with attentional disorders also share characteristics common to adults with right hemisphere brain damage, including difficulties with impulsivity, vigilance, and attention. These attentional difficulties are often associated with learning disabilities and are thought to be the direct result of right hemisphere cerebral damage or delayed maturation.

In a follow-up article, Brumback, Staton, and Wilson (1984) found that children who presented with right cerebral hemispheric dysfunction and concomitant
depression responded well to a trial of tricyclic antidepressants. Following the administration of Amitriptyline, two children had a reduction in depressive symptomatology and, more surprisingly, a marked abatement of sensori-motor neurologic symptoms. WISC-R PIQ and WRAT arithmetic scores, for example, showed a dramatic 22 and 39 point increase respectively on the antidepressant medication. Interestingly, administration of Lithium Carbonate maintained the neurological and depressive remission; however, there was no associated cognitive increase in the neuropsychological functioning with the WISC-R and WRAT scores falling back to baseline levels. Based on these data, Brumback et al. (1984) concluded that reduction in negative symptoms associated with the right hemisphere through the use of tricyclics may, in part, indicate abnormalities in the norepinephrine and/or serotonergic systems. These authors suggested that over time the possibility exists "to develop drug therapies that specifically improve different aspects of right hemisphere function" (p. 249). Although these conclusions are based on data collected from two children, they provide an interesting theoretical argument for the neural substrates of right hemisphere functioning.

2.24 Comparative Evidence for the NLD Profile and Documented RHD:

Branch, Cohen, and Hynd (1995) examined the effects of RHD or left hemisphere dysfunction (LHD) on academic achievement and attention. Participants in the Branch et al. (1995) study had documented left- or right hemisphere lesions or met a series of neuropsychological criteria. Academic achievement and attention were then used as dependent measures. Difficulties in arithmetic computation appear to be
a core characteristic of the NLD profile (Brumback & Staton, 1982; Glosser & Koppell, 1987; Gross-Tsur et al., 1995; Little, 1993; Rourke, 1989; Semrud-Clikeman, & Hynd 1990, 1991; Tranel, Hall, Olson, & Tranel, 1987; Voeller, 1986; Weintraub & Mesulam, 1983) and were hypothesized to be more pronounced in children with RHD. Similarly, ADHD symptoms have been thought to be more prominent in children with RHD (Brumback & Staton, 1982; Rourke et al., 1985; Semrud-Clikeman, & Hynd 1990, 1991; Voeller, 1986; Weintraub & Mesulam, 1983) and were hypothesized to be rated more prevalent in the RHD group.

Parent and teacher ratings of children with LHD and RHD differed significantly in comparison to the control group on measures of ADHD; however, the original hypothesis was not supported as there were no differences between the LHD and RHD scores. There was one significant effect, in favour of weaker RHD performance, found in the continuous performance test scores, that was reflective of a more impulsive responding style. Overall, Branch et al. (1995) found that the data seemed to "indicate that dysfunction of the right cerebral hemisphere may be associated with a specific component of ADHD (i.e., impulsivity), but not necessarily with the complete symptom complex" (p.41).

The pattern of academic achievement found in the Branch et al. (1995) study was different from that found in the ADHD data in that there was a significant main effect for group with the LHD group performing the poorest and the normal controls the best. Analogous to the ADHD data, however, the hypothesis that the RHD group would differ from the LHD group on arithmetic scores was not substantiated. Branch et al. suggested that this contradictory finding may be due to methodological
differences. For example, some of the research regarding NLD and arithmetic has traditionally been done with adults (Tranel, Hall, Olson, & Tranel, 1987; Weintraub & Mesulam, 1983) and arithmetic may become more difficult for this population as it matures.

It is important to note that while Branch et al. (1995) made important contributions to the understanding of the NLD profile with respect to ADHD and academic performance, there are several methodological issues associated with the study. First, given the small sample sizes of 10 per group, and the violations of homogeneity of the data within the RHD group identified by the authors, 8 statistical comparisons were made. According to Stevens (1986), the likelihood of introducing a Type I error is directly related to sample size and the number of tests utilized. In this case, the Bonferroni Inequality suggests that the likelihood of Type I error is approximately 25%.

A second criticism of Branch et al.'s (1995) methodology centres on the inclusion criteria. By requiring three of five criterion measures, the authors suggested that they would "maximize the number of subjects available for inclusion in the study while minimizing the likelihood of including subjects whose neuropsychological profiles indicated possible impairment when there was actually none" (p.37). Within the profiles of the two clinical groups, only 12 of the 20 participants met IQ criteria and 12 of the 20 participants had verbal language/visual-spatial quotients in the predicted direction. Flexible inclusion criteria may increase the number of potential subjects with existing neurological dysfunction; however, it is unclear to what degree the dysfunction represents a homogeneous population. With only 6 of the 10 RHD
participants meeting IQ or visual-spatial criteria, Branch et al. appear to be sampling from a rather diverse population. In fact, the means and standard deviations of the inclusion criteria are not reported, leaving the reader unsure of the degree of severity or variation within the groups.

An investigation by Ewing-Cobbs, Fletcher, Levin, and Boudousquie (1993) (as cited in Ewing-Cobbs, Fletcher, & Levin, 1995) examined the relationship between the NLD syndrome and RHBD using participants who had experienced traumatic brain injury. These investigators were interested in examining Rourke’s contention that individuals with NLD share similar neuropsychological and behavioural traits with RHBD patients. Seventy-five participants aged 5 to 15 who had sustained closed head injury and were free of premorbid learning disabilities and/or psychiatric diagnoses were separated into three academic groups following the Rourke (1982) methodology. The three groups were defined by their performance pattern on the WRAT (Jastak & Jastak, 1965) as follows: Group (A) had poor arithmetic scores relative to either reading and/or spelling, Group (RSA) performed poorly on all three academic measures, and Group (NI) had no impairment on any of the three measures. The researchers were interested to see if Group (A) would be distinguishable from the other two groups, and whether the pattern of neuropsychological deficits would be similar to those evidenced by Rourke’s NLD group (1982, 1989).

Ewing-Cobbs et al. (1993) examined the composition of each group and found that approximately 77% of Group RSA presented with either focal or diffuse injury to the left hemisphere. By comparison, ninety percent of Group A had CT scan data indicative of either focal or diffuse injury to the right hemisphere. According to these
authors, the relatively clear delineation of hemispheric damage attributed to the two
groups provides strong support for the Rourke (1989) NLD model and for the use of
academic criteria for inclusion measures.

Ewing-Cobbs et al. (1993) compared the three groups on a series of memory
(verbal and nonverbal), linguistic (lexical retrieval, naming, oral fluency, and receptive
vocabulary), neuropsychological (psychomotor speed, form perception, visual-motor
integration, and visual perception), and behavioural (adaptive and a checklist)
measures and found several inconsistencies with the NLD model predictions. Group A,
for example, performed more poorly on verbal memory tasks than those that tapped
visual-motor memory. In addition, the A and RSA groups performed more poorly on
the verbal composite scores than the visual-perceptual, visual-spatial composite scores,
again failing to support the NLD model.

On measures examining adaptive skills and internalizing and externalizing
behaviour patterns, the RSA and A groups differed from the normal controls, but did
not differ significantly from one another. The NLD model would predict that the A
group would be at greater risk for increased internalizing behaviours. Ewing-Cobbs et
al. (1993) suggested that the pattern of diffuse brain injury found within the RSA and
A groups likely accounted for these apparently discrepant results. In addition, these
authors found that selecting groups on academic measures exclusively appeared to
have decreased the specificity of the two groups and that groups selected on
demonstrated patterns of neurological dysfunction would have been more appropriate.
2.25 Summary of Evidence for RHD in NLD

From the time NLD was originally identified by Johnson and Myklebust (1967), it has been considered to be the outcome of RHD. The studies discussed previously provide theoretical and experimental evidence for the assertion that systems subsumed under the right hemisphere appear to be related to the NLD profile. More specifically, individuals with NLD have been found to show left-sided "soft" neurological signs, difficulty with arithmetic relative to reading (Gross-Tsur et al., 1995; Johnson & Myklebust, 1967; Rourke, 1989; Voeller, 1986, 1995; Weintraub & Mesulam, 1983), history of hemiplegia or seizure disorders (Gross-Tsur et al., 1995; Voeller, 1986, 1995; Weintraub & Mesulam, 1983), and a pattern of poor PIQ relative to VIQ (Branch et al., 1995; Gross-Tsur et al., 1995; Johnson & Myklebust, 1967; Rourke, 1989; Voeller, 1986, 1995; Weintraub & Mesulam, 1983). The two studies that utilized documented RHD (Branch et al., 1995; Ewing-Cobbs et al. 1993) provide some contradictory evidence in the use of arithmetic difficulties as a marker for RHD in NLD. Branch et al., for example, make a strong argument for excluding difficulties with arithmetic and symptoms of inattention, while Ewing-Cobbs et al. by contrast, found that arithmetic difficulties were correlated with specific right hemisphere dysfunction/lesions.

It appears from the available data that individuals with NLD present with several core features that are indicative of RHD. Visual-spatial difficulties, left-sided neurological signs, and a lower PIQ than VIQ have been reported for populations with documented RHD and/or injury, and these characteristics have recently been found within the NLD population. Difficulties associated with study methodologies, and
discrepancies found within definitions of NLD, however, have limited the generalizability of these findings. More important, a major factor in the academic, social, and visual-spatial functioning of individuals with NLD has been almost completely overlooked; language functioning. If, as mentioned earlier, the NLD profile is so profoundly affected by RHD, it is logical to assume that those linguistic features that are mediated by the right hemisphere must also be impacted.

2.3 Language Functioning and RHBD

The literature is replete with studies examining the behavioural, visual-spatial, emotional, and tactile information-processing deficits found in RHBD individuals (Cancelliere & Kertesz, 1990; Harden, Cannito & Dagenais, 1995; Kolb & Whishaw, 1985; Moya et al., 1986; Myers & Brookshire, 1996; Rhodes, 1993; Rivers & Love, 1980; Vakil, Soroker, & Biran, 1992; Van Lancker, 1997). Although the data are equivocal, the right hemisphere has also been implicated in important linguistic functions such as the regulation of emotions, spatial imagery, and inferencing. Thus, according to Richards and Chiarello "...left hemisphere (LH) linguistic predominance does not imply RH linguistic incompetence. Rather, the view that emerges from this research is that the RH plays an important, if not absolutely crucial, role in many subtle aspects of language processing" (1997, p.152).

According to some researchers (e.g., Bloom et al. 1992; Borod, Andelman, Obler, Tweedy & Welkowitz, 1992; Cancelliere & Kertesz, 1990; Cohen, Branch, & Hynd, 1994; Lalande, Braun, Charlebois & Whitaker, 1992; Richards & Chiarello, 1997; Van Lancker, 1997) the right hemisphere has been shown to be involved in the processing
and mediation of emotional speech. This right hemisphere advantage has been demonstrated at both the single-word and discourse levels. Bloom et al. (1992), for example, found that when the discourse samples of RHBD, left hemisphere brain-damaged (LHBD), and Normal Control (NC) adults were analyzed for length and content, there were no significant differences between the groups on the length of the discourse. When the samples were examined for content, however, it was found that the RHBD participants demonstrated a selective deficit for producing emotional content.

A second linguistic weakness outlined in the literature is the inability of RHBD adult participants to process syllogisms (Caramazza, Gordon, Zurif & DeLuca, 1976; Deglin & Kinsbourne, 1996). Caramazza et al. (1976) found that RHBD participants were better at solving congruent verbal problems (e.g., Mark is taller than Jim, who is taller?) than incongruent problems (e.g., Mark is taller than Jim, who is shorter?). Caramazza et al. claimed that this incongruent verbal problem required the formation of right hemisphere-based imagery, whereas the congruent problem could be solved directly in a straightforward linguistic manner based on the information provided. The inability of the RHBD participants to accurately solve the incongruent verbal problems may have reflected a failure to use visual-spatial imagery. Therefore, these authors concluded that an underlying visual-spatial deficit impeded the RHBD participants' ability to process some forms of linguistic material.

Deglin and Kinsbourne (1996) utilized hemispheric suppression on 14 adult psychiatric participants to examine the hemispheres' differential abilities to solve syllogisms. An example of a syllogism was as follows:
"Every state has a flag.

Zambia is a state.

Does Zambia have a flag, or not?" (p.290).

The investigators found that the left hemisphere functioned in a rational, logical, and formal manner, whereas the right hemisphere was dependent on context and used preexisting information to solve syllogisms. When the right hemisphere was suppressed, the syllogisms were solved with deductive reasoning, even when the context was absurd in nature. The right hemisphere, on the other hand, solved only those syllogisms that were meaningful and could not deal with abstract or absurd questions. The authors suggested that each hemisphere overcompensates and overextends itself in its unique perspective and, in the intact brain, merge to accommodate the type of question.

In addition to affecting the processing of language requiring emotional or complex/abstract visual-spatial imagery, visual-spatial deficits have also been implicated in the ability of RHBD participants to make inferences (Beeman, 1993; Brownell, Potter, Bihrle, & Gardner, 1986; McDonald & Wales, 1986; Myers & Brookshire, 1995; Ozonoff & Miller, 1996; Wapner, Hamby & Gardner, 1981). Wapner et al. (1981), for example, utilized a series of linguistic tasks that examined story recall, ordering, integrating, and inferencing. These authors found that although the adults with RHBD had no difficulty recalling elementary story facts, and their use of phonology and syntax was appropriate, they experienced considerable difficulty integrating the elements of a story. These integration difficulties were most apparent when the story elements were emotional in content. In addition, the RHBD
participants were more likely to add bizarre and unrelated elements into the story recall, suggesting that they were not fully integrating the overall meaning of the story. Wapner et al. concluded that the ability to make an inference by synthesizing available material into a coherent aggregate and, in turn, extrapolate meaning from the original content may depend upon spatial mechanisms that differ from the more mechanical visual-spatial skills required for location. Because the RHBD participants were able to accurately retell the simple elemental story facts, the poor inferencing ability could not be accounted for by a more general linguistic difficulty in memory for content.

According to McDonald and Wales (1986), the findings of Wapner et al. (1981) are confounded by two critical factors. First, given the contention that the right hemisphere has some documented involvement in the regulation of emotions (Bloom et al. 1992; Borod et al. 1992; Lalande et al. 1992), Wapner et al. (1981) failed to control for emotional content in their stories. Second, the verbal complexity of the stimuli was not examined, and it is unclear whether the poor inferencing abilities of the RHBD participants were reflective of poor comprehension and/or a specific linguistic weakness associated with inferencing.

A study by Moya et al. (1986) provides additional support for the relationship between RHD and poor language inferencing abilities. These authors measured visual-spatial abilities of RHBD adults and normal controls and correlated them with verbal narrative samples. The RHBD participants performed significantly poorer on all of the measures and the verbal abstraction or inferencing abilities and visual-spatial abilities were significantly correlated. Moya et al. argued that although the correlation
between visual-spatial abilities and verbal abstraction is robust, the nature of this relationship is highly complex.

Brownell et al. (1986) examined adults with RHBD on an inferencing task that required them to draw inferential information from two sentences. An example of a stimulus pair was:

"Barbara became too bored to finish the history book.
She had already spent five years writing it."

An example of the True-False question set was:

"Correct inference question: Barbara became bored writing a history book.
Incorrect inference question: Reading the history book bored Barbara.
Factual question (1st sentence): Barbara grew tired of watching movies.
Factual question (2nd sentence): She had been writing it for five years" (p.313).

The investigators found that, in comparison to eight controls, eight individuals with RHBD had more difficulty answering the inferencing questions than answering the factual questions. When the information concerned incorrect inferences, the RHBD group had considerably more difficulty than the control group. The authors suggested that the RHBD group was less able to alter their thinking approach to accommodate a novel and/or incorrect inference. The RHBD group did not differ from the control group with respect to their ability to recall factual information; therefore, the deficits in inferential competencies appear to be related to a RHBD difficulty in accommodating new information into preexisting schemata.

Myers and Brookshire (1995) examined the visual and inferential complexity of picture stimuli with a RHBD group and a control group and found that both groups
were more influenced by the inferential complexity of the scenes than by the visual complexity. As predicted, the RHBD group performed significantly poorer on the inferential tasks, and when issues of visual neglect were taken into consideration, those RHBD participants who evidenced neglect did the poorest. Myers and Brookshire argued that the narrative expressive deficits often associated with RHD may be more attributable to difficulties in interpreting the inferential material and less to the visual complexity of the stimulus.

The ability of participants with RHBD to make inferences is compounded when the inference is incorrect/nonsensical (Brownell et al., 1986; Deglin & Kinsbourne, 1996) or if it is spatial in nature (Moya et al. 1986; Myers & Brookshire, 1995). In an effort to explore the interactive quality of these two areas of linguistic weakness, McDonald and Wales (1986) introduced a methodology that allowed them to examine the interpretation of spatial language and inferencing abilities of RHBD participants. McDonald and Wales argued that the inferencing paradigm used by Wapner et al. (1981) was not accurate in assessing the core inferencing abilities due to the high verbal demands the task placed on the RHBD participants.

McDonald and Wales utilized a recognition paradigm with short simple stories that required one-step inferences. The participants were given a series of three-sentence stories and later examined for recognition accuracy. The first two sentences in each story were related to one another and only one correct inference could be drawn from them. The participants were asked if they recognized both the implicit inference and the original sentences. This inferencing task was first utilized by Bransford, Barclay, and Franks (1972) with adults and later developed by Paris and
his associates (e.g., Paris & Carter, 1973; Paris & Mahoney, 1974) to assess the conceptualization strategies utilized by children during memory tasks. McDonald and Wales introduced novel recognition items for their stories comprising two distinct sets: one requiring a spatial reference, the other no spatial reference. As a result, the authors were better able to identify specific linguistic weaknesses associated with RHBD based on the need for visual-spatial inferences. Given the findings of Wapner et al. (1981), McDonald and Wales hypothesized that the information would be stored verbatim and, as such, the RHBD participants would not make the implicit inferences included in the two story types.

In comparing adults with RHBD to normal adult-controls, McDonald and Wales (1986) found that the RHBD group performed significantly poorer on the task overall. When the answers were examined further, the RHBD participants were found to be as competent as the normals at making the appropriate inferences. Although the contention that the RHBD participants would be less able to make appropriate inferences was not statistically substantiated in this study, McDonald and Wales did find that the RHBD group performed the poorest on the two spatial inference conditions. These findings are comparable to the Caramazza et al. (1976) suggestion that an underlying right hemisphere visual-spatial deficit may impede the ability to process some forms of linguistic material. It is important to note that McDonald and Wales found that the normal controls had significantly lower scores on the two spatial sections of this task. It appears as though the ability to make spatial inferences requires a different form of retrieval or simply increases the memory load necessary to make accurate inferences.
Even though McDonald and Wales (1986) did not substantiate the contention of Wapner et al. (1981) that RHBD participants would perform more poorly than the control group on recognizing inferences, the trend in the McDonald and Wales data was suggestive of poor inferencing abilities on the part of the RHBD participants. The discrepancy between these two studies is perhaps less indicative of the robustness of the effect, but rather to the difference in the mode of response of the task. Wapner et al. used a free-recall paradigm to elicit inferences, whereas McDonald and Wales utilized a simple recognition paradigm. It may be that when extraneous information is provided, such as in a story retell task, individuals with RHBD experience difficulty limiting their focus to the essential information. This inability to structure and consequently retrieve accurate information may be a fundamental weakness associated with right hemisphere damage.

In summarizing the data presented on individuals with RHBD, it is clear that there are methodological difficulties that make it difficult to ascertain the primary and/or contributing factors to their linguistic difficulties. However, information culled from the available data points to the fact that they are likely to experience several difficulties with linguistic elements. First, individuals with RHBD have difficulty making inferences and appear to rely heavily on preexisting context that may be complicated by the addition of extraneous/nonsensical information and spatial elements. Second, individuals with RHBD have difficulty structuring information, making the retrieval of linguistic elements somewhat problematic if there is an excess of information available. Finally, the accuracy of emotional inferencing and recall of emotional content are problematic and appear to exacerbate retrieval difficulties.
2.4 Examination of NLD Language Abilities:

The linguistic difficulties associated with RHBD mentioned above appear to be pervasive and affect the daily functioning of those individuals. Currently, there is little research on the linguistic competencies of individuals with NLD. According to some researchers (e.g., Gross-Tsur et al., 1995; Foss, 1991; Johnson, 1987; Voeller, 1986; Weintraub & Mesulam, 1983), paralinguistic difficulties (e.g., eye contact, prosody) are present in the NLD population, although the measures were not normed or accurately described in the literature.

In the only paper focusing on the linguistic difficulties of NLD, Rourke and Tsatanis (1996) borrow from Bloom's (1988) framework for Language dimensions and categorized the NLD linguistic deficits and assets into three primary areas: Language Form, Content, and Use. Language Form refers to the structure of language that is further characterized by syntax, phonology, and morphology. According to Rourke and Tsatanis (1996), the phonemic assets and auditory perception skills of children with NLD contribute to an overall ease with the more routinized, structured use of language.

Language Content, or the semantics and lexicon, however, appears to be more problematic for children with NLD (Rourke & Tsatanis, 1996). Although high verbal output and strong single-word decoding skills appear to make them competent in Language Content, closer examination reveals that these individuals have a paucity of content and are more comfortable with straightforward and repetitive discourse. In addition, individuals with NLD tend not to utilize context, have difficulty with
connotative or metaphoric aspects of words, and struggle with the idiosyncrasies of speech, irony, and humor.

Inferential abilities, which fall under Language Content in Bloom's (1988) taxonomy, are not mentioned as a weakness in children with NLD by Rourke and Tsatanis (1996). In an earlier study, Ozols and Rourke (1985) examined the inferential abilities of young children with NLD. Ozols and Rourke used four experimental measures to investigate the social sensitivity of the NLD population in general, and making inferences in particular, through a task that examined “the children’s ability to make inferences regarding the reasons for feelings that occur in social situations” (p.292) from two coloured photographs. The authors found that the NLD group did not differ from the control group across the four measures and that the language comparison group did significantly poorer on the inferencing task. Unfortunately, the reader is left unclear as to the relative strength of NLD inferential competencies as the sample size for each of the groups was extremely small (i.e., seven per group) and the investigators failed to include any of the means or standard deviations from the dependent measures.

The final area of language ability described by Rourke and Tsatanis (1996) is Language Use. Language Use, or pragmatics, in children with the NLD profile is described as “especially deficient” (p.37). The speech of individuals with NLD is often characterized by excess loquaciousness, repetitions, and a limited awareness of the context of the discussion. In addition, these individuals utilize little or no expressive prosody and, in particular, may have difficulty with linguistic and emotional prosody (Ozols & Rourke, 1985). These authors contend that children with NLD not only
experience difficulty with linguistic context, but also have difficulty assessing the facial and or gestural subtleties of the speaker.

Even though Rourke and Tsatanis (1996) described the language difficulties associated with NLD in detail, and attempted to categorize them into meaningful linguistic sections, their lack of data is of primary methodological concern regarding the linguistic assets and deficits of NLD. Rourke (1989) goes into considerable detail in explaining how a NLD child/infant explores the world by relying upon verbal interaction to the exclusion of weaker physical somatosensory manipulation. Although these descriptions are detailed, they are currently without reference and have not been investigated empirically. Throughout these descriptions, with the exception of emotional and gestural prosody (Ozols & Rourke, 1985), there are no data presented to support their argument. Difficulties with metaphors, for example, are described as problematic for children with NLD, but there is no accompanying reference or data source. In addition, the verbal tests that were administered to the NLD population do not include any metaphor or idiomatic measures. It is unclear how the authors arrived at these conclusions and one must assume that their impressions have been formed retrospectively.

Upon reviewing the linguistic difficulties associated with the NLD profile, it is clear that the use of the term "relative strength" to describe the language functioning of individuals with this disorder is questionable. Paralinguistic, pragmatic, and higher level language abilities (e.g., humour, metaphor) all appear to be negatively affected in these individuals. However, the linguistic difficulties that have been presented for NLD are based on nonstandardized paralinguistic measures (e.g., Gross-Tsur et
al., 1995; Voeller, 1986; Weintraub & Mesulam, 1983), descriptive language samples of automatic expressive language abilities (Rourke & Tsatsanis, 1996), or clinical observation (Foss, 1991; Johnson, 1987; Johnson and Myklebust, 1967). With the exception of Ozols and Rourke's (1985) experimental inferencing task, there exists no formal examination of the subtle linguistic features of children with NLD.

2.5 Objectives of the Present Study

The objective of this study was to provide a clearer picture of the language functioning of children with NLD by determining: 1) if their language is characterized by inferential difficulties as would be predicted by the findings for RHBD, 2) whether their language inferencing difficulties are greater when they depend upon the interpretation of visual-spatial relationships, and 3) if there is a relationship between difficulties they may experience in spatial language inferencing and emotional language inferencing. This study included a straightforward selection criteria process for identifying NLD that incorporated two of the most salient criteria found in the above mentioned studies: significantly poor PIQ relative to VIQ and poor Arithmetic relative to Reading decoding. An additional descriptive measure of psychomotor speed was also included in an effort to further validate the NLD profile.

The ability to make inferences has been identified as problematic for individuals with RHBD and was, therefore, predicted to be difficult for the NLD population. Information was collected from three different language inferencing tasks. First, the McDonald and Wales (1986) Spatial/nonspatial Inferencing Task (SIT) was administered in an effort to discriminate between spatial and nonspatial language
inferencing abilities for stimuli that were as free as possible of emotional content. Consistent with the RHBD profile outlined above, it was predicted that the NLD participants would exhibit difficulty with the task and, more importantly, that they would be less accurate when the inferences were dependent upon spatial orientations.

The second measure incorporated a story inferencing paradigm in an effort to better understand the effect of emotional content on the language inferencing abilities of NLD participants. It was predicted that the NLD children would perform poorly on the inferencing sections of this story inferencing measure (SIM) and that they would have particular difficulty integrating emotional elements of the stories.

The third measure was the Making Inferences subtest from the Test of Language Competence-Expanded Edition (TLC-E) (Wiig & Secord, 1989). The TLC-E, is a standardized and norm-referenced measure of children's expression and comprehension of social discourse.

2.6 Hypotheses

2.6.1 Spatial/nonspatial Inferencing Task (SIT):
1) The performance of the C group on the spatial and Nonspatial inferencing tasks will be significantly better than both the NLD and VI groups.
2) The performance of the NLD and VI groups will not differ on the Nonspatial section. Due to the previously outlined visual-spatial difficulties associated with NLD, the NLD group will perform significantly poorer than the VI group on the Spatial section.
3) Based on the McDonald and Wales (1986) finding that individuals with, and without, RHBD performed significantly better on the Nonspatial sections of the SIT than on the Spatial sections it was assumed that all three groups would perform more poorly on the Spatial section. The visual-spatial difficulties associated with the NLD group will become more apparent when the relative differences between these two sections within each group are examined. It was predicted that the NLD group's relative difference for Nonspatial > Spatial would be significantly greater than in the other two groups.

2.6.2 Story Inferencing Measure (SIM)

4) The C group will perform significantly better than the NLD and VI groups on the general and emotional inferencing questions.

5) The NLD group was expected to perform no differently from the VI group on the general inferencing section. The NLD group's performance on the emotional inferencing section, on the other hand, is predicted to be significantly poorer than the VI group. This prediction is based, in part, on the serious socioemotional difficulties identified in the literature for NLD (Fuerst et al. 1990; Rourke & Fuerst, 1992; Rourke et al. 1989) and the assumption that difficulties with processing emotional information will impact on their ability to make emotional inferences.

6) The performance of the NLD group on the emotional inferencing questions was expected to be poorer than their performance on the general inferencing questions. This relative difference in the direction indicated was predicted to be significantly
greater than any difference that may be found between the two types of inferencing in the C and VI groups. These differences will reflect the particular problem with interpretation of social-emotional information reported for children with NLD (Little, 1993; Rourke, 1989).

2.6.3 The Test of Language Competence - Expanded Edition (TLC-E)

7) The performance of the C group on the Making Inferences subtest will be significantly better than in both the NLD and VI groups.

8) Due to the general linguistic nature of the task, it was predicted that the NLD will perform better than the VI group on this subtest.

Given the fact that the SIT and the SIM are experimental measures, correlations between the dependent measures will be undertaken across the total sample and within groups.
Method

Participants

Prior to each participant's involvement in this study, a signed consent was collected from parents and an assent form was collected the participants (Please see Appendices 1 and 2). These forms had received approval from the research ethics committees of OISE/UT, the two institutions that provided access to the potential participants, and a local school board. Of the 81 participants assessed by the investigator, 47 met all of the selection criteria outlined below.

Nonverbal Learning Disability Group (NLD):

These 14 participants were obtained from a list of active and/or referred clients to a hospital child development clinic or from an agency that works exclusively with children and adolescents who are experiencing learning disabilities.

Verbally-Impaired Group (VI):

The 14 participants were obtained from the same two clinics as the NLD participants.
**Control Group (C):**

These 19 participants were obtained from a local school board, were performing within the average range of academic and intellectual functioning, and had not been identified as having an LD.

Each participant was tested individually by the investigator. The testing was completed in approximately 2 to 2 1/2 hours and done in a small, private room that was made available in each of the three settings. Specific inclusion/exclusion criteria for the three groups are described in Table 1. Children from all three groups were within the age range of nine to thirteen years. None of the children were primarily visually or hearing impaired, spoke English as a second language, or were identified as having a neurologically degenerative condition. All of the participants were right-handed.

Given the focus of this study on spatial and emotional language inferencing, all participants were first tested on their understanding of basic spatial and emotional vocabulary to eliminate the possible confound of vocabulary difficulties. The experimental Spatial and Emotional Receptive Language Pretest (SERLP) has a total score of 10 and a pass was considered to be a score of 8 on the receptive vocabulary measure (see Appendix 3).

Following the Harnadek and Rourke (1994) methodology, the Grooved Pegboard Test (Klove, 1963) was included as a descriptive measure in an attempt to further articulate group differences. According to Harnadek and Rourke (1994), the Grooved
Pegboard Test was one of four neuropsychological tests that served to classify NLD participants from R-S children and Normal controls with a high degree of accuracy.

Table 1

**Participant Characteristics on Independent Measures**

<table>
<thead>
<tr>
<th>Independent Measures</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
</tr>
<tr>
<td>WISC-R or WISC-III</td>
<td>FSIQ Estimate</td>
</tr>
<tr>
<td>WRAT-R or WRAT-III</td>
<td>arithmetic&gt;30th%ile</td>
</tr>
<tr>
<td></td>
<td>reading &gt;30th%ile</td>
</tr>
<tr>
<td></td>
<td>spelling &gt;30th%ile</td>
</tr>
<tr>
<td>Descriptive Measure</td>
<td>Grooved Pegboard less than 1 SD</td>
</tr>
<tr>
<td></td>
<td>below the mean</td>
</tr>
</tbody>
</table>

**Note.** C = Control, NLD = Nonverbal Learning Disability, and VI = Verbally-Impaired.

- The C group was administered a short-form of the WISC-III that consisted of Vocabulary, Similarities, Block Design and Object Assembly (Sattler, 1992).
- The NLD and VI groups had a 10 point or more VIQ - PIQ discrepancy (Harnadek and Rourke, 1994).
- Following the Harnadek and Rourke (1994) methodology, there was a 10 or more standard score point difference between the WRAT Reading or Spelling and lower Arithmetic scores for the NLD group. To further clarify the groups, there was a 9 point or less discrepancy between the Arithmetic and the Spelling or Reading subtests for the C group.
- All academic percentile cut-off scores were based on Shafrir and Siegel (1994).
- Following Harnadek and Rourke (1994) methodology
Measures

**Pretest Measure:**

1) Spatial and Emotional Receptive Language Pretest (SERLP) (see Appendix 3)

Given the spatial and emotional nature of the inferencing measures, each child was given the SERLP in an attempt to help screen-out those children who were experiencing considerable difficulty comprehending basic spatial/emotional language. Each child was asked to point to five of six simple hand-drawn faces that depicted a primary emotion (e.g., “point to angry” etc.). In addition, a simple drawing was presented and the children were asked to identify five spatial aspects of the picture (e.g., “Who is behind the tree?” “What is under the car?” etc.). A score out of a possible 10 was recorded for each participant. The SERLP was piloted using 17 normally-achieving children to assess the accuracy of the pictorial designs. The mean accuracy rate for the pilot group was 9.82 (SD=0.53).

**Independent Measures:**


The WISC series was designed to assess the intellectual ability of children aged 6 through 16 years, eleven months. The test is administered individually and three composite intelligence quotient (IQ) scores are provided: Verbal, Performance and Full Scale. The Full Scale Short Form estimate (Sattler, 1992) of the WISC-III was given to those participants who fulfilled the criteria for the Control Group. The validity
coefficient of the Short Form is approximately 0.943 (Sattler, 1992). The reliability and validity and standardization procedures for the WISC-R are well known (Sattler, 1988; Wechsler, 1974).

The WISC-III was standardized using a sample of 2,200 children controlling for age, gender, race, geographic location, and parent education. The average reliability coefficients for each of the 13 subtests range from .69 to .87. The reliability coefficients for the three composite scores are: Verbal .95, Performance .91, and Full Scale .96. The corrected stability coefficients for the three age samples provided range from .56 to .95. Adequate validity is demonstrated with correlations between subtest and IQ scores on the WISC-III and the WISC-R ranging from .42 to .90.


The WRAT series is a standardized, individually administered measure of academic skills that covers three areas: Reading, Spelling, and Arithmetic. The WRAT-R was standardized using a stratified sample of 5,600 individuals across the United States. The test-retest reliabilities ranged from .79 to .96. The construct validity is demonstrated with increasing performance from five years to adulthood. The WRAT-R was reported to correlate with other achievement and ability tests within the .60 to .80's range (Jastak & Wilkinson, 1984).

The WRAT3 is a single level format for individuals aged 5 to 75. The WRAT3 has two alternate forms. The Blue Form was used for this study. The WRAT3 was normed using 4,433 individuals representing 23 different age categories. Reliability
measures include median test coefficient alpha's that range from .85 to .95 across the nine WRAT3 tests (both forms). Test-retest stability coefficients are reported to range from .91 to .98 on the nine tests. Item separation values are high for the nine tests indicating an appropriate level of content validity for the WRAT3. The WRAT3 Reading, Spelling, and Arithmetic subtests correlate with the WISC-III Full Scale score .68, .64, and .71 (respectively).

Descriptive Measure:

1) Grooved Pegboard Test (Klove, 1963)

The Grooved Pegboard Test is described as a manipulative dexterity task that requires the child to place a number of key-shaped pegs into a series of 25 randomly positioned slots. The time taken, in seconds, to fill the 25 slots is the salient measure. The task is done with the dominant hand first and then the nondominant hand.

Norms were collected on 1,460 individuals and are provided by the publisher (Trites, 1989). The normative data are provided according to age, gender, and dominant/non dominant hand. Scores are reported in standard deviations. A positive score connotes poorer performance than the normative group and a negative score reflects a better score. Poor performance on this measure is reflective of visual-motor coordination difficulties.
Dependent Measures:

1) Spatial/nonspatial Inferencing Task (SIT)

The recognition task introduced by McDonald and Wales (1986) was modified and used to assess differences in spatial and nonspatial inferencing abilities. The recognition paradigm was originally utilized to examine constructive memory strategies employed by adults (Bransford & Franks, 1971; Bransford, Barclay & Franks, 1972) and children (Paris & Carter, 1973; Paris & Carter, 1974). Although reliability and validity data are not available on this measure (S. McDonald, personal communication, October 5, 1994), the studies noted above that have utilized this paradigm with adults or children have found consistent results.

The recognition task requires the participant to listen to a series of short stories and draw meaning from information that is not contained within the underlying structure of the individual sentences (Paris & Carter, 1973). The following is an example of a story that represents the acquisition set (see Appendix 4):

The bird is inside the cage.
The cage is under the table.
The cage is yellow.

The first two sentences are premise items and the third is a filler item included to provide additional noncontextual information that is not required to make the original inference. The inference that can be garnered from the first two premise sentences is that the bird is under the table.

Following the presentation of the acquisition set and a brief interval, the participant is presented with a recognition test that includes one true premise (i.e.,
heard before), one true inference (i.e., was not heard before but could be inferred from the story), and two false but syntactically similar items. An example of the recognition item for the above story is (see Appendix 5):

The cage is under the table (True premise)
The bird is under the table (True inference)
The cage is on the table (False premise)
The bird is on the table (False inference)

All of the above mentioned studies (e.g., Bransford & Franks, 1971; Bransford, Barclay & Franks, 1972; McDonald & Wales, 1986; Paris & Carter, 1973; Paris & Carter, 1974) found that participants consistently recognized the semantically comparable, but unheard, true inference as having been presented in the acquisition set. It appears that the inference is naturally made, and that the information is stored in memory as being heard before. The recognition paradigm, therefore, has demonstrated reliability for children, adults and clinical populations. In addition, an element of validity is substantiated in that McDonald and Wales (1986) were able to show that this measure differentiated between normal and brain-damaged adults.

For the present study, close inspection of the recognition items revealed three logical and/or semantic difficulties within the four sets that necessitated changing several of the original items. First, the original set was created in Australia and, therefore, required some vocabulary changes. Second, although the authors implied that emotional content was reduced, there remained several items that had mild to moderate emotional content. In an effort to more closely control for emotional content, emotional contexts were removed. More specifically, any reference to the five emotions of Happiness, Sadness, Anger, Surprise, and Disgust was eliminated. Finally, and
most importantly, the linguistic patterns of the different items were not consistent within or across the four sets. The bird and cage story, for example, can be defined as an A (bird) - B (cage), B (cage) - C (table), and B (cage) - D (yellow) relationship. Throughout the McDonald and Wales (1986) stimulus set there were several different story types (e.g., A - B, C - A, A - D; A - B, D - A, B - D etc.). As it was felt that each distinct type of semantic pattern would necessitate qualitatively different memory requirements, for the present study, two semantic patterns were adopted and equally represented in all four sets in an attempt to control for the memory requirements of the task. The two patterns are represented by: A - B, B - C, B - D and A - B, C - A, B - D.

Like the McDonald and Wales (1986) study, this study introduced a second acquisition set that consisted of nonspatial stories. An example of this second set is as follows:

The restaurant sold only hamburgers
The boy ate at the restaurant
The hamburgers were all beef

The accompanying recognition set for this story is:

The boy ate hamburgers in the restaurant (True inference)
The restaurant sold only hamburgers (True premise)
The restaurant sold only hot dogs (False premise)
The boy ate pizza in the restaurant (False inference)

Twelve stories were included in both the spatial and nonspatial set. In an effort to control for the presentation of visual-spatial information explicitly included in each question, the filler items were manipulated so that half were spatial in nature and half were nonspatial.
There were three separate acquisition sets in total with eight stories in each for a total of 24 stories and four answers for each story resulting in a total score for this measure of 96. For the purpose of analyses, the total score was divided into two combined scores - one for the spatial (SS + SN) and one for the nonspatial (NN + NS) question sets. Each set consisted of 48 answers in total.

2) Story Inferencing Measure (SIM)

Two adventure stories, "Buried Alive" and "Shipwrecked", that were matched for length, complexity, and information content, by Chapman et al. (1992) were recorded onto an audiotape and played to each child (see Appendices 6 & 7). Two stories were utilized to control for biases that may have been related to story content. Following the presentation of each story, the participant was read three sets of questions: factual, general inferencing, and emotional inferencing. The factual questions were included to provide a basic measure of auditory comprehension and auditory memory. These questions required the participant to provide specific information based on story content (e.g., "who was...?, how many...? etc.). There were 10 factual questions per story for a total of 20 questions. A total score out of 20 was recorded for each participant. The general inferencing questions, following a true/false format, required an individual to make inferences based on information that was not explicitly provided in the stories. The emotional inferencing questions followed the
identical format as the general inferencing questions and required the individual to make inferences of an emotional nature. For each story there were 10 general inferencing and 10 emotional inferencing questions. Across the two stories the total score for general inferencing and emotional inferencing was 20 in each case. Even though there is research supporting the use of these two stories with children, they were piloted with a sample of 17 normally-achieving children in an effort to be certain about the clarity of the items and reduce possible ceiling or floor effects. The mean accuracy scores and the standard deviation scores for the three areas were as follows: factual (13.88, 3.14), general inferencing (15.65, 1.69), and emotional inferencing (18.18, 1.42).

3) The Test of Language Competence - Expanded Edition (TLC-E) (Wigg & Secord, 1989b)

The TLC-E was designed to measure delays in developing linguistic competencies in children aged 5 to 18 years through the examination of semantic, pragmatic, and syntactic language skills. The TLC-E, Level 1 is designed for individuals five to nine years of age; whereas, the TLC-E, Level 2 is designed for individuals aged nine to 18. The Making Inferences subtest was used from this measure. This study used the TLC-E Level 2 exclusively. In developing the norms for the TLC-E, approximately 1,800 individuals were tested for Level 2.

The Making Inferences subtest requires children to construct multiple inferences from a limited set of information. Each item describes a chain of events in which one or more causal links are missing. For example, "Mom went to the bakery to
buy a cake", followed by "Later, mom made pudding for dessert instead". The child is required to select from four available responses to determine two plausible explanations for the outcome of the event. "The bakery did not have a cake" is a reasonable inference, whereas "Everyone was asleep" would be considered an unreasonable inference. According to Wigg and Secord (1989b), the child is required to generate inferences, interpret propositions, and generate underlying scripts based solely on the causal chain of events included in the scripts.

The reliability coefficients for this subtest range from .57 to .71 for the eight age groups reported. Criterion validity with a subsample of 28 language-learning disabled (LLD) children yielded a correlation of .54 between the Making Inferences subtest and the WISC-R Full Scale Score.

According to the standardized scoring, if the participant selected one of the two appropriate inferences a score of one was counted for that question. If both possible inferences were correctly identified, the participant received a score of three. If neither section was answered correctly, a score of zero was recorded. The total score for this subtest was out of 36. Each participant's score on this subtest was converted to a Standard Score with a mean of 10 and one standard deviation of plus or minus three.

Procedures

Independent Measures:

Following parental consent and participant assent, the independent measures were administered to each participant. A full WISC-III was given to the NLD and VI
groups, or previous WISC-III or WISC-R scores were used if these tests had been administered within two years prior to inclusion in this study. Permission was granted to obtain only a Short Form WISC-III IQ estimate in the C group. The WRAT3 was administered unless previous WRAT3 or WRAT-R scores were available from within the last two years. If at this point the participant did not meet the criteria for one of the three research groups, the participant and her/his family were given a research report outlining performance on these measures.

If, upon completion of the independent measures, the participant satisfied the criteria for one of the three groups, s/he was then asked to complete the three dependent measures. Upon completion of dependent measures, the participant and his/her family received a research report outlining individual and group performances.

**Dependent Measures:**

1) Spatial/Nonspatial Inferencing Task (SIT)

In an effort to minimize order effects, the 24 stories from the acquisition set were randomly separated into three blocks of eight. These three blocks remained constant and the order of presentation for each block was rotated for each participant. Consistent with administration procedures for the task identified in previous research (e.g., McDonald & Wales, 1986; Paris & Carter, 1973), one block of stories (8 stories in a row) was read to the participant and followed by a one minute interval during which s/he was asked to count as high as possible until told to stop. The counting task served to prevent participants from utilizing mnemonic or rehearsal strategies during the
interval. Following the one minute interval, each question in the recognition set was presented and the participant was required to answer the question "Have you heard this sentence before?" with a "yes" or "no" response. It is important to note that the participants were not asked to make a judgment about the whether the sentence was true or not. This follows from the assumption of the task that in indicating whether they had heard the sentence before, the participant's answer is based on having already processed the information in a factual or inferential manner.

The order of the stories in the recognition set was the same as in the acquisition set to avoid confusion. The items within each recognition set were randomized to minimize order effects. The entire procedure was repeated for the remaining two blocks.

2) Story Inferencing Measure (SIM)

One story was played aloud for the participant. The participant was presented with 30 questions: 10 factual, 10 general inferencing, and 10 emotional inferencing. The factual questions were presented first followed by the 20 inferencing questions. The order of the inferencing questions was randomized and the list of questions was read to each participant. The participant was then required to provide a "true" or "false" response for the two inferencing sets. These steps were repeated for the second story. The "Shipwrecked" story was always presented first, followed by the "Buried Alive" story.

3) Test of Language Competence - Expanded Edition: Making Inferences Subtest
Each participant listened to, and had available to read, one trial story and the four accompanying answers. Upon completion of the trial, the participant was given the remainder of the 12 stories.
Results

Demographic Information:

Table 2 includes the demographic information for the three groups. There were no significant differences between the three groups on age $F(2, 46) = 1.34$, $p = .272$, socioeconomic status (SES), $F(2, 29) = .99$, $p = .386$, gender $\chi^2 (2, n=47) = 3.2$, $p = .200$, or ethnicity $\chi^2 (2, n=47) = 2.5$, $p = .300$. Given the fact that contrasting IQ discrepancy patterns were utilized in the selection of participants in the NLD and VI groups, by definition these two clinical groups were not comparable on either their VIQ or PIQ. Selecting on the basis of such discrepancies also made comparison of FSIQ's inappropriate across the three groups (Sattler, 1992). It is important to note, however, that the PIQ of the VI group, the VIQ of the NLD group and the short-form FSIQ of the C group were all within the average range of intellectual functioning (Sattler, 1992). Furthermore, the NLD and VI groups did not differ with respect to their FSIQ, $t(1,26) = 5.97$, $p = .36$. Correlations between IQ (FSIQ, VIQ, PIQ) as they were available in each group, with the dependent measures can be found in Table 9.
Table 2

**Independent Measures and Demographics**

<table>
<thead>
<tr>
<th>Group</th>
<th>( M )</th>
<th>( SD )</th>
<th>( M )</th>
<th>( SD )</th>
<th>( M )</th>
<th>( SD )</th>
</tr>
</thead>
<tbody>
<tr>
<td>C ((n=19))</td>
<td>11.25</td>
<td>0.77</td>
<td>11.72</td>
<td>1.12</td>
<td>11.75</td>
<td>1.05</td>
</tr>
<tr>
<td>NLD ((n=14))</td>
<td>53.73</td>
<td>13.04</td>
<td>43.17</td>
<td>14.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VI ((n=14))</td>
<td>82.79</td>
<td>8.58</td>
<td>85.21</td>
<td>4.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>106.21</td>
<td>11.67</td>
<td>92.79</td>
<td>5.09</td>
<td>77.43</td>
<td>5.29</td>
</tr>
<tr>
<td>SES* (% reported)</td>
<td>58</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FSIQ^b</td>
<td>107.00</td>
<td>7.59</td>
<td>91.71</td>
<td>18.50</td>
<td>74.43</td>
<td>12.66</td>
</tr>
<tr>
<td>VIQ</td>
<td>107.58</td>
<td>8.32</td>
<td>89.21</td>
<td>16.51</td>
<td>77.43</td>
<td>10.88</td>
</tr>
<tr>
<td>PIQ</td>
<td>105.58</td>
<td>7.67</td>
<td>71.79</td>
<td>12.68</td>
<td>76.07</td>
<td>17.50</td>
</tr>
<tr>
<td>WRAT-III Reading</td>
<td>-0.68c</td>
<td>0.65</td>
<td>2.19</td>
<td>2.00</td>
<td>0.86</td>
<td>1.34</td>
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<tr>
<td>WRAT-III Spelling</td>
<td>-0.11</td>
<td>0.79</td>
<td>2.68</td>
<td>1.90</td>
<td>1.04</td>
<td>1.77</td>
</tr>
<tr>
<td>WRAT-III Arithmetic</td>
<td>10.00</td>
<td>0.00</td>
<td>9.71</td>
<td>0.61</td>
<td>9.93</td>
<td>0.27</td>
</tr>
</tbody>
</table>

**Demographics**

<table>
<thead>
<tr>
<th>Gender (%)</th>
<th>Male</th>
<th>8(42)</th>
<th>10(71)</th>
<th>9(64)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>11(58)</td>
<td>4(29)</td>
<td>5(36)</td>
<td></td>
</tr>
<tr>
<td>Educational Placement (%)^d</td>
<td>( R )</td>
<td>100</td>
<td>36</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>( W )</td>
<td>0</td>
<td>50</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>( FT )</td>
<td>0</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>Caucasian</td>
<td>19</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
**Note.** C = Control, NLD = Nonverbal Learning Disability, and VI = Verbally-Impaired, SERLP = Spatial and Emotional Receptive Language Pretest.

a From Blishen, Carrol, & Moore (1987). SES data was not provided by some families, therefore, the percent reported is included.
b The Full Scale WISC-III was not obtained for the Normal Control Group; but a Short Form Estimate based on Similarities, Vocabulary, Block Design, and Object Assembly subtests (Sattler, 1992). Calculation of the Verbal and/or Performance IQ scales from the Short Form of the WISC-III is not recommended (Sattler, 1992).
c Reported in Standard Deviations. A higher score indicates a slower placement speed.
d R= Regular Classroom, Withdrawal support, and FT= Full-time Special Education Classroom

### Analyses:

The five dependent variables were examined for violations of assumptions of normal distribution (i.e., skewness) (see Appendix 8). Two of the measures exceeded the critical values for skewness (Stevens, 1986). The Emotional Inferencing measure and the Nonspatial section of the SIT measure were negatively skewed and loglinear transformations were applied to correct these data. The Bartlett-Box $F$ test was used to determine homogeneity of the covariance matrices for subsequent comparisons (Stevens, 1986). None of the five covariance matrices was significant; therefore, homogeneity was confirmed.

Following the loglinear transformations, a one-way MANOVA was calculated for main effects using SPSS for Windows Version 7.1. The alpha level was set, a priori, at $p< .05$ for all analyses. Due to the relatively small sample sizes, power estimates ($p<.05$) were calculated for the overall MANOVA in addition to the post hoc Univariate F-tests and ranged from moderate to good (i.e., .52 to .99). The MANOVA revealed an overall Group effect $F(2, 44) = 4.5, p<.001$. The scores for the
dependent measures and the subsequent Univariate $F$-tests are reported in Table 3.

Table 3

Means, Standard Deviations, and Significance Levels for the Inferencing Measures

<table>
<thead>
<tr>
<th></th>
<th>C (n=19)</th>
<th>NLD (n=14)</th>
<th>VI (n=14)</th>
<th>$F$ (2,45)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIT: Spatial</td>
<td>17.61(2.47)</td>
<td>14.79(2.74)</td>
<td>15.82(2.55)</td>
<td>5.08</td>
<td>$p=.01$</td>
</tr>
<tr>
<td>(max=24)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>SIT: Nonspatial</td>
<td>21.59(2.10)</td>
<td>20.50(2.19)</td>
<td>19.32(3.67)</td>
<td>2.76</td>
<td>$p=.075$</td>
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<tr>
<td>(max=24)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIM: Emotional</td>
<td>18.00(1.33)</td>
<td>16.14(2.68)</td>
<td>16.64(2.31)</td>
<td>3.49</td>
<td>$p=.039$</td>
</tr>
<tr>
<td>(max=20)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIM: General</td>
<td>15.37(1.64)</td>
<td>13.79(2.61)</td>
<td>13.36(1.98)</td>
<td>4.43</td>
<td>$p=.018$</td>
</tr>
<tr>
<td>(max=20)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TLC: $a$</td>
<td>9.74(2.66)</td>
<td>6.71(2.55)</td>
<td>5.21(1.97)</td>
<td>14.80</td>
<td>$p=.001$</td>
</tr>
</tbody>
</table>

Note. C = Control, NLD = Nonverbal Learning Disability, and VI = Verbally-Impaired.

$a$ = The TLC Making Inferences Subtest data is reported in standard score format with Mean of 10.
SIM = Story Inferencing Measure

The 5 dependent variables were transformed to $z$-scores to highlight the broad trend of the inferential profiles across the three groups (see Figure One). Performance on all of the inferencing tasks was lowest in the NLD and VI groups. Emotional and Spatial inferencing were lowest in the NLD group, while on all other inferencing measures the VI group had the lowest scores.
Figure 1: Z-scores Transformations for Dependent Variables
With the exception of the Nonspatial measure, the groups were significantly different. Following the MANOVA and ANOVA's, post hoc comparisons were performed using the Tukey simultaneous confidence interval technique. It should be noted that while the experimenter error rate (EER) was high (i.e., confidence interval of 75%) given the relatively small sample sizes and the experimental nature of two of the tasks, an alpha level of .05 was maintained for these multiple comparisons.

Spatial/Nonspatial Inferencing Task (SIT):

As noted earlier, it was necessary to adapt the original SIT from McDonald and Wales (1986) because of the variation found among the linguistic demands of the questions. An examination of the two patterns A - B, B - C, B - D and A - B, C - A, B - D adopted for this study revealed that the participants did not differ in their responses (i.e., first pattern vs. second pattern), \( t(2,46) = 1.36, p = .180 \).

Hypothesis #1

The performance of the C group on the spatial and nonspatial tasks will be significantly better than both the NLD and VI groups.

This hypothesis was partially supported in that closer examination of the Spatial inferencing combined scores indicated that the C group performed
significantly better than the NLD group \( (p = .013) \); however, there was no difference between the performance of the C and VI groups \( (p = .157) \).

**Hypothesis #2**

*The performance of the NLD and VI groups will not differ on the nonspatial section. Due to the previously outlined visual-spatial difficulties associated with NLD, the NLD group will perform significantly poorer than the VI group on the Spatial section.*

This prediction was not supported as the NLD and the VI groups did not differ on the Spatial \( (p = .572) \) or the Nonspatial \( (p = .606) \) sections of the SIT.

**Hypothesis #3**

*Given the visual-spatial difficulties associated with the NLD group, it was predicted that their performance on the nonspatial section will be better than the spatial sections (i.e., \( \text{NLD - nonspatial} > \text{NLD - spatial} \)).*

This hypothesis was supported as there was a significant difference between the two conditions in the predicted direction within the NLD group, \( t(1,13) = 7.20, p = .0001 \). Closer examination of the two remaining groups, however, revealed that this trend was also significant for the VI group, \( t(1,13) = 8.74, p = .001 \), and the Control group, \( t(1,18) = 6.92, p = .001 \). The magnitude of the difference between a higher nonspatial and lower spatial score was compared among the three groups. Although the largest difference was found within the NLD group, the overall difference among the three groups was not significant, \( F(2,46) = 2.15, p = .129 \).
SIT Condition Analysis:

The Spatial and Nonspatial scores are combined scores that represent the mean of two individual scores in each case (i.e., SS + SN, and NS + NN respectively). The scores for the three groups on these four SIT conditions are presented in Table 4 together with the results from statistical comparisons.

Table 4:

Means, Standard Deviations, and Tests of Significance for the Individual SIT Conditions

<table>
<thead>
<tr>
<th>Group</th>
<th>C (n=19)</th>
<th>NLD (n=14)</th>
<th>VI (n=14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td>18.42</td>
<td>16.00</td>
<td>16.86</td>
</tr>
<tr>
<td>SN</td>
<td>16.79</td>
<td>13.57</td>
<td>14.79</td>
</tr>
<tr>
<td>NS</td>
<td>21.58</td>
<td>19.79</td>
<td>19.21</td>
</tr>
<tr>
<td>NN</td>
<td>21.58</td>
<td>21.21</td>
<td>19.43</td>
</tr>
</tbody>
</table>

Note. C = Control, NLD = Nonverbal Learning Disability, and VI = Verbally-Impaired, SS = spatial inference-spatial filler, SN = spatial inference-nonspatial filler, NS = nonspatial inference-spatial filler, and NN = nonspatial inference-nonspatial filler.

a = The maximum score for each response pattern is 24.

Given the significant difference on the combined Spatial score between the C and NLD groups, a one-way ANOVA was performed to assess group differences on the two individual spatial scores. Only the Spatial Inference-Nonspatial Filler (SN) condition differed significantly. As would be expected, the difference of the
pairwise Univariate result was accounted for by a significant difference between the C group and the more poorly performing NLD group ($p = .004$).

**Response Pattern Analysis:**

Following the McDonald and Wales (1986) methodology, the results from an analysis of the SIT response types (true premise, true inference, false premise, and false inference) for each of the three groups collapsed across the inferencing conditions are displayed in Table 5. This analysis determined if there was a difference among the groups in their ability to recognize whether they had previously heard the specific kind of response. A one-way ANOVA revealed a significant difference between the groups on the false inference response type and the false premise type.

**Table 5:**

**SIT Response Type Means and Standard Deviations Collapsed Across Conditions**

<table>
<thead>
<tr>
<th>Group</th>
<th>C (n=19)</th>
<th>NLD (n=14)</th>
<th>VI (n=14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M (SD)$</td>
<td>$M (SD)$</td>
<td>$M (SD)$</td>
<td>$F(2,45)$</td>
</tr>
<tr>
<td>TP* 19.95(2.63)</td>
<td>19.50(2.14)</td>
<td>18.93(2.09)</td>
<td>0.763</td>
</tr>
<tr>
<td>TI 17.00(3.87)</td>
<td>15.36(3.69)</td>
<td>16.21(2.15)</td>
<td>0.946</td>
</tr>
<tr>
<td>FP 20.42(2.12)</td>
<td>18.00(3.21)</td>
<td>17.64(4.99)</td>
<td>3.165</td>
</tr>
<tr>
<td>FI 20.95(1.54)</td>
<td>17.50(4.33)</td>
<td>17.50(3.63)</td>
<td>6.462</td>
</tr>
</tbody>
</table>

Note. C = Control, NLD = Nonverbal Learning Disability, and VI = Verbally-Impaired, TP = true premise, TI = true inference, FP = false premise, and FI = false inference.

$a$ = The maximum score for each response type is 24.
The overall significant difference found for the false inferencing response type was accounted for by the poorer performance of the NLD ($p = .015$) and VI ($p = .015$) groups relative to the C group. The two clinical groups did not differ on this response format ($p = 1.00$).

In an attempt to further delineate the differences found for the response types, a final analysis was undertaken to examine response types within each group (see Table 6). Each response type (i.e., TP, TI, FP, FI) was compared within each response condition (i.e., SS, SN, NS, NN) to determine potential interaction effects.
Table 6: SIT Response Type by Condition Within Groups Analysis

<table>
<thead>
<tr>
<th>Group</th>
<th>C (n=19)</th>
<th>NLD (n=14)</th>
<th>VI (n=14)</th>
<th>F(2,45)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP*</td>
<td>4.74(0.99)</td>
<td>4.57(0.85)</td>
<td>4.50(0.94)</td>
<td>0.281</td>
<td>p = .756</td>
</tr>
<tr>
<td>TI</td>
<td>3.68(1.63)</td>
<td>3.07(1.00)</td>
<td>3.79(1.05)</td>
<td>1.258</td>
<td>p = .294</td>
</tr>
<tr>
<td>FP</td>
<td>4.84(0.96)</td>
<td>4.07(1.54)</td>
<td>4.21(1.53)</td>
<td>1.65</td>
<td>p = .212</td>
</tr>
<tr>
<td>FI</td>
<td>5.16(0.83)</td>
<td>4.29(1.27)</td>
<td>4.36(1.08)</td>
<td>3.601</td>
<td>p = .036</td>
</tr>
<tr>
<td>SN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP</td>
<td>4.53(1.12)</td>
<td>4.07(1.07)</td>
<td>4.07(1.14)</td>
<td>0.944</td>
<td>p = .397</td>
</tr>
<tr>
<td>TI</td>
<td>3.16(1.42)</td>
<td>2.50(1.45)</td>
<td>2.93(1.21)</td>
<td>0.932</td>
<td>p = .402</td>
</tr>
<tr>
<td>FP</td>
<td>4.58(0.96)</td>
<td>3.64(1.39)</td>
<td>4.07(1.49)</td>
<td>2.233</td>
<td>p = .119</td>
</tr>
<tr>
<td>FI</td>
<td>4.53(0.77)</td>
<td>3.36(1.50)</td>
<td>3.71(0.83)</td>
<td>5.409</td>
<td>p = .008</td>
</tr>
<tr>
<td>NS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP</td>
<td>5.58(0.69)</td>
<td>5.43(1.09)</td>
<td>5.07(1.07)</td>
<td>1.195</td>
<td>p = .312</td>
</tr>
<tr>
<td>TI</td>
<td>5.00(1.20)</td>
<td>4.50(1.51)</td>
<td>4.86(0.77)</td>
<td>0.718</td>
<td>p = .493</td>
</tr>
<tr>
<td>FP</td>
<td>5.58(0.69)</td>
<td>4.93(1.00)</td>
<td>4.36(1.65)</td>
<td>4.729</td>
<td>p = .014</td>
</tr>
<tr>
<td>FI</td>
<td>5.42(0.69)</td>
<td>4.93(1.38)</td>
<td>4.93(1.38)</td>
<td>1.033</td>
<td>p = .365</td>
</tr>
<tr>
<td>NN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP</td>
<td>5.11(0.94)</td>
<td>5.43(0.76)</td>
<td>5.29(0.99)</td>
<td>0.525</td>
<td>p = .595</td>
</tr>
<tr>
<td>TI</td>
<td>5.16(1.12)</td>
<td>5.29(0.99)</td>
<td>4.64(1.08)</td>
<td>1.442</td>
<td>p = .247</td>
</tr>
<tr>
<td>FP</td>
<td>5.42(0.77)</td>
<td>5.36(0.36)</td>
<td>5.00(1.24)</td>
<td>0.956</td>
<td>p = .392</td>
</tr>
<tr>
<td>FI</td>
<td>5.89(0.32)</td>
<td>5.21(0.80)</td>
<td>4.50(1.87)</td>
<td>6.230</td>
<td>p = .004</td>
</tr>
</tbody>
</table>

Note. C = Control, NLD = Nonverbal Learning Disability, and VI = Verbally-Impaired, TP = true premise, TI = true inference, FP = false premise, and FI = false inference, SS = spatial inference-spatial filler, SN = spatial inference-nonspatial filler, NS = nonspatial inference-spatial filler, and NN = nonspatial inference-nonspatial filler.
a = The maximum score for each response set is 6.

Within the SS condition, the FI response type was significantly different across the three groups, $F(2,46) = 3.98, p = .036$; however, the poorer performance of the NLD group relative to the C group only approached significance ($p = .073$).

This finding was identical in the SN condition of the SIT, $F(2,46) = 5.41, p = .008$. 
with the NLD group performing significantly worse than the C group on their ability to reject false inferences as not heard before ($p = .011$). Within the NS condition, the FP response type was significantly different across the three groups, $F(2,46) = 6.10, p = .014$, with the VI group performing significantly more poorly ($p = .015$) than the C group in their ability to reject false premises that were not heard before (FP response type). The FI response type in the NN condition differed significantly across the groups, $F(2,46) = 7.88, p = .004$, with the VI group experiencing significantly more difficulty than the C group in rejecting false inferences as not being heard before ($p = .004$).

**Story Inferencing Measure:**

Although the factual questions were not included in the main analysis, a brief examination of the results is warranted. The reported means and standard deviations are as follows: C group (14.95, 1.93), NLD group (11.86, 4.57), and the VI group (11.14, 3.80). An analysis of these means revealed a significant group difference, $F(2,46) = .572, p = .006$, that was accounted for by the superior performance of the C group relative to the NLD ($p = .050$) and VI ($p = .012$) groups. There was no difference between the two clinical groups on these questions ($p = .862$). In addition, the factual responses were collapsed across the three groups and there was no effect for story order, $t(2,46) = 1.940, p = .058$. 
Hypothesis #4

The C group will perform significantly better than the NLD and VI groups on the general and emotional inferencing questions.

This hypothesis was partially supported as the C group performed significantly better than the VI group on the general inferencing measure ($p = .022$); however, the C group performed significantly better than the NLD group on the emotional inferencing task ($p = .042$).

Hypothesis #5

The NLD group was expected to perform no differently from the VI group on the general inferencing section. The NLD group's performance on the emotional inferencing section, on the other hand, was predicted to be significantly poorer than the VI group.

This hypothesis was not supported as the NLD and VI groups did not differ on the general ($p = .861$) or emotional inferencing ($p = .821$) tasks.

Hypothesis #6

The performance of the NLD group on the emotional inferencing questions was expected to be poorer than their performance on the general inferencing questions. In an effort to highlight patterns of specific deficit, relative differences between the general and emotional inferencing scores within groups were examined.

This hypothesis was unsupported given the significant difference in the opposite direction (i.e., emotional inferencing > general inferencing) between the two tasks within the NLD group, $t(1,13) = 3.37$, $p = .005$. This pattern was the same as that
found within the VI group, \( t(1,13) = 4.65, p = .001 \), and the C group, \( t(1,18) = 6.597, p = .001 \) suggesting that the general inferencing section may have included a higher number of difficult questions. The magnitude of the difference between the emotional and general inferencing scores was compared among the three groups and although the largest difference was found within the NLD group, the overall differences were not significant, \( F(2,46) = .605, p = .551 \).

**The Test of Language Competence (TLC)**

**Hypothesis #7**

*The performance of the C group on the Making Inferences subtest will be significantly better than both the NLD and VI groups.*

This hypothesis was supported as both the NLD \( (p = .003) \) and the VI \( (p = .001) \) groups did significantly poorer than the C group on the TLC subtest.

**Hypothesis #8 (NLD >VI)**

*Due to the general nature of the language inferences, it was predicted that the NLD group would perform better than the VI group on this subtest.*

This hypothesis was not supported as the performance of the NLD group and the VI group did not differ significantly on this subtest \( (p = .278) \).
Correlations:

Table 7

**Intercorrelations Between the Dependent Measures Collapsed Across Groups (n=47)**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General Inferencing</td>
<td>--</td>
<td>.467**</td>
<td>.408**</td>
<td>.479**</td>
<td>.372*</td>
</tr>
<tr>
<td>2. Emotional Inferencing</td>
<td>--</td>
<td>.281</td>
<td>.465**</td>
<td>.324*</td>
<td></td>
</tr>
<tr>
<td>3. Spatial Inferencing</td>
<td>--</td>
<td>.396**</td>
<td></td>
<td></td>
<td>.136</td>
</tr>
<tr>
<td>4. Nonspatial Inferencing</td>
<td>--</td>
<td></td>
<td>.169</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Test of Language Competency: Making Inferences Subtest</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** p<.01, * p<.05

From the large number of significant correlations it appears as though the five inferencing measures are similar on several constructs. Each measure, for example, is correlated with a minimum of two other inferencing tasks. It should be noted, however, that the Spatial and Nonspatial tasks are separate elements from the same task as are the Emotional and General tasks, thereby increasing the likelihood of inflated correlations.

Table 8 lists the intercorrelations by group. These correlations were designed to demonstrate patterns within each of the three groups. It should be noted that by calculating a large number of correlations, the probability of family-wise error is increased. However, due to the experimental nature of two of the three inferencing measures, it was important to illustrate patterns within the groups.
Table 8

**Intercorrelations Between the Dependent Measures for Each Group**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. General Inferencing</td>
<td>--</td>
<td>.330</td>
<td>.346</td>
<td>.334</td>
<td>-.155</td>
</tr>
<tr>
<td>2. Emotional Inferencing</td>
<td>--</td>
<td>.001</td>
<td>.211</td>
<td>-.297</td>
<td></td>
</tr>
<tr>
<td>3. Spatial Inferencing</td>
<td>--</td>
<td>.400</td>
<td>--</td>
<td>-.211</td>
<td></td>
</tr>
<tr>
<td>4. Nonspatial Inferencing</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>-.684**</td>
<td></td>
</tr>
<tr>
<td>5. Test of Language Competency: Making Inferences Subtest</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
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<tbody>
<tr>
<td>NLD</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1. General Inferencing</td>
<td>--</td>
<td>.510</td>
<td>.283</td>
<td>.435</td>
<td>.337</td>
</tr>
<tr>
<td>2. Emotional Inferencing</td>
<td>--</td>
<td>.532*</td>
<td>.447</td>
<td>.522</td>
<td></td>
</tr>
<tr>
<td>3. Spatial Inferencing</td>
<td>--</td>
<td>.520</td>
<td>--</td>
<td>.024</td>
<td></td>
</tr>
<tr>
<td>4. Nonspatial Inferencing</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>.191</td>
<td></td>
</tr>
<tr>
<td>5. Test of Language Competency: Making Inferences Subtest</td>
<td>--</td>
<td>--</td>
<td>--</td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>VI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. General Inferencing</td>
<td>--</td>
<td>.248</td>
<td>.318</td>
<td>.472</td>
<td>.373</td>
</tr>
<tr>
<td>2. Emotional Inferencing</td>
<td>--</td>
<td>-.215</td>
<td>.555*</td>
<td>.188</td>
<td></td>
</tr>
<tr>
<td>3. Spatial Inferencing</td>
<td>--</td>
<td>.189</td>
<td>--</td>
<td>-.161</td>
<td></td>
</tr>
<tr>
<td>4. Nonspatial Inferencing</td>
<td>--</td>
<td>.508</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>5. Test of Language Competency: Making Inferences Subtest</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
</tbody>
</table>

**p<.01, *p<.05**

Note. C = Control, NLD = Nonverbal Learning Disability, and VI = Verbally-Impaired

The only two measures within the C group that were correlated were the TLC and the Nonspatial section of the SIT. The Nonspatial section was also significantly correlated with the Emotional inferencing measure in the VI group. Within the NLD group, however, the two correlated measures were the Emotional inferencing and Spatial section of the SIT.
### Table 9

**Intercorrelations Between IQ and the Dependent Measures for Each Group**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. IQ (FSIQ)</td>
<td>-.057</td>
<td>.089</td>
<td>.386</td>
<td>.246</td>
<td>-.041</td>
<td>-.035</td>
<td>-.108</td>
<td></td>
</tr>
<tr>
<td>2. General Inferencing</td>
<td>--</td>
<td>.330</td>
<td>-.155</td>
<td>.372</td>
<td>.248</td>
<td>.460*</td>
<td>.116</td>
<td></td>
</tr>
<tr>
<td>3. Emotional Inferencing</td>
<td>--</td>
<td>-2.297</td>
<td>.094</td>
<td>-.130</td>
<td>.267</td>
<td>.123</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. TLC</td>
<td>--</td>
<td>-.087</td>
<td>-.343</td>
<td>-.651**</td>
<td>-.564*</td>
<td></td>
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<td>.575*</td>
<td>.326</td>
<td>-.044</td>
<td>.318</td>
<td>.650*</td>
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<td>.510</td>
<td>.337</td>
<td>.414</td>
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<td>.758**</td>
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<td>.472</td>
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**Note.** C = Control, NLD = Nonverbal Learning Disability, VI = Verbally-Impaired, TLC = Test of Language Competency: Making Inferences Subtest, SS = spatial inference-spatial filler, SN = spatial inference-nonspatial filler, NS = nonspatial inference-spatial filler, and NN = nonspatial inference-nonspatial filler.

Of the 21 correlations comparing IQ to the dependent measures 3 were significant. The three significant correlations were found within the NLD group were General...
Inferencing \((p = .002)\), Emotional Inferencing \((p = .029)\), and nonspatial inference-
nonspatial filler \((p = .012)\)
Discussion

The primary contribution of the present study is in advancing knowledge about the language functioning of children with NLD. Results indicate that children with NLD have difficulties in language inferencing despite the fact that they demonstrate average overall verbal abilities. The language inferencing difficulties of these children are of a degree that make them as severe as, and therefore indistinguishable from, those associated with general verbal impairment. The nature and distinctiveness of the NLD linguistic difficulties only becomes clear in how they deviate from the performance of the control group.

The difficulties of children with NLD were evident specifically when their language inferencing depended upon interpreting visual-spatial relationships. It is in this respect that their inferencing problems seem to be tied to their core visual-spatial deficit with its presumed right hemisphere focus (Rourke, 1983). The problem seems to be at the level of inferencing, because these children had no difficulty recognizing the meaning of individual items of spatial vocabulary.

The poorer ability that was shown by these children in making emotional inferences about story content provides additional evidence for their language inferencing problems. It was only in the NLD group that difficulties in emotional inferencing were found to be related to problems in spatial language inferencing. The presence of emotional inferencing weaknesses in conjunction with spatial language inferencing difficulties is consistent with the model of NLD as a disorder
in which problems in interpreting social-emotional content can be associated with a basic underlying visual-spatial deficit (Rourke, 1983). The current results highlight the need to consider the impact of this connection on the effectiveness of the oral language functioning of these children, in addition to the much greater attention that has traditionally been given to their problems with nonverbal communication (Glosser & Koppell, 1987; Gross-Tsur et al., 1995; Johnson & Myklebust, 1967; Rourke, 1989; Semrud-Clikeman & Hynd, 1990, 1991; Voeller, 1986, 1995; Weintraub & Mesulam, 1983).

The finding that the NLD group experiences significantly more difficulty than the C group on the combined Spatial scores of the Spatial/Nonspatial Inferencing Task (SIT) and not on the combined Nonspatial scores suggests that these difficulties are specific. Although all three groups have more difficulty with the Spatial section, the NLD group has a relative weakness in this area that is greater than in the C group. This difficulty cannot be interpreted as a strictly generic difficulty with memory given that the NLD group performs comparably with the C group on the two Nonspatial sections. As mentioned earlier, the Spatial and Nonspatial sections were controlled for linguistic content, story length, and complexity. In addition, this difficulty cannot be linked to a fundamental inability to recognize spatial concepts as this group, without exception, was able to accurately identify the spatial questions on the Spatial and Emotional Receptive Language Pretest (SERLP). The NLD group, therefore, must have a specific impediment in inferencing that is evident when the linguistic demands are spatial in nature.
The NLD group's deficit in spatial language inferencing is more clearly delineated when the specific responses to the SIT are examined. When the material is Nonspatial, children with NLD have as much success as the C group with all four question types — accepting true inferences and premises as being heard before and rejecting false premises and inferences as not being heard before. When the two Spatial sections are examined, however, a specific type of weakness emerges for the NLD group, namely difficulty in accurately rejecting false inferences as not being heard before. This finding replicates the McDonald and Wales (1986) finding that individuals with RHBD had a relative weakness with rejecting false inferences. Those authors found that the RHBD group also had difficulties rejecting false premises as not being heard before.

McDonald and Wales (1986) proposed that the RHBD difficulty with rejecting false information was the result of a memory retrieval problem, rather than a generalized inferencing difficulty. More specifically, they suggested that the RHBD group memorized the material normally, but were experiencing difficulty retrieving the information. Material in the true premise and true inference conditions, for example, would be relatively easy to access because the question would automatically stimulate the memory for the original item. In contrast, the false premise and false inference conditions would require the individual to accurately and spontaneously retrieve the original story in order to make the comparison. The finding that children with NLD in the present study have no problem detecting false premises in all four conditions (SS, SN, NS, NN) and are able to accurately make judgments on false inferences in the NS and NN
conditions makes it difficult to argue that they have a problem with retrieval like individuals with RHBD. The reason for the NLD group’s problem must lie elsewhere.

Given the specificity with which the NLD group experiences difficulty with false inferences and their relative competency with true inferences, it appears as though their difficulty lies in the reconciliation of the false information. Individuals with RHBD have been shown to experience a specific difficulty incorporating contradictory or incongruent statements in their thinking (Beeman, 1993; Caramazza et al., 1976; Deglin & Kinsbourne, 1996; Tompkins, Bloise, Timko, & Baumgaertner, 1994) and this finding has been extended to difficulties in accurately making inferences on incongruent information (Brownell et al., 1986; Kaplan, Brownell, Jacobs, & Gardner, 1990; Richards & Chiarello, 1997). In the present study, the false inference response type requires the individual to hold the false inference (incongruent information) in memory, recall the two original items, make the necessary inference, and then judge the accuracy of the inference with reference to the original items. Children in the NLD group may experience similar difficulties to individuals with RHBD in dealing with the incongruity in the false inferencing condition. Once again, however, the finding that the NLD group was able to accurately make judgments on the Nonspatial false inferences suggests that this difficulty is highly specific to false inferences that are spatial in nature.

A problem in working memory could be involved as making an inference not only requires retrieving and holding onto story elements, but also linking them to detect the underlying relationship. A brief examination of working memory as
outlined in Just and Carpenter’s (1992) capacity theory of comprehension may help to articulate the specificity with which the NLD group experiences difficulties with the SIT inferencing task.

Just and Carpenter (1992) proposed a theory of memory capacity that can be expressed as the amount of activation available in working memory necessary to support storage and/or processing. If the activation level of language elements (e.g., words, themes, phrases etc.) are within an individual’s threshold, the element is maintained in working memory. If the activation available to the system is less than that required to perform the comprehension task, however, some of the original elements are displaced. According to Just and Carpenter, individual differences in capacity are to be expected and are theoretically due to a number of potential factors including efficiency, motivation, and vocabulary, to name a few.

Tomkins et al. (1994) examined the capacity theory of comprehension by investigating the correlation between working memory and discourse comprehension in individuals with RHBD. These researchers found that as the processing demands of the task increased (i.e., congruent information → incongruent information), the magnitude of the correlations increased. In addition, Tomkins et al. also found this pattern with their control group suggesting that the working memory capacity theory may apply regardless of cognitive acuity. These authors suggested that in order to revise an inconsistent inference, the listener must represent the new inconsistent information in working memory and integrate it with the existing information set.
If the working memory resource allocation perspective is applicable to NLD, it would be predicted that as the processing demands of the SIT increase, limitations in working memory capacity may be compromising the accuracy on the inferencing response types. As outlined above, the two Spatial sections of the SIT (SN and to a lesser degree SS) were problematic for the NLD group, whereas the Nonspatial sections (NN and NS) were not. It may be that the working memory activation level necessary to perform a spatial inference exceeded the threshold for the NLD group (i.e., spatial elements increase the demands on working memory).

An examination of the SIT response types indicates that the true premise and true inference responses are considered to be relatively straight-forward tasks as the judgments that are made follow directly and/or logically from the original material that was presented (McDonald & Wales, 1986). The false premise response type appears to place greater demands on working memory of the listener by requiring her/him to make judgments on incongruent premises. The false inference response type, by extension, should place the greatest demands on working memory as an inference is required on new information that is incongruent with the original information. The NLD group’s processing and storage limits may have been progressively burdened with the increasing demands on working memory associated with the false inferencing response type; but this becomes problematic for them only when the relationships they are dealing with are spatial in nature.

To account for the additional burden spatial elements may place on working memory, some authors (e.g., Landau & Jackendoff, 1993; Messick, 1988) have
suggested the conceptual knowledge of spatial terms is abstract as it refers to relationships between or within items. According to Glenberg and McDaniel (1992) there are only about 80-100 prepositions to convey spatial relations and the small number stands in stark contrast to the extremely large number of possible spatial locations possible with the human perceptual apparatus. In addition, the conceptual knowledge is complicated by the fact that spatial terms are not absolute and the understanding of the term is affected by the context (i.e., size, shape, viewpoint of the speaker).

Thus, children with NLD appear to be able to make language inferences as their performance was adequate on the true inference response types, as well as the false inference response types when the latter involved nonspatial information. However, their ability to inference effectively may become compromised when the inferencing becomes complicated by the need to accommodate information that is incongruent specifically with a stated spatial relationship.

This problem in dealing with incongruencies seems to be similar to the difficulty that Rourke (1989) has reported more generally about the weakness individuals with NLD have in coping with novelty. Accommodating incongruent or incorrect information has been interpreted as one form of having to deal with new material (Brownell et al. 1986) This may place excessive demands on the working memory capacity of these individuals that, in turn, make incorporating the information problematic, particularly when the thinking involves spatial relationships. The present study has taken Rourke’s general notions of poor Language Content and difficulty dealing with novelty as characterizing NLD, and
provided a more detailed understanding of these deficits as they relate to a problem in coping with incongruencies when processing spatial information.

The NLD profile has been refined further by the finding that the NLD group has a relative weakness on the emotional inferencing section from the Story Inferencing Measure (SIM). Although the emotional and general inferencing sections contained linguistically similar items and were presented to each participant in a single randomized trial, the NLD group experienced a specific difficulty with emotional content relative to the C group. The finding that children with NLD experience difficulties with emotional material has been demonstrated by Kaminska (1994) who compared an NLD group to a C group and a VI group on an experimental facial recognition task and found that, relative to the C group, the NLD group had difficulty decoding emotions in the visual modality.

The NLD group's difficulties with the emotional inferencing questions on the SIM cannot be attributed to a comprehensive inferencing deficit as this group performed no differently from the C group on the general inferencing section. Also, even though the NLD group, like the VI group, reported fewer facts from the stories than the C group, a nonspecific memory deficit does not account for the NLD group's relatively poor performance in emotional inferencing. A general memory difficulty would presumably limit performance on both story inferencing tasks, but only emotional inferencing emerged as a relative weakness in the NLD group.

The correlation that was found between the NLD group's performance on the emotional section of the SIM and the spatial section of the SIT suggests that there
may be a core deficit linked to a more generalized RHD. In an attempt to identify relationships between RHBD and emotion, Borod et al. (1992) examined RHBD participants' ability to identify emotional words and sentences and compared them to a LHBD group and a control group. These authors found that the RHBD group performed significantly worse than the control group and no differently from the LHBD group on emotional and nonemotional language tasks. Interestingly, the RHBD group was the only group to perform significantly worse on the emotional tasks than on the nonemotional tasks. Borod et al. posited that emotional processing involves holistic strategies that may rely on functions that have been traditionally considered to be right hemisphere related (e.g., visual-spatial). Furthermore, these authors suggested that the critical demand of emotional processing is a spatial one that requires "...a sensitivity to relationships among emotions that entails some determination of which behavior is appropriate for a particular situation"(p.841).

The finding that emotional inferencing was correlated with spatial inferencing in the NLD group exclusively provides some support for Borod et al.'s (1992) presumption of the right hemisphere's involvement in emotion. The specificity with which the NLD group experienced difficulty on only the emotional section of the SIM, in conjunction with the above mentioned correlation, suggests that the link between visual-spatial difficulties and interpreting emotional aspects of language is tenable in this population. This correlation may also indicate the potential role working memory capacity plays in emotional inferencing. More specifically, the working memory demands for emotional inferencing may exceed
those required in the general inferencing section because of the need to affix an additional element (emotion) to the existing context of the inference. The addition of the emotional element may have the effect of exceeding the working memory threshold of the NLD group and place them at a disadvantage for comprehending emotional inferences. Although the link between emotion and visual-spatial abilities has been previously hypothesized by Rourke (Ozols & Rourke, 1985; Rourke, 1989), the present study was able to demonstrate a specific relationship between the two for children with NLD.

In contrast to the specificity demonstrated by the NLD group on the SIT and SIM relative to the C group, this group's performance on the Test of Language Competency (TLC): Making Inferences subtest was indistinguishable from the VI group, with both clinical groups performing more poorly than the C group. A closer examination of the correlations in Table 7 demonstrates a significant relationship between the Making Inferences subtest and the general and emotional section of the SIM. An evaluation of the Making Inferences subtest revealed a consistently high degree of variability among the 12 subtest items with respect to emotional content, sentence structure, and complexity of the inferences. Given the difficulty that was found for the VI group compared to the C group with the general inferencing section, and the NLD group's difficulty with the emotional section, it would be predicted that both groups would find the Making Inferences subtest difficult given the scope of content covered by this measure. Indeed, the VI and NLD group means for this subtest were more than one standard deviation below the mean (i.e., below the 10th percentile) of the standardization sample, attesting to
the severity of their language inferencing problems as evidenced on this norm-referenced measure.

Although the present study's finding on the Making Inferences subtest does not necessarily further refine the NLD profile, it does draw attention to a critical issue, namely that the NLD group did not differ significantly from the VI group on any of the three language inferencing measures. This linguistic similarity is important in highlighting the degree of language deficits of the NLD population and has several important implications for educators and clinicians. Teachers, for example, need to be aware of the language inferencing difficulties in the NLD population and, although the degree of inferencing deficit may be similar to that of individuals with VI, the pattern of weakness (i.e., emotional and spatial weaknesses) is unique to the NLD group. In remedial programming it may be beneficial to teach individuals with NLD strategies for breaking down an inference into its elemental components and then reconstructing the elements in order to fully comprehend the meaning. This instruction might be focused on the interpretation of information containing spatial and/or emotional content.

Given the previously noted socioemotional difficulties associated with NLD (e.g., Little, 1993; Rourke, 1989) it is reasonable to assume that language inferencing difficulties are involved in their social misperceptions. More specifically, individuals who experience difficulty incorporating incongruent information in their interpretation of language, and who have trouble accurately interpreting emotionally-laden linguistic material, will undoubtedly be at a disadvantage during regular social discourse. In addition to attributing the socioemotional difficulties outlined in the NLD model
(Rourke, 1983, 1989) to "...problems in identifying and recognizing faces, expressions of emotion, and other subtle nonverbal identifiers of important dimensions of human communication" (Rourke, 1989, p.98), the present results indicate the importance of considering the possible contribution of problems in dealing with incongruencies and the emotional content of language to these difficulties.

**Limitations and Future Directions:**

The relatively small number of subjects in the NLD and VI groups is a limitation of the present study. The limited number of participants is due to the selection criteria employed to identify the three groups and points to the larger definitional issue within the NLD literature. The extremely small incidence rate of NLD noted earlier for Rourke and his colleagues, recent findings that Arithmetic may not serve to accurately discriminate this population (Branch et al. 1995), and the variability with which this subtype has been described and defined (e.g., Brumback & Staton, 1982; Glosser & Koppell, 1987; Gross-Tsur, Shalev, Manor, & Amir, 1995; Semrud-Clékieman, & Hynd 1990, 1991; Voeller, 1986, 1995; Weintraub & Mesulam, 1983) indicate the need to adopt more reliable and accessible criteria for NLD. Future studies should examine the selection criteria used in this study with larger samples to determine the discriminant validity of the selection process.

A second selection criteria limitation for this study centred on the VI group. The VI group selection was limited to IQ and academic criteria and was not based on norm-referenced language measures. Future studies should include language
measures to further highlight the degree and specificity of verbal impairment in the VI group, in addition to underscoring the verbal assets of the NLD group.

An additional limitation of this study can be found in the lack of social and/or emotional functioning measures. Given the relationship found between spatial inferencing and emotional inferencing, future studies should include a series of measures to determine the level of socioemotional functioning of the NLD population. Existing research on individuals with NLD has demonstrated the presence of internalizing emotional disturbances (e.g., Casey et al., 1991); however, given the issues with sample selection noted above, this relationship is tentative at best.

Contrary to the NLD model (Rourke, 1989), aspects of auditory memory may be problematic for this population. In light of the potential relationship between working memory and inferential abilities that has been identified, future research should focus on the working memory capacities of the NLD population. More specifically, other forms of language inferencing that incorporate incongruent information should be examined with this group to ascertain the extent to which they are affected by working memory capacity deficits. A clearer understanding of the NLD working memory capacity may allow researchers and educators to better predict areas of difficulty with this population that may aid in remediation.

The specific pattern of language inferencing difficulties found in the NLD group in this study appear to represent a core linguistic deficit. It is unclear, however, whether this core deficit would extend to nonverbal inferencing abilities. If the core features of the NLD profile are causally linked (Rourke, 1989) in future
research, it would be predicted that a pattern of weak nonverbal inferencing ability would be identified within the NLD population.

Another consideration involves the response format used in the SIT in this study. This format was consistent with the existing research with this measure (e.g., McDonald & Wales, 1986) and, for the NLD group, yielded a comparable pattern of results to those in previous studies (e.g., Bransford & Franks, 1971; Bransford, Barclay & Franks, 1972; McDonald & Wales, 1986; Paris & Carter, 1973; Paris & Carter, 1974). In future research, the “yes” “no” response about whether a sentence was remembered might be modified by asking participant’s to actually judge the veracity of the sentence in order to more directly tap their understanding of the inference.

A final suggestion for future research centres on the relationship between NLD and RHBD. If, as has been suggested in this study, the NLD deficit profile is similar to that of individuals with RHBD, it will be important to examine the relationship between the two groups. More specifically, children with NLD should be compared to groups of children who have experienced RHBD (e.g., hydrocephalus) to further refine the underlying core deficits theorized to be subsumed by the right hemisphere. Furthermore, if the NLD and RHBD core linguistic deficits are comparable, it may be beneficial to examine the relationship between previously identified linguistic deficits of RHBD and NLD. Examples of some linguistic deficits identified within the RHBD population include: prosody, lexical semantic processing, discourse processing, and figurative language use (Richards & Chiarello, 1997).
Conclusion:

Although a tentative link between NLD and linguistic weakness has been made in the literature (e.g., Foss, 1991; Gross-Tsur et al., 1995; Johnson, 1987; Johnson and Myklebust, 1967; Rourke & Tsatsanis, 1996; Voeller, 1986; Weintraub & Mesulam, 1983) the findings are equivocal and often unsupported by data. This study is the first empirical examination of the linguistic features of NLD and identifies several important features of the NLD profile. First, the degree of the language inferencing problems characterized by NLD is significant and are indistinguishable from a group of children with identified verbal impairments. Second, working memory may play a role in these inferential difficulties by limiting the capacity of children with NLD to incorporate incongruent information of a spatial nature into their thinking. Finally, weaknesses in inferencing about the emotional subtleties of language are identified and the potential relationship between these and difficulties with spatial inferences are outlined.
References


Title of Research Project: 
Can problems in judging and appreciating time and space lead to problems in understanding some forms of language?

Scientific Title: 
Nonverbal learning disabilities: an understanding of inferential competency.

Investigators: 
1) Dr. Tom Humphries, 
Psychologist, Child Development Clinic, Hospital for Sick Children 
Assistant Professor, Department of Paediatrics, University of Toronto 
Adjunct Professor, Department of Applied Psychology, Ontario Institute for Studies in Education

2) David Worling, Doctoral Candidate, 
Ontario Institute for Studies in Education, University of Toronto

Purpose of the Research: 
Two groups of children who have documented learning disabilities, one in the area language and the other in the area of perception (judging and appreciating time and space) will be compared to a group of children who do not have learning disabilities on three different inferencing measures in an effort to see if learning disabled children have more difficulty with inferencing.

We are interested in finding out how children with different types of learning disabilities understand and make inferences. An example of an inference would be "When you see smoke...." with the inference being "there must be fire." Even though the word 'fire' was not included in the original sentence, most of us will automatically fill in the blank. Although making inferences is natural for most of us, it can be difficult for certain people. This ability is important because it is required in a great deal of our schooling, work, and social life.

Description of the Research: 
Three different groups of children will be asked to participate in this study: Nonverbal Learning Disabled (NLD), Language Delayed (LD), and children without learning disabilities (Controls). There will be two separate testing stages. In the first stage children will complete five measures to help us place them in the correct group. The second stage will involve three different inferencing measures.
Stage One/Inclusion Measures:
In order to make our groupings we require each child to come to the Hospital for Sick Children and complete five assessment measures. These measures will help identify strengths and areas that are difficult for each child.

1) Wechsler Intelligence Scale for Children (Revised or Third Edition) (WISC-R or WISC-III). This intelligence measure examines thinking abilities through measuring a range of language and performance (e.g., puzzles, fine motor etc.) skills.

2) Wide Range Achievement Test (Revised or Third Edition)(WRAT-R or WRAT-III). This measure examines academic achievement on Mathematics (computation), Spelling and Reading (single word identification).

Note: If either the WISC or the WRAT have been given within the last two years, permission to use those scores will be requested rather than retesting.

3) Grooved Pegboard Test. Each child will fit keyhole-shaped pegs into holes with the left and right hand.

4) Spatial Language and Emotional Recognition Pretest. Children will be asked to point to five simple faces, to identify a primary emotion (e.g., anger, surprise etc.). In addition, a picture will be presented and the children will be asked to identify certain aspects of the picture (e.g., "What is in front of the tree?").

The total time required to complete the five measures in Stage One is expected to be approximately 2 1/2 hours. The results of these measures will be confidential and stored in a locked cabinet with Dr. Humphries. If, at this point, your child does not fit into one of the groups we will send you a report on your child's results. Please note that regardless of whether your child has been chosen for the study after Stage One, these measures are not considered a full Psychoeducational Assessment and will not affect your position on the Child Development Clinic wait list or services you will receive from the Clinic.

Stage Two/Experimental Measures:
Stage Two will be completed on the same day as Stage One if your child did not need to complete the WISC-III or WRAT-III measures; otherwise, Stage Two will be completed on a separate occasion at the Hospital for Sick Children.

Once we have identified all three groups of children, we will ask them to complete three different inferencing measures. The first measure requires that the child listen to, and try and remember, a series of short sentences to see if they can make inferences about the meaning of the sentences. The second measure will have the children listen to a short story and retell the story back in as much detail as possible. Several questions will then be asked to see how each child pulls information from the story. The final measure will be taken from a standardized test and will ask each child to make inferences based on descriptions of familiar home or school settings.
The total time required to complete the three measures in Stage Two is expected to be approximately 1 hour. A research report giving the results of your child on both Stage One and Two will be available to you following the collection of the information. This report will also provide the overall averaged results of all of the children involved in the study.

The total time we think it will take to finish all of the testing (Stage One and Two) should be around three and a half hours all together. Breaks will be provided throughout the testing time so that everyone is able to keep their attention focused on the task and do their best.

**Potential Harms (Injury, Discomforts or Inconvenience):**

Taking the time to complete the tests could be an inconvenience. A child could feel some discomfort if they have difficulty answering some of the questions, but the examiner will give them every support and encouragement. Many of the questions involve making inferences and, therefore, many may not involve an obvious right or wrong answers. That may elicit some anxiety on the part of some children.

**Potential Benefits:**

We hope that information collected from this project will help clinicians and educators better understand different types of learning disabilities. With this new information, we hope to provide parents and teachers with an understanding of how some children with learning disabilities use and interpret language and, more importantly, how to better help these children. In addition, the information we collect with your child will provide you with a unique profile of his/her areas of strength and need.

**Confidentiality:**

Confidentiality will be respected and no information that discloses the identity of the subject will be released or published without consent unless required by law. For your information, the research consent form will be inserted in the patient health record. The results of the tests described above will be used for research purposes only in the context of this study. Although these results do not constitute a clinical assessment, you will be provided with a written report. We recommend that the results of these tests be interpreted by a registered psychologist.
Consent:

I acknowledge that the research procedures described above have been explained to me and that any questions that I have asked have been answered to my satisfaction. I have been informed of the alternatives to participation in this study, including the right not to participate and the right to withdraw without compromising the quality of medical care at the Hospital for Sick Children for my child and for other members of my family. As well, the potential harms and discomforts have been explained to me and I also understand the benefits (if any) of participating in the research study. I know that I may ask now, or in the future, any questions I have about the study or the research procedures. I have been assured that records relating to my child and my child's care will be kept confidential and that no information will be released or printed that would disclose personal identity without my permission.

I hereby consent for my child ________________ to participate.

____________________
Name of Parent

____________________
Signature

The Person who may be contacted about the research is: Dr. Tom Humphries

Who may be reached at telephone #: (416)

Name of person who obtained consent

____________________
Signature

____________________
Date
Appendix 2:

Information/Assent Form

TITLE OF STUDY: Can problems in judging time and space lead to problems in understanding some forms of language?

SCIENTIFIC TITLE: Nonverbal Learning Disabilities: an understanding of inferential competencies.

INVESTIGATORS:

- Dr. Tom Humphries
  Psychologist, Child Development Clinic
- Mr. David Worling
  Doctoral Candidate,
  Ontario Institute for Studies in Education

Why are we doing this study?
We are interested in how children with learning difficulties understand certain kinds of language. Some children with learning difficulties in certain areas have more trouble with language than other children. We are looking for ways to better understand these language difficulties so that those children may be helped with their language skills.

What will happen during the study?
You will be asked to come down to Integra and answer questions from several different tests. Your answers will help us understand how children use their language to solve problems and answer questions. You will be asked to answer questions from five to seven different tests. It should take around three and a half hours all together to finish these tests. After you finish the study, a report will be shared with you and your family explaining how you did on the different tests and what the study showed.

Are there good things and bad things about the study?
We don't think there are any problems with the tests, but it may require you to concentrate for a long time. Some of the questions will be quite easy and others may be quite hard for you. The person giving you the tests will make sure that you don't feel too frustrated with the hard questions. In helping us with this project you would be helping us understand how children use their language to solve problems and answer questions.

Who will know about what I did in the study?
If you are part of this test your name and address will not be given to anyone and the report will be shared with only you and your parents.
Can I decide if I want to be in the study?
If you do not want to be part of this test that is O.K. No one will be upset or disappointed. If you say yes now but change your mind, you can say no to the person giving you the tests and that will be O.K. Your mother, or father is also reading some information about this test. They will talk to you about it. Ask them questions if you do not understand what you have read or heard. They will help you to understand. Please ask the person giving the tests any questions that you may have. They will also help you to understand.

Assent

I was present when ________________ read this form and gave his/her verbal assent.

Name of person who obtained assent

Signature

Date
Appendix 3:
Spatial and Emotional Receptive Language Pretest

1. Point to Mad
2. Point to Happy
3. Point to Surprised
4. Point to Disgusted
5. Point to Sad

Spatial Pretest

1. Who is behind the tree?
2. What is under the car?
3. What is in front of the door?
4. What is in the tree?
5. What is above the house?
Appendix 4:  
Spatial/Nonspatial Inferencing Task

Acquisition Set # 1

The books were to the right of the lamp
The glasses were on top of the books
The lamp was on the centre of the table

The teacher read the class a story
The girl listened to the teacher
The story was about basketball

The man liked the flowers
The flowers were roses
The flowers were inside wrapping paper

The newspaper was on the desk
The lamp was near the newspaper
The desk was brand new

The plane flew east of the city
The city was Toronto
The city was spread over a large area

The children sat under the tree
The parents sat next to the children
The tree was in the corner of the garden

The cow was behind the barn
The milking pail was under the cow
The barn was very old and grey

The car was next to the mail box
The mail box was in front of the post office
The mail box was leaning to the left
Spatial/Nonspatial Inferencing Task

Acquisition Set # 2

The boy smelled dinner
Dinner was going to be chicken
The dinner was a tasty meal

The lemons were in the basket
The basket was behind the curtains
The basket was red and white

The house was made of wood
The wood was old
The wood was painted white

The girl's went swimming
The lake was warm for the girl's
Swimming was a summer activity

The circus had clowns
John liked the circus
The clowns worked inside the tent

The farmer sold vegetables
The family paid the farmer
The vegetables were in a basket

The roses stood in a vase
The vase was placed on the windowsill
The vase was near the edge

The tree stood on top of the hill
The hill was very close by
The hill was stony and rocky
Spatial/Nonspatial Inferencing Task

Acquisition Set # 3

The shops were next to the house
The house was on the left side of the street
The house was dark and old

The restaurant sold only hamburgers
The boy ate at the restaurant
The hamburgers were all beef

The boy ran in the race
The race was the first of the year
The race ended in front of the school

Susan took the train
The train was on time
The train had many cars

The mouse found some cheese
The cheese was all eaten
The cheese was beside the plate

The boat was in a Hurricane
The mast was broken on the boat
The Hurricane moved East to West

The bread was on the counter
The butter was beside the bread
The counter was on one side of the room

The box was to the right of the tree
The chair was on top of the box
The tree was green and brown
Appendix 5:
Spatial/Nonspatial Inferencing Task

Recognition Set # 1

The books were to the right of the lamp  
The glasses were on the right of the lamp  
The books were to the left of the lamp  
The glasses were to the left of the lamp

The girl listened to the story  
The teacher read the class a story  
The teacher read to himself  
The girl could not hear the story

The man liked the flowers  
The man did not like the roses  
The man liked the candy  
The man liked the roses

The lamp was on the desk  
The newspaper was under the desk  
The lamp was under the desk  
The newspaper was on the desk

The plane flew east of Toronto  
The plane flew west of the city  
The plane flew east of the city  
The plane flew west of Toronto

The children sat in the tree  
The children sat under the tree  
The parents sat in the tree  
The parents sat under the tree

The cow was in front of the barn  
The cow was behind the barn  
The milking pail was behind the barn  
The milking pail was in front of the barn

The car was down the street from the post office  
The car was next to the mail box  
The car was opposite to the restaurant  
The car was in front of the post office
### Spatial/Nonspatial Inferencing Task

#### Recognition Set # 2

<table>
<thead>
<tr>
<th>Sentence</th>
<th>TP</th>
<th>TI</th>
<th>FP</th>
<th>FI</th>
</tr>
</thead>
<tbody>
<tr>
<td>The boy smelled dinner</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The boy smelled chicken</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The boy smelled breakfast</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The boy could not tell what was for dinner</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The lemons were in front of the curtain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The lemons were behind the curtains</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The lemons were outside the basket</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The lemons were in the basket</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The house was new</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The house was made of stone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The house was old</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The house was made of wood</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The girl's went climbing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The girl's went swimming in the lake</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The lake was warm for the girl's</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The girl's went swimming in the ocean</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>John did not like the clowns</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>John liked the clowns</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The circus did not have clowns</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The circus had clowns</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The farmer sold hay</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The family bought vegetables from the farmer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The farmer sold vegetables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The family bought a tractor from the farmer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The roses were placed on the windowsill</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The roses were placed below the windowsill</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The roses were below the vase</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The roses stood in a vase</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The tree stood beside the hill</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The tree stood on top of the hill</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The tree was very far away</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The tree was very close</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Spatial/Nonspatial Inferencing Task

#### Recognition Set # 3

<table>
<thead>
<tr>
<th>Sentence</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>The house was on the left side of the street</td>
<td>TP</td>
</tr>
<tr>
<td>The shops were on the left side of the street</td>
<td>TI</td>
</tr>
<tr>
<td>The house was on the right side of the street</td>
<td>FP</td>
</tr>
<tr>
<td>The shops were on the right side of the street</td>
<td>FI</td>
</tr>
<tr>
<td>The boy ate hamburgers at the restaurant</td>
<td>TI</td>
</tr>
<tr>
<td>The boy ate pizza at the restaurant</td>
<td>FI</td>
</tr>
<tr>
<td>The restaurant sold only hamburgers</td>
<td>TP</td>
</tr>
<tr>
<td>The restaurant sold only hot dogs</td>
<td>FP</td>
</tr>
<tr>
<td>The boy ran in the race</td>
<td>TP</td>
</tr>
<tr>
<td>The boy ran in the first race of the year</td>
<td>TI</td>
</tr>
<tr>
<td>The boy watched the race</td>
<td>FP</td>
</tr>
<tr>
<td>The boy ran in the last race of the year</td>
<td>FI</td>
</tr>
<tr>
<td>Susan was late</td>
<td>FI</td>
</tr>
<tr>
<td>Susan took her car</td>
<td>FP</td>
</tr>
<tr>
<td>Susan was on time</td>
<td>TI</td>
</tr>
<tr>
<td>Susan took the train</td>
<td>TP</td>
</tr>
<tr>
<td>The cat ate the cheese</td>
<td>FI</td>
</tr>
<tr>
<td>The mouse ate the cheese</td>
<td>TI</td>
</tr>
<tr>
<td>The mouse found some bread</td>
<td>FP</td>
</tr>
<tr>
<td>The mouse found some cheese</td>
<td>TP</td>
</tr>
<tr>
<td>The boat was in a hurricane</td>
<td>TP</td>
</tr>
<tr>
<td>The hurricane broke the mast on the boat</td>
<td>TI</td>
</tr>
<tr>
<td>The boat was in a snow storm</td>
<td>FP</td>
</tr>
<tr>
<td>The mast was broken by the sail</td>
<td>FI</td>
</tr>
<tr>
<td>The bread was on the counter</td>
<td>TP</td>
</tr>
<tr>
<td>The butter was on the counter</td>
<td>TI</td>
</tr>
<tr>
<td>The butter was under the counter</td>
<td>FI</td>
</tr>
<tr>
<td>The bread was on the table</td>
<td>FP</td>
</tr>
<tr>
<td>The box was to the right of the tree</td>
<td>TP</td>
</tr>
<tr>
<td>The chair was to the right of the tree</td>
<td>TI</td>
</tr>
<tr>
<td>The box was to the left of the tree</td>
<td>FP</td>
</tr>
<tr>
<td>The chair was to the left of the tree</td>
<td>FI</td>
</tr>
</tbody>
</table>
Appendix 6:
Story Inferencing Measure

Story #1
Shipwrecked

Once there were three brothers who fished together in the ocean. They were good sailors and usually were gone from home for only a short time. One day, they all fell asleep on their boat. While they slept, the anchor broke loose and the boat drifted away in the dark night. It finally crashed against some rocks. The boys woke up frightened but then saw an island about a mile from the wrecked boat. They swam for their lives and finally all reached the island. The boys were grateful to be alive but they knew they were lost.

In the beginning, life on the island was very hard. The boys could not find fresh water or food. But they knew they could survive if they worked together. First, they looked for coconuts. Then they caught birds with their bare hands and cooked them over an open fire. They always had enough to eat and drink and never felt hungry again.

The blazing sun was always hot on the island. But one day the rainy season began. The brothers knew they had to build a shelter. They searched the island and found parts of their wrecked boat. They tied the wood together and built a simple cabin and kept dry when the rain came.

The boys still dreamed every night of returning home to their family. One day, they spotted a ship. They became excited and set fire to some large bushes. The black smoke rose high in the sky and the ship's captain spotted it. He ordered his men to go ashore, where the sailors were welcomed by the three brothers. They shouted their thanks. After 15 long months on the island, they were finally going home.
### Story Inferencing Measure

**Story #1**

**Specific Details**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How many brothers were there?</td>
<td></td>
</tr>
<tr>
<td>2. How did they get lost?</td>
<td></td>
</tr>
<tr>
<td>3. What did they eat on the island?</td>
<td></td>
</tr>
<tr>
<td>4. Why did they build a shelter?</td>
<td></td>
</tr>
<tr>
<td>5. How long were they on the island?</td>
<td></td>
</tr>
<tr>
<td>6. How did the boat get wrecked?</td>
<td></td>
</tr>
<tr>
<td>7. Why did the boys go sailing on their boat?</td>
<td></td>
</tr>
<tr>
<td>8. How did the bushes catch fire?</td>
<td></td>
</tr>
<tr>
<td>9. What did they build a shelter with?</td>
<td></td>
</tr>
<tr>
<td>10. How far did the boys have to swim from the wrecked boat to reach the island?</td>
<td></td>
</tr>
</tbody>
</table>
### Inferential Questions

<table>
<thead>
<tr>
<th>Question</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The boys forgot about home. (G)</td>
<td>T/F</td>
</tr>
<tr>
<td>2. The boys will want to go sailing as soon as they get home. (G)</td>
<td>T/F</td>
</tr>
<tr>
<td>3. The boys knew how to make a fire without matches. (G)</td>
<td>T/F</td>
</tr>
<tr>
<td>4. The boys were surprised when the rain came one day. (E)</td>
<td>T/F</td>
</tr>
<tr>
<td>5. The boys were happy to be away from home and friends. (E)</td>
<td>T/F</td>
</tr>
<tr>
<td>6. The boys are good swimmers. (G)</td>
<td>T/F</td>
</tr>
<tr>
<td>7. Their family and friends will be mad at them for not calling. (E)</td>
<td>T/F</td>
</tr>
<tr>
<td>8. The boys got lost because they were not used to sailing. (G)</td>
<td>T/F</td>
</tr>
<tr>
<td>9. After reaching the island, the boys were still afraid. (E)</td>
<td>T/F</td>
</tr>
<tr>
<td>10. They were sad to leave the island. (E)</td>
<td>T/F</td>
</tr>
<tr>
<td>11. The boys built the shelter to protect them from wild animals. (G)</td>
<td>T/F</td>
</tr>
<tr>
<td>12. The boys were afraid when they saw the sailors. (E)</td>
<td>T/F</td>
</tr>
<tr>
<td>13. The Captain was surprised to see the black smoke rising from the deserted island. (E)</td>
<td>T/F</td>
</tr>
<tr>
<td>14. The boys were sad that their boat got wrecked. (E)</td>
<td>T/F</td>
</tr>
<tr>
<td>15. The boys were happy to see the ship. (E)</td>
<td>T/F</td>
</tr>
<tr>
<td>16. The sailors were angry for having to stop at the island to pick up the boys. (E)</td>
<td>T/F</td>
</tr>
<tr>
<td>17. The boys set fire to the bushes to give a signal. (G)</td>
<td>T/F</td>
</tr>
<tr>
<td>18. The boys must have been very hungry and thirsty for the first few days. (G)</td>
<td>T/F</td>
</tr>
<tr>
<td>19. The boys were tired when they went fishing on their boat. (G)</td>
<td>T/F</td>
</tr>
<tr>
<td>20. The weather is always nice on the island. (G)</td>
<td>T/F</td>
</tr>
</tbody>
</table>

Note: G = general inferencing question, E = emotional inferencing question
Appendix 7:
Story Inferencing Measure

Story #2

Buried Alive

Jim had been a truck driver for 20 years. He was a very careful driver and he never took chances. One day it had been snowing for several hours. The roads were getting bad and Jim could hardly see where he was going. He wanted to get home safely, so he looked for a wide place at the side of the road, pulled over his eighteen-wheeler, and fell fast asleep. He was finally able to relax.

Jim woke up many hours later. It was dark inside the truck but his watch said it was morning. The snow on the truck was keeping the sun out. Jim knew he was trapped. First, he turned on the windshield wipers. Then he tried to push open the door. But the wipers and the door wouldn’t budge. Jim started to worry.

By noontime, it was getting harder and harder to breathe. The air in the truck was running out. Jim remembered that he had a blowtorch in the back of the truck. He lit it, cut a hole in the roof, and melted the snow above the hole. Sunlight and fresh air poured in. Jim was relieved but he knew it would take a long time for all that snow to melt. A whole week went by.

One day, two state police officers saw an exhaust pipe sticking out of the snow. They thought that the driver of the truck might be dead. The officers took shovels out of their car and started digging the snow. About 10 minutes later, they reached the door and pulled it open. Jim smiled at the officers. He was tired and he was hungry. But he was alive!
## Story Inferencing Measure

**Story #2**

**Specific Details**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How long had Jim been a Truck driver?</td>
<td></td>
</tr>
<tr>
<td>2. Why did he have to pull off the road?</td>
<td></td>
</tr>
<tr>
<td>3. What time of day did he wake up?</td>
<td></td>
</tr>
<tr>
<td>4. What did he use to cut the hole?</td>
<td></td>
</tr>
<tr>
<td>5. How long was he in the truck?</td>
<td></td>
</tr>
<tr>
<td>6. Who was Jim rescued by?</td>
<td></td>
</tr>
<tr>
<td>7. What kind of truck was Jim driving?</td>
<td></td>
</tr>
<tr>
<td>8. How long did it take the police to dig him out?</td>
<td></td>
</tr>
<tr>
<td>9. How many police rescued Jim?</td>
<td></td>
</tr>
<tr>
<td>10. How long had it been snowing before he stopped his truck?</td>
<td></td>
</tr>
</tbody>
</table>
Story Inferencing Measure

Story #2

Inferential Questions

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The police were angry for having to dig so much. (E)</td>
<td>T / F</td>
</tr>
<tr>
<td>2. Jim wasn’t afraid when he couldn’t open the door. (E)</td>
<td>T / F</td>
</tr>
<tr>
<td>3. Jim was angry when he saw the police. (E)</td>
<td>T / F</td>
</tr>
<tr>
<td>4. Jim was happy when he woke up in the truck. (E)</td>
<td>T / F</td>
</tr>
<tr>
<td>5. The snow was piled very deeply on top of the truck. (G)</td>
<td>T / F</td>
</tr>
<tr>
<td>6. Jim was happy that the exhaust pipe had been sticking out of the snow. (E)</td>
<td>T / F</td>
</tr>
<tr>
<td>7. Jim was surprised when he woke up and looked at his watch. (E)</td>
<td>T / F</td>
</tr>
<tr>
<td>8. Jim was an experienced truck driver. (G)</td>
<td>T / F</td>
</tr>
<tr>
<td>9. The officers were surprised to see Jim alive. (E)</td>
<td>T / F</td>
</tr>
<tr>
<td>10. Jim cut a hole in the roof because it was too dark to see in the truck. (G)</td>
<td>T / F</td>
</tr>
<tr>
<td>11. Jim was sad to be away from home for a week. (E)</td>
<td>T / F</td>
</tr>
<tr>
<td>12. Jim had to get off the road because he was falling asleep while driving. (G)</td>
<td>T / F</td>
</tr>
<tr>
<td>13. When the officers found Jim he was cold. (G)</td>
<td>T / F</td>
</tr>
<tr>
<td>14. Jim was sad when the blowtorch put a hole in his truck. (E)</td>
<td>T / F</td>
</tr>
<tr>
<td>15. The windshield wipers didn’t work because they were broken. (G)</td>
<td>T / F</td>
</tr>
<tr>
<td>16. Jim kept a good supply of food in his truck. (G)</td>
<td>T / F</td>
</tr>
<tr>
<td>17. The officers knew Jim was in the truck because they saw the exhaust pipe sticking out of the snow. (G)</td>
<td>T / F</td>
</tr>
<tr>
<td>18. Jim was driving through Florida when his truck got trapped. (G)</td>
<td>T / F</td>
</tr>
<tr>
<td>19. Jim was lonely in the truck. (E)</td>
<td>T / F</td>
</tr>
<tr>
<td>20. Jim does not like to drive in the heavy snow. (G)</td>
<td>T / F</td>
</tr>
</tbody>
</table>

Note: G = general inferencing question, E = emotional inferencing question
Appendix 8:

Corrected Skewness Values for Dependent Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Skewness Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIT: Spatial</td>
<td>0.005</td>
</tr>
<tr>
<td>SIT: Nonspatial</td>
<td>-0.800</td>
</tr>
<tr>
<td>SIM: General</td>
<td>-0.457</td>
</tr>
<tr>
<td>SIM: Emotional</td>
<td>-0.759</td>
</tr>
<tr>
<td>TLC: Making Inferences</td>
<td>0.356</td>
</tr>
</tbody>
</table>

Note: Critical value (0.05) for Skewness = 1.009 (Stevens, 1986)

SIT = Spatial/nonspatial Inferencing Task
SIM = Story Inferencing Measure
TLC = Test of Language Competency