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# Social Functioning in Nonverbal Learning Disorder and High Functioning Autism: A Pilot Study

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# SOCIAL FUNCTIONING IN NONVERBAL LEARNING DISORDER AND HIGH FUNCTIONING AUTISM: A PILOT STUDY

by

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## Declaration of Originality

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**Abstract**

The variant of autism spectrum disorder (ASD) in which there is no evidence of a comorbid intellectual disability (often informally referred to as high functioning autism [HFA]) and nonverbal learning disorder (NLD) are two clinical disorders associated with social difficulties. Whereas social functions have been studied extensively in ASD, relatively little research has investigated social functioning in NLD. As such, it is unclear whether the pattern and severity of social functioning difficulties is different between these disorders. Furthermore, it is often challenging to establish a differential diagnosis between these disorders, which is critical given the need for different treatment approaches. The present study aimed to investigate parents' perceptions of social adjustment in these groups, as well as to identify reliable differences in pragmatic communication, social motivation, and other aspects of social functioning based on behaviour inventories and standardized direct observation of social behaviour. Twenty-two participants (10 in the NLD group and 12 in the HFA group) between the ages of 9 and 17 years were recruited from Southwestern Ontario. The results indicated that overall both groups are characterized by social difficulties, with those of children in the HFA group tending to be more severe. The mean scores of each group were elevated in the At-Risk range on the Behavioral Symptoms Index composite of the BASC-2, indicating some social adjustment difficulties in both groups. The Social Interaction Difference Index (SIDI) from the Children's Communication Checklist-2 (CCC-2) and the Overall Total score from Module 3 of the Autism Diagnostic Observation Schedule-2 (ADOS-2) each significantly discriminated between the groups. The Reduced Contact and Social Interest subscale of the Children's Social Behaviour Questionnaire Revised (CSBQR) did

not significantly predict group membership, and both groups were reported to have low frequency of interacting with peers. The present findings provide preliminary support that children in both groups experience social adjustment difficulties, pragmatic language difficulties, as well as reduced social interest in others, and preliminary evidence regarding the clinical usefulness of the CCC-2 and the ADOS-2 in the context of establishing a differential diagnosis between HFA and NLD.

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## List of Abbreviations

AAIDD – American Association on Intellectual and Developmental Disabilities

ADOS – Autism Diagnostic Observation Schedule

ADOS-2 – Autism Diagnostic Observation Schedule - Second Edition

ADOS-G – Autism Diagnostic Observation Schedule - Generic

ADHD – attention-deficit/hyperactivity disorder

ADI-R – Autism Diagnostic Interview Revised

APA – American Psychiatric Association

ASD – autism spectrum disorder

BASC-2 – Behavior Assessment System for Children - Second Edition

CARS – Childhood Autism Rating Scale

CCC – Children's Communication Checklist

CCC-2 – Children's Communication Checklist - Second Edition

C-HRNB – Halstead-Reitan Neuropsychological Test Battery for Children

CSBQR – Children's Social Behaviour Questionnaire - Revised

DSM-5 – Diagnostic and Statistical Manual of Mental Disorders - Fifth Edition

DSM-IV-TR – Diagnostic and Statistical Manual of Mental Disorders - Fourth Edition: Text Revision

EIBI – Early Intensive Behavioural Intervention

FSIQ – Full Scale Intelligence Quotient

FTNW – Fingertip Number Writing Test of the Kløve-Matthews Sensory-Perceptual Examination

GCC – Global Communication Composite of the CCC-2

HFA – high functioning autism

ICD-10 – International Classification of Diseases and Related Health Problems - Tenth Edition

ICF – International Classification of Functioning, Disability and Health

ICF-CY – International Classification of Functioning, Disability and Health: Children and Youth Version

JOLO – Judgement of Line Orientation

LDAWE – Learning Disability Association of Windsor-Essex County

NLD – nonverbal learning disorder

PIC – Personality Inventory for Children

PIC-R – Personality Inventory for Children Revised

PDD-NOS – pervasive developmental disorder, not otherwise specified

PRI – Perceptual Reasoning Index of the WISC-IV

PRS – Parent Rating Scale of the BASC-2

ROC – receiver operating characteristic

SIDI – Social Interaction Difference Index of the CCC-2

SOCIAL – socio-cognitive integration of abilities model

TPT – Tactual Performance Test

VCI – Verbal Comprehension Index of the WISC-IV

WAIS-R – Wechsler Adult Intelligence Scale Revised

WASI – Wechsler Abbreviated Scale of Intelligence

WIAT-III – Wechsler Individual Achievement Test Third Edition

WRAVMA – Wide Range Assessment of Visual Motor Abilities

WISC – Wechsler Intelligence Scale for Children

WISC-III – Wechsler Intelligence Scale for Children Third Edition

WISC-IV – Wechsler Intelligence Scale for Children Fourth Edition

## Chapter 1: Introduction

Competently navigating the social landscape in one's life is a hallmark of positive, healthy functioning throughout the lifespan (Stump, Ratliff, Wu, & Hawley, 2009). Unsuccessfully navigating the social landscape can have a profound and wide-ranging impact on children's daily lives and development, including negative consequences for academic achievement and coping skills (Miles & Stipek, 2006), as well as for physical and mental health (Spitzberg, 2003). With regard to the latter, social problems have been associated with anxiety, delinquency, and substance use, among a variety of other difficulties (Fydrich, Chambless, Perry, Buergener, Beazley, 1998; Green & Biederman, 1999; Renwick & Emler, 1991).

When social problems are severe enough to significantly impact daily functioning, this may be an indication of a psychological disorder. A significant disruption to social functioning represents an associated feature or a diagnostic criterion of a variety of childhood disorders within the major diagnostic systems used by mental health professionals, including the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, 2013) and the tenth edition of the *International Classification of Diseases and Related Health Problems* (ICD-10; World Health Organization, 2004). Among the psychological disorders that are associated with social dysfunction are anxiety disorders (Fombonne, Wostear, Cooper, Harrington, & Rutter, 2001), mood disorders (Fombonne et al., 2001), as well as many developmental disorders, including social (pragmatic) communication disorder (APA, 2013), learning disorders (Gadeyne, Ghesquiere, & Onghena, 2004; Greenham, 1999), NLD (Ozols & Rourke, 1985; Ris & Nortz, 2008), and autism spectrum disorder (ASD;

Simonoff et al., 2008). With regard to the latter, children with ASD often experience significant difficulty fulfilling social roles in their family or community, functioning in a classroom setting, or integrating with peers at school or in the community (Humphrey & Symes, 2011; Scheuermann & Webber, 2002; Wing, 1981). Children with NLD may experience a similar pattern of difficulties, including difficulty forming and maintaining friendships with peers (Strang & Del Dotto, 1985; Rourke, Fisk & Strang, 1986; Semrud-Clikeman, 2007) and a tendency to engage in inappropriate social behaviors, such as misjudging the appropriate distance from others during social interactions (Rourke et al., 1986). Especially enigmatic is understanding the similarities and differences among the social problems that are associated with ASD and NLD (Semrud-Clikeman, 2007).

Children with ASD are a heterogeneous group, with some children having a comorbid intellectual disorder or a language impairment and others having intellectual and verbal abilities that are within normative expectations. It is estimated that 25 percent of children with ASD have limited or no functional speech (Lord et al., 2004; Weitz, Dexter, & Moore, 1997). The form of ASD without a comorbid intellectual impairment is often informally labelled high functioning autism (HFA; Klinger, Dawson, Barnes & Crisler, 2014; Pennington, 2008). The HFA label also includes children who were diagnosed with Asperger's disorder under previous diagnostic systems, given that this diagnosis included only children who did not have intellectual or language delays. Although the core social features required for diagnosis are the same in children with ASD who do and do not have a comorbid intellectual disorder or language impairment, there are some differences in aspects of social functioning between higher and lower functioning groups, with IQ being identified as an important moderating variable (Schatz

& Hamdan-Allen, 1995). For example, those with HFA tend to have somewhat more favourable social adjustment (Sigman, Dissanayake, Arbelle, & Ruskin, 1997) and adaptive functioning (Schatz & Hamdan-Allen, 1995), although these are still below normative expectations overall (Semrud-Clikeman, Walkowiak, Wilkinson, & Minne, 2010; Thomeer et al., 2012; Volker et al., 2010). Higher verbal abilities in ASD have been found to be positively related to initiating social exchanges and responsiveness to social exchanges (Hauck, Fein, Warehouse, & Feinstein, 1995; Sigman & Ruskin, 1999; Stone & Caro-Martinez, 1990). In spite of these relative strengths, social behavior of children with HFA does not occur at the same frequency and is not of the same quality as that of typically developing children, including functioning within the area of language pragmatics, or the social use of language (Lord & Magill-Evans, 1995).

Similarly, the quality of the social behavior of children with NLD and social (pragmatic) communication disorder, particularly in terms of nonverbal behaviors and pragmatic aspects of communication, has been reported to be of a lower caliber than that of typically developing peers (Swineford, Thurm, Baird, Wetherby, & Swedo, 2014; Tsatsanis & Rourke, 2003), in the context of the absence of an intellectual disability and functional language abilities. Given the similarities in social difficulties and in relative strengths in intellectual functioning and functional language abilities among HFA, NLD, and social (pragmatic) communication disorder, these three disorders are often challenging to disentangle diagnostically.

From the standpoint of mental health professionals, understanding the similarities and differences in social functioning between HFA and NLD is important for diagnostic and treatment purposes (Davis & Broitman, 2011). In order to examine the issue of

overlap between disorders associated with similar profiles of social problems as comprehensively as possible, a number of issues must be explored. The definitions of major terms and constructs commonly used in the research literature pertaining to social functioning will be discussed first. Subsequently, the criteria used to diagnose the disorders of interest and any relevant history in the evolution of the diagnoses in commonly used diagnostic systems will be reviewed. Major theoretical approaches to social functioning and a framework to guide clinical thinking when evaluating children for these disorders will then be outlined. Specific research that has investigated differential diagnosis of these disorders will also be summarized. These topics will be reviewed in order before the present study is described.

**Definitions of Terms Commonly used in the Social Neuroscience Literature**

To ensure the consistent use of terminology and for definitional clarity, a number of commonly used terms and definitions from the social cognitive neuroscience literature will be reviewed. These are arranged from superordinate multidimensional constructs to subordinate constructs, including those emphasizing aspects of interpersonal behavior and those emphasizing particular cognitive functions. There are two common approaches to defining constructs: using operational definitions that describe ways in which the construct can be observed and measured, or defining constructs in terms of their relationships to other constructs (AAIDD, 2010). The latter approach will be used in this section because it allows an understanding of the proposed superordinate and subordinate relationships among constructs and it facilitates organization of the relevant constructs. For each term, definitions will be provided, component constructs and their relationships to other relevant constructs will be described (in the case of multidimensional constructs),

and supplementary information regarding the history of the terms or the theories of social functioning from which they were drawn will be included where relevant. The overarching theories of social functioning that underpin the present investigation will be referenced briefly when describing some terms, and these theories will be outlined in detail in a subsequent section.

**Social competence and social functioning**. Social competence and social functioning are terms that have been used interchangeably in the research literature to refer to the same underlying construct (Yager & Ehmann, 2006). Social competence has been described as "mega-construct" (Cavell, Meehan, & Fiala, 2003, p. 433) with multiple dimensions. Numerous definitions of social competence have been put forward in the research literature, but a general consensus surrounding a definition has not yet emerged (Cavell et al., 2003; Hupp, LeBlanc, Jewell, & Warnes, 2009; Stump et al., 2009). In terms of common definitions of these two terms, social competence has been referred to generally as children's ability to thrive within their respective social environments (Stump et al., 2009). Another influential theory defined social competence broadly as "effectiveness in interaction" (Rose-Krasnor, 1997, p. 111) and also more specifically as children's ability to simultaneously meet their individual social or personal goals and sustain positive relationships across time and social contexts (Rubin and Rose-Krasnor, 1992). Social functioning has been defined as employing social skills to interact with others in day-to-day contexts (Tobin, Drager, & Richardson, 2014). A more comprehensive general definition states that social functioning is a multidimensional construct that refers to the overall performance of day-to-day activities that have an interpersonal component, such as employment, intimate relationships with others, and

recreational activities (Green, 1996; Yager & Ehmann, 2006). In terms of common themes among definitions, many definitions share an emphasis on the multidimensional nature of the construct as well as a focus on overall social performance across a variety of everyday contexts (Cavell et al., 2003; Green, 1996; Yager & Ehmann, 2006). Social competence is also viewed by many researchers as having multiple levels of complexity, including the level of the individual (e.g., a person's social skills and overall level of social adjustment) and the level of interactions with one or more conversation partners (e.g., typical performance of social skills when interacting with others in everyday contexts; Yeates et al., 2007)

In spite of similarities among definitions of the construct at the superordinate level, differences remain among theories in terms of the specific components that are included. Specifically, many definitions have some overlap, but often include a different assortment of components or hypothesize different relationships among their respective components. For example, Cavell (1990) reported a hierarchical model of social competence in which social skills are subsumed by social adjustment, which is in turn subsumed by social competence, the superordinate construct. A model proposed by Yeates et al. (2007) purports bidirectional relationships among three levels of social competence: social cognition, social interactions, and social adjustment. Other models of social functioning often include social cognition (Beauchamp & Anderson, 2010) and social skills (Beauchamp & Anderson, 2010; Gresham & Elliott, 1987) as components of social functioning, with each of those constructs including component variables as well, such as attention, executive functions, communication skills, adequate awareness and identification of emotions, and emotion regulation (Beauchamp & Anderson, 2010;

Halberstadt, Denham, & Dunsmore, 2001). Unfortunately, in spite of numerous published articles identifying features, measures, and correlates of social competence, a comprehensive and unifying theory of the construct has not yet emerged (Stump et al., 2009).

Stump et al. (2009) made a useful distinction between theories of social competence that are "top-down" and theories that are "bottom-up." The former describe theories that initially identify behaviours deemed to be socially competent--typically behaviors that are socially appealing, culturally valued, or morally principled--and studies subsequently investigate the common underlying roots of such behaviors (Stump et al., 2009). In contrast, the "bottom-up" approach focuses on the individual, the needs that drive an individual's behavior, and the way in which those needs are met through social means. That is, the "bottom-up" approach focuses on identifying the roots of the behavior determining social outcomes, and allows for multiple pathways to achieving social competence (Stump et al., 2009). Specific social strategies are conceptualized as a means to an end (i.e., meeting an individual need) as opposed to being the primary manifestation of social competence. For example, Stump et al. (2009) note that bottom-up theories begin with the individual and his or her innate needs and drives (e.g., social motivation, the need to be accepted by others; Maniaci, 2009); such theories are not nested within a moral framework (i.e., a behavior need not necessarily be virtuous or altruistic to be socially competent), and focus instead on whether the individual achieves his or her defined social goals that relate to meeting an innate need as one of the measures of outcome. While there are benefits and limitations to either approach, viewing social competence through a bottom-up approach lends to comparing similarities and

differences in component abilities among clinical groups that have been documented to have difficulties with aspects of social competence while taking into account organismic variables, such as motivation to interact with others. The bottom-up approach aligns more closely with the present study.

**Social adjustment.** Social adjustment has been defined somewhat differently depending on the theory that is referenced. Crick and Dodge (1994) conceptualize social adjustment as the extent to which children interact agreeably with peers, refrain from abrasive or incompetent social behaviour, and competently display adaptive social behavior. In contrast, Cavell (1990) defines social adjustment on a broader scale. Specifically, social adjustment is the extent to which children meet developmentally based societal and cultural expectations across various domains, including physical and mental health, academic achievement, legal status, employment status, familial status (e.g., composition and level of cohesion), social status (e.g., peer acceptance; number, quality, and type of relationships), and socioeconomic status. In Canada, for example, as well as many other areas in the world, there are general societal expectations that children will be physically and mentally healthy, will be achieving at grade level academically, will adhere to social and moral behavioral conventions, and will be accepted and cared for by their family and friends (Cavell, 1990). Yeates et al. (2007) argue that the construct can be approached from the individual's perspective or from the perspective of informants who are familiar with the individual (e.g., peers, parents, teachers; Parker, Rubin, Erath, Wojslawowicz, & Buskirk, 2006; Rubin, Bukowski, & Parker, 2006). There may be a discrepancy between self-evaluations and informant evaluations of social adjustment, with the former tending to rate adjustment more positively in populations of

children with low self-awareness, such as children who have had a traumatic brain injury (Prigatano, 1991; Prigatano, Altman, & O'Brien, 1990) or children with ASD (Semrud-Clikeman, Walkowiak, Wilkinson, & Minne, 2010; Yeates et al., 2007). In light of the different definitions of social adjustment that have been offered in the literature, Cavell's (1990) definition will be emphasized in the present investigation due to its compatibility with the social outcomes construct, which is reviewed next, as well as this definition's place within a well-described theory of social competence that includes several other relevant constructs defined in this section.

In terms of the relationships between social adjustment and other constructs in the social cognitive neuroscience literature, a considerable body of research has found that social adjustment, social information processing, social performance, and social competence are interrelated (Cavell, 1990; Parker et al., 2006; Rubin et al., 2006; Yeates et al., 2007). In particular, status in many of the domains included under the umbrella of social adjustment is viewed as a product or component of social competence (e.g., Cavell, 1990; Crick & Dodge, 1994). The theory proposed by Cavell (1990) is a useful conceptualization of social adjustment because it clearly outlines a hypothesized and testable hierarchical structure of several related constructs, including social competence, social adjustment, social performance, and social skills, respectively. Furthermore, this theory's definition of social adjustment, with its emphasis on mental health, lends itself to measurement using broad-band behavioral inventories. Such inventories are capable of detecting and quantifying overall behavior patterns and symptoms, such as those consistent with internalizing or externalizing symptomatology (Lachar, 1990).

**Social outcomes.** In the context of psychological research, an outcome is a key variable or dimension that is chosen to represent an aspect of natural recovery from, or the effects of an intervention on, an illness, psychological disorder, or injury (Malec, 2011). Measuring an outcome involves the evaluation of abilities or functions that are relevant to the chosen key dimension (Malec, 2011). In the case of research investigating social outcomes in developmental disabilities, outcome variables have included integration in personal and community life; acquisition and generalization of social, practical, or academic skills across environments; the social impact of an intervention on children and their families such as meaningful changes in personal, family, or school settings (e.g., acquiring new social relationships, increased community participation, or decreased stress in the family; Tsatsanis, Foley, & Donehower, 2004); and, more generally, the degree of success children have in performing social roles and participating in society (Priebe, 2007). The term has also been used synonymously with long-term psychosocial adjustment (Yeates & Selman, 1989). When social outcomes are conceptualized in terms of social adjustment, they are subsequently amenable to measurement over time with standardized behavioral inventories that assess social adjustment (Tsatsanis et al., 2004). Yeates et al. (2007) argued that a comprehensive investigation of social outcomes should include evaluation at the level of the individual (i.e., social skills and social adjustment) as well as at the level of dyads and groups (i.e., performance of an individual during social interactions).

**Adaptive behavior**. Adaptive behavior is a multidimensional construct that includes some components that overlap with social functioning (American Association on Intellectual and Developmental Disabilities, 2010). The definition of adaptive behavior,

which has also been referred to as adaptive skills or adaptive functioning interchangeably in the research literature, has historically been surrounded by some contention among researchers and has evolved over time (Kamphaus, 2003). Recent conceptualizations of adaptive behavior define this construct as the extent to which individuals meet societally determined standards of personal independence and social role fulfillment relative to peers with a similar sociocultural background (APA, 2013; Grossman, 1983; Tassé et al., 2012). The general consensus that has emerged from the research literature is that adaptive behavior is developmental in nature, increases in complexity over time; is situated within an individual's cultural context; and focuses on typical performance of skills and behaviors in one's everyday routines and environment as opposed to optimal performance under ideal conditions (Kamphaus, 2003; Tassé et al., 2012).

Although historically some researchers have argued that adaptive behavior is a unidimensional construct (e.g., Bruininks, McGrew, & Maruyama, 1988), adaptive behavior is currently widely considered to be a multidimensional construct based on the findings compiled from a large body of factor analytic research (Tassé et al., 2012; Widaman, Borthwick-Duffy, & Little, 1991). In spite of some disagreement among researchers regarding the structure of the components of adaptive behavior (Arias, Verdugo, Navas, & Gómez, 2013) as well as its relationship to other constructs in the social cognitive neuroscience literature, it is generally agreed that adaptive behavior includes three components: conceptual, practical, and social skills (Harrison & Oakland, 2003; Widaman et al., 1991; Widaman & McGrew, 1996). Conceptual skills include cognitive functions such as academic abilities, memory, application of practical knowledge, navigation of unfamiliar situations, and problem resolution (AAIDD, 2010;

APA, 2013). Practical skills include managing money and time, managing basic self-care activities, maintaining one's health and safety, using technology (e.g., phones or computers), traveling or using public transportation, engaging in recreational activities, and developing and adhering to a schedule (AAIDD, 2010; APA, 2013). Social skills include empathy, self-esteem, adherence to legal rules and regulations, avoidance of victimization, management of social conflict, interpersonal communication skills, and judgment in interpersonal situations, among others (AAIDD, 2010; APA, 2013). Although fine and gross motor skills were included as a dimension of adaptive behavior at one time (i.e., DeStefano & Thompson, 1990; Rourke, Fisk & Strang, 1986), motor skills are now commonly regarded as directly related to physical development and as more appropriately assessed separately from adaptive behavior (Luckasson et al., 2002; Schalock et al., 2010). The three main components of adaptive behavior have been identified and replicated in populations of typically developing children as well as children with an intellectual disability (Arias et al., 2013).

In terms of the history of the construct and the theory from which it was drawn, adaptive behavior has been discussed primarily in the context of the intellectual disabilities literature (Harrison & Oakland, 2003). However, over the course of time it has been shown that the evaluation of adaptive behavior is also important in the assessment of children with other psychological and physical disorders, such as ASD (Bölte & Poustka, 2002; Fisch, Simensen, & Schroer, 2002; Harrison & Oakland, 2003), developmental delay (Harrison & Oakland, 2003), specific learning disabilities (Ditterline, Banner, Oakland, & Becton, 2008; Oakland & Harrison, 2008; Harrison & Oakland, 2003), attention-deficit/hyperactivity disorder (Sikora, Vora, Coury, &

Rosenberg, 2012), traumatic brain injury (Andrews, Rose, & Johnson, 1998; Max et al., 1998), as well as hearing and visual impairments (Harrison & Oakland, 2003; Metsiou, Papadopoulos, & Agaliotis, 2011). The groups most often studied include children who have an intellectual disability, an ASD, or children with both of these disorders (Damberga et al., 2014).

An area in which clarification is needed is identifying the relationship between the constructs of social competence and adaptive behavior. Initially the term social competence was used to identify the adaptive behavior construct (DeStefano & Thompson, 1990). However, this practice declined long ago as research refined the definition and conceptualization of adaptive behavior (Kamphaus, 2003). More recently, some researchers purport that social competence subsumes adaptive behavior (e.g., Gresham & Elliott, 1987), while others categorize social competence under the umbrella of adaptive behavior (Cavell et al., 2003; Widaman et al., 1991; Widaman & McGrew, 1996). Furthermore, the adaptive behavior construct has been criticized for the lack of definitional clarity in the research literature (Harrison & Boan, 2004). Other researchers criticize the factor analytic method of identifying the scope and content of the adaptive behaviour construct, arguing that this method provides no way of determining whether potentially important dimensions of this construct have been overlooked (Reschly, Myers, & Hartel, 2002). There are also bottom-up theories of social competence, namely self-determination theory (Deci & Ryan, 2000), which is a theory of adaptive behavior, but has been argued to applicable as a theory of social competence as well (Stump et al., 2009). Furthermore, adaptive behavior is a skills-based definition, while social competence includes additional dimensions, such as outcomes or products of social

functioning. Overall, it appears that there is at least some overlap between social competence and adaptive behavior, particularly with regard to social skills, a widely recognized component of both (Jewell, Grippi, Hupp, & Krohn, 2007), but that there may be separable dimensions as well, such as certain adaptive behaviours that may not necessarily involve social interaction (e.g., meal preparation or some other daily living skills). Further scholarly work is needed to sort out the complex relationship between adaptive functioning and social competence, including whether one construct subsumes the other, or whether there are distinct areas or areas of overlap between the two.

**Social skills.** Social skills are multiple cognitive and behavioral abilities that include detecting socially-relevant cues and information, interpreting these accurately, formulating appropriate and strategic responses based on that information and the present context, and adeptly executing a planned response in a way that maximizes the chance of achieving one's social goals and maintaining positive social relationships with others (Bedell & Lennox, 1997). The social skills construct is a component of many theories of social competence (e.g., Beauchamp & Anderson, 2010; Cavell, 1990; Rose-Krasnor & Denham, 2009; Yager & Ehmann, 2006; Yeates et al., 2007) and has been reported by various authors to include an array of abilities.

In terms of the components of this construct, different theories include somewhat different components. Yager & Ehmann (2006) conceptualize social skills as forming a hierarchy that ranges from basic skills that are discrete and observable (e.g., prosody or eye contact) to complex skills that integrate multiple lower level skills (e.g., initiating an interaction, providing support to others, dealing with interpersonal conflicts). Social cognition is subsumed by social skills implicitly or explicitly in many theories of social

functioning (e.g., Beauchamp & Anderson, 2010; Cavell, 1990; Crick & Dodge, 1994; Rose-Krasnor & Denham, 2009; Yager & Ehmann, 2006; Yeates et al., 2007).

Pragmatic communication has been defined as a collection of complex social skills that involve social cognitive components (e.g., identifying or planning social goals in a given situation), linguistic components (e.g., word selection), supralinguistic components (e.g., knowledge of tacit rules that govern conversation in a given culture, such as appropriate ways to initiate, maintain, and end a social interaction, and nonverbal behaviors, such as body language, distance between speakers, tone of voice, and facial expressions), and contextual components (i.e., calibrating language and nonverbal behaviors to the current conversation partner and situation, such as using formal language in a formal setting with conversation partners who are of a high status; Ciccia, 2011). Pragmatic aspects of communication have been described as an organizational framework people use to plan and execute verbal and nonverbal behaviors that maximize the probability of them achieving their social goals in a particular situation (Ciccia, 2011).

Social emotional reciprocity is also a complex social skill that has implications for social competence as well as the formation and closeness of relationships (Feldman, Bamberger & Kanat-Maymon, 2013). Social emotional reciprocity has been defined as the ability to initiate and sustain social interaction by engaging in emotionally appropriate taking of turns when sharing thoughts and feelings with others (APA, 2013; Constantino & Todd, 2000). Appropriate social emotional reciprocity facilitates the smooth navigation of social interactions and relationships, and has been described as a hallmark of social competence (Feldman et al., 2013).

Most theories of social competence have purported that social skills are a necessary, but not a sufficient determinant of social competence (e.g., Cavell, 1990; Gresham & Elliott, 1987; Lemerise & Arsenio, 2000; Rose-Krasnor & Denham, 2009). Many theorists differentiate between children's social skill capabilities and their typical level of performance. A number of other factors that influence the expression of social skills have been identified, including motivational factors (Gresham & Cavell, 1986; Gresham & Elliott, 1984; Chevallier, Molesworth & Happe, 2012); affective factors, such as emotion regulation (Lemerise & Arsenio, 2000); situational factors (Cavell, 1990); and developmental factors, such as self-efficacy (Rose-Krasnor & Denham, 2009), as well as the impact of early relationships on shaping children's emotional development (Cavell, 1990). In short, social skills form the foundation of many theories of social competence, but it is generally agreed among researchers that other factors and constructs are important and contribute to the expression of social skills and social competence.

**Social cognition.** Social cognition refers to aspects of higher order thinking that are critical to interpreting social cues and formulating appropriate responses and the brain systems that underlie them (Adolphs, 2002, 2003, 2006; Scourfield, Martin, Lewis, & McGuffin, 1999). Social cognition has been defined as a sequential process that involves perceiving socially relevant stimuli, processing of this information to generate possible responses, selecting and executing a response, and finally evaluating the effectiveness of that response in meeting their goals for the situation (Crick & Dodge, 1994; D'Zurilla & Goldfried, 1971; Lemerise & Arsenio 2000; Lipton & Nowicki, 2009; Wallace et al., 1980; Yager & Ehmann, 2006; Yeates et al., 2007). Social cognitive abilities are considered to be social skills (Beauchamp & Anderson, 2010).

There are a number of theories of social cognition, including the contextual social cognitive model (Lochman & Wells, 2002), the Social-Emotional Learning Framework (Lipton & Nowicki, 2009), Emotional Intelligence (Mayer & Salovey, 1997), and the Social Information Processing Model (Crick & Dodge, 1994). Crick and Dodge (1994) postulated a model of social cognition that has been influential (Ladd, 1999) and used as a foundation for several subsequent theories (e.g., Beauchamp & Anderson, 2010; Halberstadt, Denham, & Dunsmore, 2001). Crick and Dodge's (1994) theory includes six component cognitive processes that are involved in processing social information. These are encoding salient information, interpreting social cues and developing a mental representation of a given social interaction, establishing social goals, identifying possible responses, selecting an appropriate response, and finally carrying out the selected response (Crick & Dodge, 1994). This model integrates research data and insights from multiple fields, including developmental psychology, clinical psychology, and cognitive science (Crick & Dodge, 1994).

As with other social skills, it is widely recognized that a multitude of factors influence social cognition in any given situation, and that performance in a particular situation may be inadequate in spite of adequate social skills and knowledge (Cavell, 1990; Lemerise & Arsenio, 2000). For example, emotion regulation and executive abilities can impact social cognition (Dodge, Laird, Lochman, & Zelli, 2002; Guralnick, 1999; Lemerise & Arsenio, 2000), as can other cognitive, personality, or affective variables (Dodge et al., 2002).

**Social Motivation.** The terms social motivation, social interest, motivation to be socially accepted, and "belongingness motivation" (Maniaci, 2009, p. 165) have been

used interchangeably to refer to the same construct (Leary & Allen, 2011). Social motivation has been conceptualized as rooted in an innate human drive which has been referred to by various terms, such as "the need to belong," "the need for belonging," and "the need for relatedness" (Maniaci, 2009, p. 165). This construct has been defined somewhat differently depending on the theory that is referenced. For example, social motivation has been defined as a desire for social interaction or affiliation (Leary & Allen, 2011), as the spontaneous self-driven initiation of social interaction (Kohls, Chevallier, Troiani, & Schultz, 2012), as well as the desire to develop and sustain at least a minimal number of social relationships that are significant and rewarding to the individual (Leary & Cox, 2008; Maniaci, 2009). Chevallier, Kohls, Troiani, Brodkin, and Schultz (2012) argue that adequate description of this construct requires explanations of social motivation that pertain to immediate and future goals of the individual, as well as the evolutionary pressures of natural selection that have been exerted on humans over time. That is, at the level of the individual, social motivation is a set of biological mechanisms and psychological biases that incline a person to prioritize socially relevant information, find social interaction rewarding , and maintain relationships (Chevallier, Kohls, et al., 2012). From an evolutionary standpoint, Chevallier, Kohls, et al. (2012) argue that those individuals who cooperated and collaborated with others to meet their survival needs tended to have a greater chance of surviving, of adapting to their environment, and of reproducing, making a cooperative orientation a desirable and adaptive trait that was shaped by selection pressures.

The study of the link between social motivation and reward processing in humans remains a relatively new area of research (Kohls et al., 2012). Although the components

of reward have been thoroughly investigated, there are few available theories that outline specific components of social motivation. Chevallier, Kohls, et al. (2012)'s Social Motivation Theory of Autism is one such theory, and it includes three components of social motivation that are behavioral manifestations of the construct. Specifically, social orienting, social reward, and social maintaining are included as the major components. Social orienting refers to noticing and prioritizing socially relevant information (Chevallier, Kohls, et al., 2012). Social reward refers to both the desire to spontaneously initiate social interaction as well as the enjoyment brought about by interacting with others (Chevallier, Kohls, et al., 2012). Social maintaining refers to the desire to maintain social relationships, as well as efforts taken to foster and maintain relationships (Chevallier, Kohls, et al., 2012).

The components of reward processing have been outlined in multiple theories. "Wanting" and "liking," although sometimes defined and labelled slightly differently, are two components of reward processing that have been included in several theories (Berridge, Robinson, & Aldridge, 2009; Chevallier, Kohls, et al., 2012; Schultz, 2006). Berridge et al. (2009) and Schultz (2006) also include "learning" as a component of reward processing, and Schultz (2006) included subcomponents of learning as well. Wanting refers to the incentive one has to seek and engage in social interaction in order to experience pleasure (Berridge et al., 2009; Chevallier, Kohls, et al., 2012). Liking refers to pleasure experienced as a result of social interaction (Berridge et al., 2009; Chevallier, Kohls, et al., 2012). Learning refers to associations that are developed between reward-related cues and pleasure that are used to predict what social stimuli will be wanted and liked in the future (Berridge et al., 2009; Schultz, 2006).

Theoretical approaches to social motivation are rooted in drive theories as well as theories of reward (Berridge et al., 2009; Leary & Cox, 2008). With regard to the former, social motivation is widely considered to stem from a fundamental human need to belong to one or more social groups (Axelrod & Hamilton, 1981; Buss, 1995; Leary & Allen, 2011, Maniaci, 2009). Psychological drives have been defined as organizing processes that incite purposive behavior (Gallistel, 1975; Hebb, 1949; Ikemoto, 2010). Although there are some variations in the definition of psychological needs between theories, there is general agreement that drives involve impulses to meet needs and that need satisfaction contributes to overall well-being. A potent emotional response may be invoked when needs are not met to draw the individual's attention and motivate them to meet the need. Failure to meet needs may lead to significant negative consequences for socio-emotional or health-related functioning (Maniaci, 2009). It is hypothesized that a disruption to the need to belong may explain the fundamental nature of autism spectrum disorders (Chevallier, Kohls, et al., 2012; Dawson, Carver, et al., 2002; Dawson, Webb, & McPartland, 2005; Grelotti, Gauthier, & Schultz, 2002; Waterhouse, Fein, & Modahl, 1996).

Theories of reward also inform conceptualizations of social motivation and complement drive theories. Specifically, Berridge et al. (2009) outlined evidence that the psychological experience of reward includes desire, enjoyment, and prediction or learning. Although reward has traditionally been studied in the context of some forms of psychopathology, such as addiction (Blum, Cull, Braverman, & Comings, 1996; Blum et al., 2000; Bowirrat & Oscar-Berman, 2005; Salamone, 2006), as well as in the context of animal learning theory (e.g., Pavlov, 1927; Schultz, 2006; Thorndike, 1911), this area has

recently grown to include investigations of the role of reward as it pertains to social motivation in children with autism spectrum disorder (Blum et al., 2000; Chevallier, Kohls, et al., 2012).

Now that many commonly used definitions have been outlined, the next section will discuss some of these constructs as they relate to social competence difficulties observed in children with the disorders under investigation.

## Nonverbal Learning Disorder

In this section, definitions of learning disorders in general and NLD will be described. The evidence supporting the validity of NLD will be introduced and will be revisited throughout the various components of this section. A brief outline of the history of NLD will be presented. A discussion of the main features of NLD as outlined in the most comprehensive model of the disorder that is currently available (e.g., Rourke, 1989) and updates to this model (e.g., Casey, 2012) will follow. Subsequently, NLD's current representation in diagnostic systems will be described, as will information pertaining to its descriptive epidemiology. This section will close with a review of the literature that investigates the social adjustment difficulties, adaptive behavior difficulties, and pragmatic language difficulties that are associated with NLD.

**Defining learning disorders and NLD**. The term "learning disorder" has been defined in a number of ways and has been approached from a number of different perspectives, including formal diagnostic systems, such as the DSM-IV-TR (APA, 2000) and DSM-5 (APA, 2013), the field of education, the field of neuropsychology, advocates for special education, and the law (Tannock, 2013). There is currently no consensus regarding the definition (Lewandowski & Lovett, 2014; Tannock, 2013). Pennington

(2008) used the term "learning disorder" to refer to "any neurodevelopmental disorder that interferes with learning of academic and/or social skills" (p. 3). This use of the term is unique in that it includes social dimensions in the definition, whereas most other definitions do not explicitly include this or note that it is an associated feature of learning disorders. Additionally, Pennington (2008) used "learning disorders" as a broad term that subsumes learning disabilities, such as the specific learning disabilities listed in DSM-5 (APA, 2013), as well as other neurodevelopmental disorders, including ASD. A widely used definition offered by the Learning Disabilities Association of Ontario (2016) states that learning disorders involve impairments in cognitive processes involved in learning, including acquiring, remembering, comprehending, or organizing information, that lead to unexpectedly low academic performance in one or more areas, in the context of reasoning abilities that are within normative expectations. The cognitive processes are impaired due to a combination of one or more congenital, genetic, or biological variables. The skills most commonly affected include oral language, reading, written language, and mathematics. Furthermore, the Learning Disabilities Association of Ontario (2016) argues that achievement may be within expected levels, but that in order to diagnose a learning disorder there must be evidence that this level of achievement is sustained only with an atypically high level of effort and support which, if removed, would result in an unexpectedly low level of achievement. It is also noted that learning disabilities may result in social perception or social interaction difficulties.

There are three main approaches to identifying learning disorders (Fletcher, Francis, Morris, & Lyon, 2005; Lewandowski & Lovett, 2014). The low achievement approach involves identifying a learning disorder by first establishing a cutoff score

across areas assessed by standardized achievement tests, such as the 25th percentile (Siegel, 1992) or the 16th percentile (Dombrowski, Kamphaus, & Reynolds, 2004; Lewandowski & Lovett, 2014). Children who receive scores below the cutoff and do not have other factors significantly contributing to their low achievement, such as an intellectual disability or inadequate instruction, are then diagnosed with a learning disorder.

In contrast, the response to intervention approach is an indirect method of identifying learning disorders that is grounded in providing high quality instruction in research based curricula to all children. Children who are not meeting grade level expectations are initially identified through periodic testing of all students with measures based on the skills taught in the curriculum (Lewandowski & Lovett, 2014). Although there is variation among specific models of the response to intervention approach, all models emphasize that children who are not performing at grade level expectations on the periodic measures receive a more intense level of instruction and intervention. If children continue to not meet expectations with more intense instruction, individualized instruction and other accommodations may be implemented (Lewandowski & Lovett, 2014).

The third approach is the cognitive processing or intra-individual differences approach, which involves administering standardized psychological measures of cognition as a means of assessing the psychological processes that are the foundation of learning (Lewandowski & Lovett, 2014). This approach is an evolution of the IQ-achievement disparity model, which has been widely criticized on conceptual and statistical grounds (Fletcher, Lyon, Fuchs, & Barnes, 2007; Lovett & Gordon, 2005;

Sternberg & Grigorenko, 2002; Stuebing et al., 2002). Profiles of scores on cognitive measures are analyzed. If areas of weakness correlate with areas in which the child is not achieving at the expected level on standardized achievement tests and school work, while other cognitive skills are within normative expectations, this is evidence in support of a learning disorder (Lewandowski & Lovett, 2014). Harrison's (2005) approach to learning disorder identification emphasized the necessity of establishing a logical correspondence between identified weaknesses in cognitive processes that underlie learning to the demonstrated learning difficulties.

A neuropsychological approach to learning disorders dovetails with the cognitive processing approach (D'Amato, Crepeau-Hobson, Huang, & Geil, 2005; Lewandowski & Lovett, 2014) in that it emphasizes the need for a comprehensive assessment of relevant cognitive abilities that underlie learning (Pennington, 2008). Furthermore, the neuropsychological approach is grounded in evidence that there are multiple cognitive impairments associated with all learning disorders (Pennington, 2008) and that these impairments are related to the learning difficulties observed by teachers, caregivers, and peers (Pennington, 2008). There is evidence that structural and functional differences in the brains of children who have learning disorders compared with typically developing children are associated with cognitive impairments that can be detected with neuropsychological tests (Pennington, 2008).

Just as approaches to identifying learning disorders are heterogeneous in nature, so are learning disorders themselves. Research on learning disorders supports that they are comprised of different subgroups or subtypes (Fletcher, Lyon, Fuchs, & Barnes, 2007; Little, 1993), with NLD comprising one of those subtypes (Fisk & Rourke, 1983;

Johnson & Myklebust, 1967). NLD has also been referred to as nonverbal learning disability (Rouke, 1988, 1989), right-hemisphere learning disability (Pennington, 2008), as well as nonverbal perceptual-organizational-output disability (Strang & Rourke, 1985) at one time. Just as there is no consensus regarding the definition of learning disorders more generally, there is also currently no consensus regarding the definition of NLD, its diagnostic criteria, the procedures that should be followed to establish a diagnosis of NLD (e.g., Casey, 2012; Mammarella & Cornoldi, 2014; Pelletier, Ahmad, & Rourke 2001), or the impact it has on functioning in everyday contexts, including the classroom (Casey, 2012). Based on Casey's (2015) review of the history and current status of research investigating NLD, he summarized NLD as being defined by a neuropsychological and functional profile that includes impaired fine-motor functioning, visual perception, tactile perception, and speed of thinking, with average or better spelling, reading, auditory perceptual, expressive language, and basic writing abilities on standardized neuropsychological measures. Additionally, children with NLD tend to demonstrate higher standard scores on the VIQ of Wechsler intelligence scales than PIQ (Rourke, 1989) and to have difficulty with some executive functions, including nonverbal problem solving (Fisher, DeLuca, & Rourke, 1997). Some features associated with this profile include difficulty with procedural mathematics, difficulty with pragmatic language skills (Broitman & Davis, 2013; Rourke, 2000; Volden, 2004) and a proclivity towards internalized forms of psychopathology (Rourke, 2000). This profile of neuropsychological strengths and weaknesses has often been hypothesized to be linked with dysfunction of the right hemisphere (e.g., Johnson & Myklebust, 1967; Rourke, 1989), and with dysfunction of the white matter in particular (Rourke, 1989, 1995).

Given the profile of strengths and weaknesses associated with NLD and its definition at one point as a neuropsychological disorder (Rourke, 1989), the neuropsychological approach is particularly suited to investigations of NLD. One of the major advantages in adopting the neuropsychological approach to identifying learning disorders over approaches that emphasize low achievement or a discrepancy between achievement and ability in one or more academic areas (Fletcher et al., 2005) when investigating NLD is that cognitive impairments and functional difficulties in children's daily lives can be identified even in cases where performance in the subjects typically emphasized in school is not low. That is, the traditional school setting arguably places greater emphasis on cognitive functions typically associated primarily with the left hemisphere (Dowker, 2006; Gaddes & Edgell, 2010), such as reading, writing, and other language skills, as opposed to skills typically associated with right hemisphere functioning, such as visual-perceptual organizational skills and some mathematical skills (Dowker, 2006). With regard to the latter, mathematical skills do not neatly lateralize to one hemisphere, but rather tend to be associated with widespread activation in both hemispheres of the brain, particularly in the parietal lobes, in children (Kaufmann, Wood, Rubinstein, & Henik, 2011). Gaddes and Edgell (2010) argued that having a disorder that primarily impacts functions typically subserved by the right hemisphere, may not result in significant difficulties in the academic subjects studied in school, including mathematics. Indeed, NLD has been linked to low achievement in procedural mathematics in many cases, but not all persons with NLD have this difficulty (Forrest, 2004; Pennington, 1991; Rourke, 2000; Semrud-Clikeman & Hynd, 1990). Gaddes and

Edgell's (2010) assertion may help to explain some of the variability in mathematics performance among children with NLD.

**Validity of NLD**. For a disorder to be considered valid, a process of research must establish that the group of symptoms of a particular disorder co-occur consistently, form a theoretically meaningful entity, is associated with impairments that impact day-to-day functioning, and cannot be better explained or accounted for by another disorder that has already been validated (Pennington, 2008). Although some researchers are critical of the validity of NLD (e.g., Spreen, 2011), there is a body of literature that spans nearly 50 years investigating the defining characteristics, associated features, and validity of NLD. Pennington (2008) notes that there is considerably less empirical research investigating NLD compared with some other learning disorders, such as ASD, attention-deficit/hyperactivity disorder, and specific learning disorders with impairment in reading or mathematics. However, he notes that there is a sufficient research base to establish the provisional validity of NLD as research continues to be carried out to address some remaining research questions that are relevant to its validity (Pennington, 2008). The research that covers the brief history of NLD highlights that a considerable number of studies have found that the symptoms of NLD tend to cluster together and co-occur consistently. Those studies are supplemented by findings from research investigating other disorders that tend to present with NLD symptoms. For example, a profile of neuropsychological strengths and weaknesses similar to that found in NLD has been found in children with Turner syndrome, and difficulties with social adjustment or the social use of language (i.e., language pragmatics) have been found in fragile X syndrome (Pennington, 2008). In terms of symptoms forming a theoretically meaningful entity,

Rourke (1989) put forward the most comprehensive model of NLD that is currently available, which covers the profile of primary, secondary, and tertiary neuropsychological strengths and weaknesses that characterize the disorder, describes childhood outcomes of the disorder in academic and social arenas, and provides a potential explanation for some of the underlying causes of the disorder. Casey (2012), building on Rourke's (1989) model, summarized the areas of impairment in NLD and the functional impact of these impairments in children's day-to-day lives. This will be reviewed in the section that discusses the Rourke (1989) model and updates to this model. An area of ongoing investigation, and a question that undergirds the present study, is whether NLD is most appropriately conceptualized as a disorder in its own right, or whether the features of NLD can be better accounted for by existing disorders, such as ASD, social (pragmatic) communication disorder, or specific learning disorder with impairment in mathematics (Pennington, 2008). This question will be more thoroughly addressed in a subsequent section that discusses research investigating the differential diagnosis between NLD and HFA.

**Brief history of NLD**. The evolution of the description of NLD must be obtained through a review of the research literature. The developmental form of NLD was first identified by Johnson and Myklebust (1967) as a subtype of learning disorder. These authors adopted the view that learning disorders were rooted in brain dysfunction, and that for all people, learning was a process characterized by "hierarchies of experience" (Johnson & Myklebust, 1967, p. 32). The hierarchy consists of five levels: sensation, perception, imagery, symbolization, and conceptualization, respectively (Johnson & Myklebust, 1967). Johnson and Myklebust (1967) asserted that a nonverbal disorder of

learning was characterized by impairments in perception and imagery, meaning that children with NLD have difficulty bringing appropriate meaning to their sensory experiences and mentally manipulating sensory information they have perceived. They also purported that this extended to perceiving and interpreting social information. That is, children with NLD were reported to have difficulty with correctly interpreting other's affect and with understanding how others perceive them (Johnson & Myklebust, 1967). These authors also hypothesized that NLD was a disorder that involved primarily systems ordinarily thought to be subserved by the right hemisphere (Johnson & Myklebust, 1967).

Casey (2015) provided a summary of the early studies that investigated and established an empirical basis of the neuropsychological features of NLD. An early series of studies (e.g., Rourke, Dietrich, & Young, 1973; Rourke & Telegdy, 1971; Rourke, Young, & Flewelling, 1971) used neuropsychological measures to investigate similarities and differences among children with diverse learning difficulties. Children were divided into groups on the basis of their performance on the Wechsler Intelligence Scale for Children (Wechsler, 1949). Specifically, one group included children with a Verbal Intelligence Quotient (VIQ) at least ten standard scores points higher than their Performance Intelligence Quotient (PIQ), another group included children with the opposite pattern of standard score point differences between the VIQ and PIQ, and a third group included children who had a VIQ and a PIQ that were within four standard score points of each other. The findings from these studies supported the position that there are multiple subtypes of learning disorders. Furthermore, the findings indicated different patterns of performance across the three groups of children that corresponded with literature investigating the lateralization of functions in adults. Specifically, children who

demonstrated higher VIQ compared with PIQ tended to perform better than the group with the opposite VIQ and PIQ discrepancy on measures typically considered to tap left hemisphere functions, including significantly higher scores on rote verbal, reading, spelling, and auditory-perceptual tasks. Children with superior PIQ compared with VIQ tended to demonstrate the opposite pattern in that they scored significantly higher on measures typically considered to tap right hemisphere functions, including measures of visual-perceptual and arithmetic abilities.

As summarized by Casey (2015), later studies further supported the hypotheses that children selected into groups based on performance on neuropsychological measures tended to perform in ways that corresponded with the predicted VIQ-PIQ discrepancy and pattern of hemispheric dysfunction (e.g., Rourke & Finlayson, 1978; Rourke & Strang, 1978; Strang & Rourke, 1983). For example, children with impairments in reading and spelling in the context of at least average performance on arithmetic tasks tended to have a VIQ-PIQ discrepancy that favored the PIQ, a pattern that fits with left hemisphere dysfunction. In contrast, children with impairments in arithmetic in the context of at least average performance on reading and spelling tasks tended to have a VIQ-PIQ discrepancy that favored the VIQ, a pattern that fits with right hemisphere dysfunction.

Subsequent studies further investigated and found support for the features that were reported to be characteristic of NLD, including the studies carried out by Harnadek and Rourke (1994) and Pelletier et al. (2001). Many researchers within and outside of Rourke's research laboratory have consistently identified a relationship between learning disorder subtype and neuropsychological profile (Rourke, 1993a, 2000), with children

who have low arithmetic scores but average reading and spelling scores tending to have a neuropsychological profile characterized by weaknesses in tactile perception, visual-spatial organization and processing, and executive functions related to managing unfamiliar situations (Rourke, 2000). Additional evidence accumulated for the reliability and external validity of the two subtypes of learning disorders characterized by the aforementioned achievement profiles based on functional neuroimaging evidence of lateralized differences in event-related potentials that fit the predicted pattern across the groups (Dool, Stelmack, & Rourke, 1993; Mattson, Sheer, & Fletcher, 1992; Njiokiktjien, Rijke, & Jonkman, 2001).

**Theoretical models of NLD.** Rourke (1989, 1995) developed a theory of NLD that today represents the most comprehensive and integrated explanation of the neuroanatomical, clinical, and diagnostic features of the disorder. At its foundation, Rourke's theory has a hierarchy of cognitive abilities in which impairments in the primary neuropsychological functions give rise to the secondary and tertiary neuropsychological impairments, as well as the functional outcomes in conceptual, social, and practical domains, including adaptive functions and psychosocial adjustment (see Figure 1; Rourke, 1995). As a manifestation of the cognitive strengths and weaknesses identified in the primary, secondary, and tertiary levels of the model, NLD has been associated with a discrepancy between verbal and performance composites on Wechsler tests of intelligence of 10 or more standard score points, in which the performance composite is lower (Pelletier et al., 2001; Stein, Klin, & Miller, 2004).

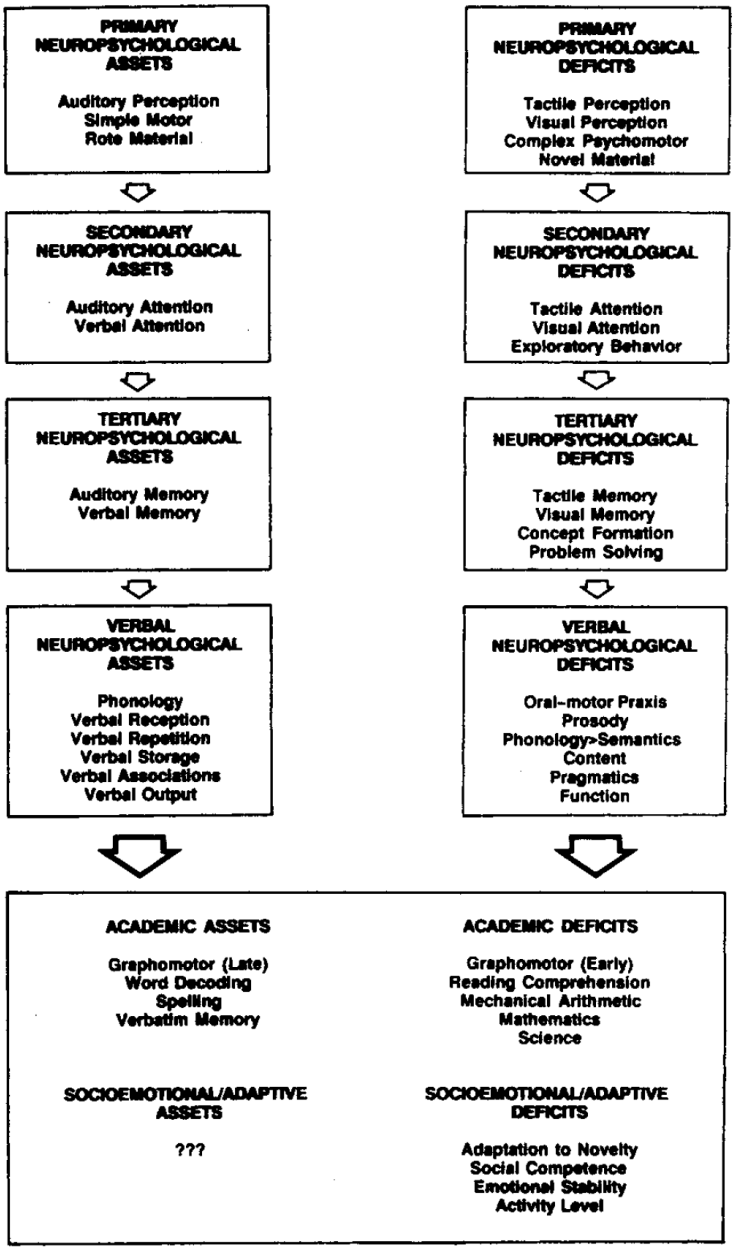


*Figure 1*. Summary of the neuropsychological strengths and weaknesses in NLD. From Rourke (2000). Reprinted with permission.

In early formulations of the model, Rourke (1982) noted that the pattern of neuropsychological impairments was consistent with functions typically thought to be subserved by the right hemisphere and, as such, he attributed NLD to dysfunction in this hemisphere. Building on the research evidence reviewed by Goldberg and Costa (1981),

Rourke (1989, 1995) proposed that dysfunction at the level of the cerebral white matter is the primary neuroanatomical basis of NLD. Specifically, Rourke (1987) identified patterns of neuropsychological impairments that were similar to those found in NLD in children with various other types of neurological disorders, such as uncomplicated callosal agenesis (Smith & Rourke, 1995), moderate to severe traumatic brain injury (Ewing-Cobbs, Fletcher, & Levin, 1995), and metachromatic leukodystrophy (Dool, Fuerst, & Rourke, 1995), among others. Rourke (1995) identified white matter dysfunction or pathology as a common underlying factor among these neurological disorders. Since there is proportionally more white matter in the right hemisphere compared with the left, Rourke (1995) hypothesized that the functions most affected would be those predominantly governed by the right hemisphere. In sum, Rourke et al. (2002) hypothesized that any condition that significantly impacted the development, functioning, or integrity of the subcortical white matter would result in cognitive weaknesses that would be consistent with the NLD profile.

There have been relatively few empirical neuroimaging studies that directly investigated Rourke's hypothesis regarding the brain mechanisms that underlie the symptoms of NLD (Pennington, 2008). Some support for white matter anomalies in NLD was provided by Fine, Musielak, & Semrud-Clikeman, (2014). These authors used magnetic resonance imaging to compare the volume of brain structures of children between the ages of 8 and 18 who met criteria for ADHD or NLD, or who were developing typically. They found that although children with NLD did not differ significantly from other experimental groups in terms of overall volume of the corpus callosum, the largest white matter structure in the brain, children in the NLD group

demonstrated the smallest volume in the splenium, the posterior segment of the corpus callosum, compared to all other groups. Partly due to the ongoing need to further validate the white matter hypothesis, the definition of NLD has evolved to focus on functional dimensions (Casey, 2012).

Casey (2012) refined Rourke's (1995) model by outlining the intact neuropsychological abilities and impairments of children with NLD and defining them in terms of domains of functioning while using standardized terms and retaining the hierarchy of cognitive abilities. As summarized by Casey (2012), the primary functional assets of children with NLD (i.e., ability to carry out tasks at a level that is on par with typically developing same-aged peers) include adequate sensation in the visual, auditory, and tactile modalities. Children with NLD also have intact basic gross motor skills, such as being able to ride a bicycle, as well as intact ability to retrieve verbal information that they have learned verbatim. At the secondary level, they have adequate auditory attention. At the tertiary level, their ability to encode auditory information is within normative expectations. They have adequate knowledge of sound-symbol relationships and phonological awareness. In terms of neuropsychological abilities that require an integration of the primary, secondary, and tertiary abilities, all aspects of memory for verbal information, including attention, encoding, repetition, and retrieval, are intact. As an extension of an integration of these abilities, these children tend to have adequate basic language, including receptive and expressive language, vocabulary, and knowledge of general information. Academically, word reading and spelling are at a level that is on par or nearly on par with typically developing peers.

The impairments of children with NLD have also been summarized in the refined model of NLD (Casey, 2012). As reported by Casey (2012), primary impairments in comparison to peers include weak (i.e., normatively below average) complex fine motor skills, and perception of visual-spatial, auditory, and tactile information. Typically, the fine motor skills and tactile perception are weaker in the left hand. Children with NLD also have difficulty adapting to novel situations, such as social interactions or situations that involve rapid change. Secondary neuropsychological impairments include attention to visual and tactile information. At the level of tertiary impairments, nonverbal problem-solving skills and concept formation are significantly weaker than those of same-aged typically developing peers. Similarly, memory for tactile and visual information represent tertiary impairments. In terms of impact to academics, higher order aspects of written and oral language, such as making inferences or abstract verbal reasoning are also normatively below average. Additionally, children with NLD are characterized by weak arithmetic skills and ability to reason using mathematical concepts.

Due to the cumulative impact of the primary, secondary and tertiary impairments on functioning, children with NLD tend to have difficulty with psychosocial adjustment and social competence (Casey, 2012; Rourke, 1995). With regard to the former, children with NLD are prone to internalizing psychopathology, including depression and anxiety (Rourke & Tsatsanis, 2000), and this is thought to be related to impairments in social perception and judgment (Strang & Rourke, 1985). In terms of social competence, the pragmatic aspects of communication tend to be weak in this population (Volden, 2004). Specifically, prosody may be monotonous or otherwise inappropriate (Klin, Volkmar, Sparrow, Cicchetti, & Rourke, 1995). Children with NLD also tend to have trouble

engaging in conversation while monitoring their own speech to maintain a topic that is of mutual interest to the speaker and the conversation partner. As a means of coping with social demands and anxiety, children with NLD tend to overuse certain verbal expressions (which may at times be inappropriate), to use tangential speech, and to speak candidly without considering the effect their words have on others. For example, they may make rude remarks and then not understand why others are upset.

Research has noted that not all of the symptoms described in Rourke (1989, 1995) and Casey's (2012) model may be present in a child with NLD (Pelletier, Ahmad, & Rourke, 2001). For example, Pelletier et al. (2001) noted that there was a VIQ-PIQ discrepancy that favored the VIQ on the WISC or WISC-R for only 41.4% of the NLD sample of 77 children, and that 89.7% of the NLD sample obtained a score on the Target Test, a measure that involves visual-spatial perception and immediate memory for visual information, that was one standard deviation or more below the normative mean. With respect to mathematics abilities, children with NLD commonly show weaknesses in this area, but not in all cases (Drummond, Ahmad, & Rourke, 2005; Pennington, 1991; Semrud-Clikeman & Hynd, 1990). Rourke (2000) reported that 72% of children with NLD had mechanical math difficulties. Furthermore, it is still debated whether or not psychosocial adjustment and social competence difficulties are critical to establishing the diagnosis of NLD (Ris & Nortz, 2008). The body of research investigating aspects of social competence in children with NLD is significantly smaller and less well-developed than the body of research that investigates the neuropsychological characteristics of NLD. As a result, the prevalence of limitations in social functioning and social competence among children with NLD is not well established and it is unclear at present as to whether

limitations in these areas should constitute a diagnostic criterion for NLD. Of note, the DSM-5 (APA, 2013) often requires that a minimum number symptoms in particular areas or in total must be present in order to diagnose certain disorders; it is not typically required that all of the listed symptoms be present in order for a diagnosis to be rendered. As such, it is possible that limitations in social competence may be best conceptualized as a diagnostic criterion that does not always need to be present to diagnose NLD.

Another relevant diagnostic issue is that many tests have been revised since the classification rules were published (Casey, 2012). It is not appropriate to use outdated tests to establish a diagnosis of NLD, or any other psychological disorder for that matter (Bush, 2010; Casey, 2012). However, it may also be problematic to use the updated version of the test and apply the rules that were established based on the previous versions, since the new tests may measure somewhat different underlying constructs (Casey, 2012). From a research standpoint, many sets of criteria have been used to define NLD. It is important to assess all neuropsychological domains that are relevant to NLD (Casey, 2012), and to choose criteria that have been shown to be useful in identifying NLD while also using tests that have not become obsolete.

**Representation of NLD in major diagnostic systems.** In spite of the vast literature that investigates NLD, this disorder does not have a unique diagnostic classification in current classification systems, such as the ICD-10 (World Health Organization, 2004) and the DSM-5 (APA, 2013). However, there are some general categories and codes in several systems that are not specific to NLD, but under which it may fit. For example, under DSM-IV-TR (APA, 2000), NLD could have been diagnosed under learning disorder not otherwise specified (Yalof, 2006). In contrast, there is no

subtype of specific learning disorder in the DSM-5 (APA, 2013) that covers the array of symptoms that characterize NLD, nor is there a general category for children who do not meet the full criteria for a listed subtype of specific learning disorder. In the ICD-10 (World Health Organization, 2004), NLD could be diagnosed under the unspecified developmental disorder of scholastic skills, a category that is akin to the DSM-IV-TR learning disorder not otherwise specified category.

**Descriptive Epidemiology**. Estimates of the prevalence of NLD have varied; arriving at a reliable estimate is likely complicated by the various approaches and sets of criteria that have been used to identify and diagnose NLD. Specifically, estimates have ranged from 1% of a clinical sample of children with learning disorders (Denckla, 1979 as cited in Pennington, 2008) to 5 to 10% of a clinical sample of children with learning disorders or ADHD (Rourke, 1989). Recent estimates suggest that the base rate of NLD is about 0.1% of the population (Forrest, 2004). Although these estimates vary, it is widely agreed that NLD is rare (Pennington, 2008). Additionally, there is approximately an equal ratio of males to females in the NLD population (Casey, 2015; Rourke, 1989).

**Social adjustment and adaptive behaviour in NLD**. Social adjustment has been studied more thoroughly in children with NLD than most other aspects of social competence. Findings pertaining to difficulties in this area for children with NLD have been mixed. Most studies have investigated children who are in late childhood or adolescence. Findings from a literature review will be reviewed first, followed by a review of several relevant studies found in a literature search for social adjustment in NLD. The studies are organized from those that included younger participants to those that included older children or adolescents in an attempt to observe trends in social

adjustment at different ages. Specifically, some authors have argued based on cross-sectional data that risk for adjustment difficulties, such as social withdrawal and depression, heightens as children with NLD move through adolescence (e.g., Casey et al., 1991; Ozonoff & Rogers, 2003; Rourke, 1989, 2000).

Little (1993) reviewed the literature from the period between 1983 and 1991 addressing reduced social competence in children with NLD. The focus was to compile and evaluate available empirical evidence from studies that addressed whether there is a reliable association between NLD and social adjustment difficulties, particularly internalizing difficulties, such as depression, anxiety, and social withdrawal. Based on the studies that were reviewed, Little (1993) noted that several of the studies provided some degree of support for the hypothesis that children with NLD are prone to social adjustment difficulties in comparison to typically developing peers who do not have a learning disorder as well as peers with other types of learning disorders. She highlighted that few of the reviewed studies had included a control group, a number of the studies had a small sample size, and some studies had a small sample size as well as no control group, making it somewhat difficult to compare the characteristics of social adjustment in NLD with typically developing children, and to generalize the results, respectively. There were diverse results regarding the extent to which children with learning disorders experience social dysfunction, and Little (1993) noted that most research studies did not separate children with learning disorders into subtypes, which may have contributed to the mixed nature of the results. It was also unclear from a number of studies as to whether social maladjustment was part of the initial referral concerns for the children with learning disorders, or if the social maladjustment developed subsequently to their initial

assessment. Another issue pertained to the reliance on parents' ratings of their children's behaviour to determine if and to what extent social maladjustment was present, particularly in the context of children with NLD. It was noted that teacher's ratings as well as direct observation, self-report inventories, and measures of acceptance by peers may provide a more comprehensive picture of the presence of social dysfunction in this group. Overall, some support was found by Ozols and Rourke (1985) and Loveland, Fletcher, and Bailey (1990) that there is an interaction between the type of learning disorder (i.e., the specific profile of cognitive strengths and weaknesses) and the ability to perceive types of verbal and nonverbal social cues. However, the relationship between the neuropsychological weaknesses and the numerous aspects of social functioning was far from being clarified. For example, it remained unclear whether specific learning disorder subtypes consistently correlate with specific types of social adjustment difficulties, such as internalized or externalized difficulties.

Forrest (2004) investigated the presence of internalizing difficulties among children between the ages of 6 and 10 with NLD, with a language-based learning disorder, or without any known disorders (i.e., typically developing children). This study incorporated the Personality Inventory for Children (PIC; Wirt, Lachar, Klinedinst, & Seat, 1977) as a measure of internalizing difficulties, and it was specifically hypothesized that children with NLD would have more difficulties with depression, anxiety, withdrawal, and psychosis than children in either of the two other groups. Contrary to expectations, it was found that there were no significant differences among the three groups in terms of parents' report of depression, anxiety, or psychosis. It was also found that children with a language-based learning disorder were rated as more likely to be

withdrawn than children with NLD or typically developing children. Of note, this study had a sample of 33 participants in total. As such, this small sample may impact the generalizability of the results. Furthermore, the children included were younger than those included in most other studies investigating internalizing difficulties in NLD, and there is some evidence that social adjustment difficulties manifest to a greater extent in adolescence rather than childhood (Casey et al., 1991; Pelletier et al., 2001).

Casey et al. (1991) investigated the presence of socioemotional difficulties in children and adolescents with NLD, hypothesizing that internalized difficulties and externalized difficulties would increase with age. The PIC (Wirt et al., 1977) was used to measure internalizing and externalizing difficulties. A cross-sectional design and a longitudinal design were used to compare a younger and an older age group of children (6 children per group in the cross-sectional design and 3 children in the longitudinal design) with NLD with respect to their performance on the PIC. In the cross-sectional analysis, children included in the younger age group ranged in age from 7.8 to 9.1 years (with a mean age of 8.5 years), while children included in the older age group ranged in age from 9.6 to 14.4 years (with a mean age of 11.6 years). These authors found that the older children's mean scores were significantly elevated (i.e., T scores greater than or equal to 70) on the Adjustment, Intellectual Screening, Psychosis, Development, Depression, and Social Skills scales of the PIC. Only group means were reported in this study and the number of individual participants who had clinically significant elevations on the scales of the PIC was not reported. Unfortunately, the small sample size precluded the authors' ability to carry out statistical analysis on the longitudinal PIC data, and these

results were not reported. As noted by the authors, the small sample size may limit the generalizability of these results.

Petti, Voelker, Shore, and Hayman-Abello (2003) investigated social adjustment in a sample of 11 children with NLD, 11 children with a language-based learning disorder, and 11 psychiatric control children; participants were matched for age and gender, and were between the ages of 9 and 14. The Internalization/Somatic Symptoms composite of the PIC-R (Lachar, 1982) was used to compare the three groups. The average composite score for each of the three groups was within the clinically significant range and did not significantly differ from one another. The relative frequency of previously diagnosed internalizing, externalizing, and other disorders among participants in the three groups was also analyzed. Externalizing disorders were most prevalent in the language-based learning disorder group (9 of 11 participants). Internalizing disorders were more common among children with NLD (4 of 11 participants) than children with a language-based learning disorder (2 of 11 participants), although they were also common among psychiatric control participants (5 of 11 participants). Overall, these findings did support that children with NLD are prone to internalizing difficulties, but did not provide support for the notion that they are necessarily more prone to internalizing difficulties than children with a language-based learning disorder. As with most of the other studies reviewed, the generalizability of these findings was limited by the small sample size.

Galway and Metsala (2011) investigated the extent to which social problem solving abilities predicted social adjustment in a group of participants with NLD and a control group of participants with average school achievement, hypothesizing that low social problem solving abilities would predict social maladjustment. Social adjustment

was measured with Achenbach Teacher Report form and the parent report form of the Child Behavior Checklist (Achenbach & Rescorla, 2001); social problem solving abilities were measured with the Child and Adolescent Social Perception Measure (Magill-Evans, Koning, Cameron-Sadava, & Manyk, 1996), and the Social Problem Solving Measure (Galway & Metsala, 2011). The sample included 32 children between the ages of 9 and 15 (16 children in the NLD group and 16 in the control group). It was found that an overall composite score created from a principal components analysis across the social problem solving measures was significantly correlated with the Total Problems and the Social Problems composite scores of both the parent and the teacher rating forms in the predicted direction. Furthermore, the overall composite score of social problem solving abilities predicted social adjustment across the groups when visual social cue interpretation and nonverbal intelligence were partialled out. Mean scores were not reported for each group on the parent and teacher social adjustment rating forms, so the extent to which children in either group had clinical elevations in their social adjustment profiles was unclear.

Semrud-Clikeman, Walkowiak, Wilkinson, and Minne (2010) conducted a study that investigated social adjustment among children with a variety of clinical disorders, including children with NLD or Asperger's disorder, and among children who were typically developing. The study included participants between the ages of 9 and 16 years. Of note, inclusion criteria for the NLD group included social dysfunction (i.e., participants must have had a score that was at least one standard deviation below the mean of the normative sample on the Social Skills Rating Scale; Gresham & Elliott, 1990), and 20 out of 24 participants in the NLD group had a comorbid diagnosis of

ADHD. The BASC-2 was used as a measure of social adjustment. Each composite was compared among the NLD, Asperger's disorder, and control groups. There was a trend across most variables of the parent report form of the BASC-2 wherein the control group obtained scores within the average range (all Indexes and subscales), and the Asperger's Disorder group and NLD group had scores within the At-Risk range (Externalizing Index, Behavioral Symptoms Index, Adaptability Index, Depression subscale, Withdrawal subscale, and Social Skills subscale) that significantly differed from the control group. Average scores did not differ between the two clinical groups. On the Internalizing composite and the Anxiety subscale, all three groups had scores in the average range, with no significant differences among the three groups on the Anxiety subscale. On the teacher report form, a similar trend was not found. Although there were some significant differences between groups, these were less meaningful because it was found that all three groups had scores within the average range on the Externalizing composite, Internalizing composite, Behavioural Symptoms Index, Adaptability subscale, Anxiety subscale, Depression subscale, and Social Skills subscale. The one subscale that did not fit this pattern was the Withdrawal subscale, which was in the At-Risk range for the Asperger's disorder group, and the average range for the NLD and control groups. The Withdrawal subscale score was significantly higher in the Asperger's disorder group than the other two groups. On the self-report form of the BASC-2, again there were some significant differences in scores between the groups, but these were less meaningful because the average scores of the participants in all three groups were within the average range across all subscales. Overall the findings supported that children with NLD or Asperger's disorder were more likely to have social adjustment difficulties compared

with typically developing controls, although one group did not stand out as having greater adjustment difficulties than the other. Group data were reported, so it was unclear if a greater proportion of individuals in one of the clinical groups had particular areas of adjustment difficulty (e.g., internalizing versus externalizing symptoms).

Pelletier et al. (2001) examined social adjustment in children with a language-based learning disorder or NLD. They hypothesized that children with the language-based learning disorder would demonstrate a different social adjustment profile as measured by the PIC or the PIC-R than children with NLD, and that children with NLD would tend to have internalizing difficulties evident in their social adjustment profile. Additionally, it was predicted that children with NLD would tend to have more severe internalizing difficulties as they aged. Participants were assigned to one of seven prototypical profiles that have been found for the PIC and PIC-R in children with learning disorders (Rourke & Fuerst, 1991) based on their scores. Some children in both groups were assigned to all 7 prototypical profiles, with the Normal subtype being the most common in both groups (34.3% of the language-based learning disorder group and 30.1% of the NLD group). Between-group comparisons of the proportion of children assigned to each prototype found that the proportion of children assigned to the Internalized Psychopathology prototype was significantly greater in the NLD compared to the language-based learning disorder group.

Pelletier et al. (2001) then split each group into two age groups—children ages 9 to 12 and children ages 13 to 15. Participants in the language-based learning disorder group were significantly more likely to be assigned to the Somatic Concern profile prototype in the older age group. Also, as predicted, children in the NLD group were

significantly more likely to be assigned to the Internalized Psychopathology profile prototype in the older group. The findings were interpreted to provide strong support for the hypothesis that children with NLD tend to exhibit greater internalizing difficulties as they age from childhood into adolescence (Rourke, 1989, 1995; Rourke, Fisk & Strang, 1986), and that children with NLD are more likely than children with a language-based learning disorder to have adjustment difficulties in general. These findings were consistent with those of Casey et al. (1991) in that more older children with NLD tended to have internalizing difficulties than younger children with NLD.

Consistent with the findings reported by the review completed by Little (1993), these recent studies indicated diverse findings with respect to social adjustment of children with NLD. Several studies supported that children with NLD are prone to internalizing difficulties, but some also found that they may exhibit externalizing difficulties as well. The two studies that investigated adjustment difficulties at different ages used cross-sectional designs and had small sample sizes, but they supported that children with NLD were more prone to social adjustment difficulties as they aged. Some studies had a selection bias in that they included social functioning difficulties as one of the inclusion criteria. Social adjustment difficulties in children with NLD require further study to continue to investigate the extent to which they experience social adjustment difficulties and to clarify trends in social adjustment of children as they age.

**Pragmatic communication in NLD.** Some nonverbal aspects of pragmatic communication have been studied in NLD while other aspects of pragmatic communication have not been thoroughly investigated. Many anecdotal accounts from experienced clinicians have outlined difficulties that children with NLD as a group tend

to exhibit in this area, but relatively few empirical research articles have systematically studied pragmatic language difficulties in NLD.

Rourke and Tsatsanis (1996) reviewed the pragmatic difficulties that are common in children with NLD based on observation in clinical and research contexts. Similar to children with HFA, children with NLD also tend to have difficulty with nonverbal and verbal pragmatic skills. In the nonverbal domain, children with NLD tend to have difficulty with interpreting and integrating contextual cues appropriately in social interactions, such as facial expressions and gestures (e.g., Petti et al., 2003), as well as with appropriate prosody. They also have difficulty understanding anything beyond literal speech, including interpreting figurative forms of speech, appreciating irony and humour, and making inferences based on available information. In the verbal domain, children with NLD tend to have difficulty adhering to certain tacit rules of conversation. Their speech is marked by tangents as well as minimal organization, structure, and cohesion. Their speech has also been characterized as straightforward and repetitive, as well as having limited emotional prosody.

In terms of relevant studies, Ozols and Rourke (1985) investigated certain pragmatic skills in children with learning disorders, including a "spatial disorder" group that consisted of children who demonstrated neuropsychological strengths and weaknesses consistent with NLD, a "language disorder" group that consisted of children with significant difficulty with auditory-perceptual and language-related abilities, but intact visual-spatial abilities, and a control group of typically developing children with average achievement and no history of significant learning or emotional difficulties. There were seven children included in each group who ranged in age from eight to eleven

years. Among other things, this study investigated selection of appropriate nonverbal gestures and facial expressions in reaction to a story.

In terms of the results, there were several nonsignificant trends that were in the expected direction. For example, the control group tended to obtain higher scores across all measures compared to the other two groups; the language disorder group tended to score higher than the NLD group on tasks that required a nonverbal response; and the NLD group tended to score higher on tasks that required a verbal response. The means and standard deviations for each group on the experimental tasks were not reported by the authors, so it is unclear if the language disorder group or the spatial disorder group demonstrated normatively below average scores on one or more of the experimental tasks.

In addition to the statistical findings, several qualitative observations were noted regarding the demeanour and behaviour of the NLD group for the duration of their participation in the study. With regard to pragmatic communication, it was noted that participants in the NLD group rarely directed emotional expressions to the examiner. They also tended to have an unusual prosody in that their tone of voice was often monotonous with occasional use of an exaggerated tone of voice. Additionally, they tended to be less engaged in interactions with the examiner compared with children in the language disorder group. Specifically, children in the NLD group showed less variability in their emotional expressions and they smiled and laughed less often. Overall, they tended to exhibit stereotyped and restricted emotional responses. Interestingly, these are qualities that are often associated with ASD, although it was unclear based on the authors' descriptions if these qualities in children in the NLD group were mild or severe

in nature. One of the limitations of the study was the small sample size which hampered the generalizability of the findings and may have prevented some findings from being statistically significant.

## Autism Spectrum Disorder

In this section, ASD and HFA will be defined. Subsequently, an abbreviated outline of the history of ASD as it has been represented in the editions of the *Diagnostic and Statistical Manual of Mental Disorders* will be presented. ASD's current representation in diagnostic systems will be described as will information pertaining to ASD's descriptive epidemiology. This section will close with a review of the literature that investigates the social adjustment difficulties, adaptive behavior difficulties, and pragmatic language difficulties that may occur in children with HFA.

**Definition.** In contrast to the neuropsychological basis of the diagnosis of NLD, ASD is defined and diagnosed based on behavioural criteria. ASD is a neurodevelopmental disorder that is severe and pervasive. It is characterized by impairments in communication and social interaction, as well as behaviours that are restricted or repetitive in nature (Volkmar, 2011). As a group, children with ASD exhibit wide variation in their intellectual, language, and social abilities (Jewell et al., 2007). Although some children diagnosed with ASD are also diagnosed with an intellectual disability, others have intellectual abilities that are average or above average compared to peers (Klinger et al., 2014). The form of ASD without a comorbid intellectual impairment is often referred to as high functioning autism (Klinger et al., 2014; Pennington, 2008). The history of ASD is rooted in the scientific literature and has been codified in several versions of the *Diagnostic and Statistical Manual of Mental Disorders*.

**Brief history of ASD.** The term "autism" was coined by Bleuler (1911/1950) to describe a symptom of schizophrenia. Asperger (1944/1991) and Kanner (1943) first described symptoms associated with Asperger's disorder and autism, respectively. The accounts from both authors were written independently and included the term "autism" to highlight the low social awareness of the children they studied, who also had significant difficulties with peer relationships as well as restricted or repetitive behaviors or interests (McGrath & Peterson, 2009). Notable differences between the accounts of Kanner (1943) and Asperger (1944/1991) included more functional language skills, atypical specialized interests, and somewhat better social awareness in the group of children described by Asperger.

There have been a number of changes to the definition and diagnostic criteria of autism over time. The disorder first became formally codified in the third edition of the *Diagnostic and Statistical Manual of Mental Disorders* (APA, 1980), in which it was identified as infantile autism. It was categorized as a pervasive developmental disorder that involved three domains: limited or no responsiveness to others, impairment in communicative skills, and bizarre reactions to the immediate environment, all appearing before 30 months of age (Baker, 2013). The revised third edition of the *Diagnostic and Statistical Manual of Mental Disorders* (APA, 1987) had a more complex definition of autistic disorder in which the requirement for the onset of symptoms prior to 30 months of age was removed and children were required to meet 8 of 16 criteria across the domains of social interaction, communication, and restricted interests or behaviors. The subcategory of pervasive developmental disorder not otherwise specified was introduced to categorize children who did not meet the full criteria for autistic disorder. The DSM-

IV (APA, 1994) and the DSM-IV-TR (APA, 2000) further refined the diagnostic criteria for autistic disorder. Rett's disorder and Asperger's disorder were also added as new subcategories of the pervasive developmental disorders. Asperger's disorder was the label used to describe children who did not have an impairment in communication and did not have evidence of a significant developmental delay in cognitive, language, or adaptive functioning, but who otherwise met the criteria for autistic disorder in the domains of social interaction and stereotyped, restricted, and repetitive interests or behaviours (APA, 2000).

**Diagnostic features of ASD in DSM-5.** Over the course of the present study, the transition from DSM-IV-TR (APA, 2000) to DSM-5 (APA, 2013) occurred in the field of mental health. With the advent of DSM-5 (APA, 2013), the pervasive developmental disorders were restructured and consolidated under the category of ASD, with subcategories eliminated. This consolidation of PDD-NOS, autistic disorder, and Asperger's disorder under the ASD label was based on widespread research findings that these three categories generally differed in a quantitative way rather than a qualitative way in terms of symptom severity and level of intelligence (Meyer & Minshew, 2002), supporting that they are best conceptualized as points on a continuum or spectrum rather than discrete categories (McGrath & Peterson, 2009). For example, the Asperger's disorder diagnosis in DSM-IV-TR is generally considered to represent the milder end of the autism spectrum, given the criteria that adaptive, language, and cognitive development must be within the average range compared to peers (Kanne & Mazurek, 2011). Further support for the conceptualization of ASD as a continuum was provided by studies of first degree relatives of children with autism that indicated milder subclinical

symptoms of autism were common among these family members (McGrath & Peterson, 2009).

In addition to the consolidation of the categories of pervasive developmental disorders, the core domains of ASD were consolidated from three in DSM-IV-TR (APA, 2000) to two in DSM-5 (APA, 2013). Specifically, qualitative social interaction impairments and communication impairments were combined into one domain (i.e., social communication impairments) due to practical difficulties that clinicians often faced when attempting to separate symptoms into the former two core domains, as well as research supporting the dissociation between restricted and repetitive interests or behaviours and the former two core domains (Klinger et al., 2014). The present diagnostic criteria require impairments in social communication and social interaction which occur in multiple contexts and result in impairments in social or other areas of functioning (APA, 2013). These can include impairments in the spontaneous use of behaviours that are part of nonverbal communication to reduced or little interest in interacting with others (i.e., diminished or minimal social motivation; APA, 2013). Additionally, the symptoms must have been present early in life, and co-occurring intellectual impairment, language impairments, and genetic or medical conditions must be stated in the diagnostic formulation.

**Descriptive Epidemiology of ASD.** ASD is considered to be largely genetic, with evidence from twin studies in behaviour-genetic research indicating that the concordance rate of ASD is much higher in monozygotic twins than in dyzygotic twins and non-twin siblings (Graziano, 2002; Lichtenstein, Carlström, Råstam, Gillberg, & Anckarsäter, 2010). The prevalence of ASDs based on criteria from the DSM-5 is estimated to be

approximately 1.5% of the general population (Baio, 2014). About 40% of individuals diagnosed with ASD also meet the criteria for intellectual disability (i.e., about 60% of children diagnosed with ASD have the high functioning variant of the disorder; Rice, 2009). ASDs also occur more commonly in boys than girls, with a ratio of approximately four to one (Rice, 2009).

**Social adjustment in HFA.** Social adjustment has been studied more extensively in children across the continuum of ASD than it has in specific populations of children with HFA. Children with ASD often present with one or more secondary behavioural or emotional difficulties (Lecavalier, 2006), such as symptoms of anxiety and depression (MacNeil, Lopes, & Minnes, 2009). Furthermore, symptoms of anxiety occur in 11 to 84% of persons with ASD, depending on the study that is referenced (White, Oswald, Ollendick, & Scahill, 2009). Similarly, most studies that focus on children with HFA support that these children tend to struggle with social adjustment, and particularly with internalizing and externalizing difficulties. For example, some studies support that children with HFA may be particularly prone to symptoms of depression in comparison to children with ASD who are lower functioning (e.g., Kim, Szatmari, Bryson, Streiner, & Wilson, 2000; Weissman, Orvaschel, & Padian, 1980; Whitehouse, Durkin, Jacquet, & Ziatas, 2009). A fair number of studies have investigated children who are in late childhood or adolescence. Several relevant and recent studies found in a literature search for social adjustment in HFA are reviewed in the following section. The studies are organized from those that included younger participants to those that included older children or adolescents. Subsequently, studies investigating adaptive behavior and pragmatic language skills in HFA are also reviewed.

Volker et al. (2010) used the PRS of the BASC-2 to investigate the presence of internalizing, externalizing, and behavioural difficulties in a group of children with HFA and a group of typically developing children. Sixty-two participants between the ages of 6 and 16 years were included in each group. In this study, HFA was defined as children diagnosed with ASD who also did not have a language delay, had an IQ on the WISC-IV that was greater than a standard score of 70, and had a standard score on either the PRI or the VCI that was greater than 80. Results indicated that the HFA group obtained a mean profile on the PRS of the BASC-2 that included At-Risk elevations on the Attention Problems, Hyperactivity, and Depression subscales. Additionally, Clinically Significant elevations were found on the Behavioural Symptoms Index as well as the Withdrawal and Atypicality subscales. Scores on all three composites and all subscales that were elevated in the At-Risk or Clinically Significant ranges were significantly higher than those obtained by the control group. The average score on the Aggression subscale was also significantly higher than the control group, but this is less meaningful given that this score was within normative expectations.

Thomeer et al. (2012) conducted a study that investigated the impact of a five week psychosocial intervention for children with HFA. HFA was defined as meeting the diagnostic criteria for an ASD while not having an intellectual or language impairment, as measured by the WISC-IV (Wechsler, 2003) and the Comprehensive Assessment of Spoken Language (Carrow-Woolfolk, 1999), respectively. Thirty-five children between the ages of 7 and 12 with HFA were randomly assigned to participating in the intervention or to a waiting list; the results from the intervention are not germane to the topic at hand and are not reported here. All participants had caregivers or teachers

complete the BASC-2 PRS and TRS (Reynolds & Kamphaus, 2004), respectively, at the outset of the study as a measure of their baseline social adjustment. Due to the targeted nature of the intervention, not all subscales and composites of the TRS and PRS of the BASC-2 were reported by the authors. The children in both groups were found to exhibit Clinically Significant elevations on the Withdrawal subscale and At-Risk elevations on the Social Skills subscale of the BASC-2 PRS at baseline prior to participation in the intervention. The elevations remained the same for the waiting list group when the PRS was completed again 5 weeks later. Similarly, on the BASC-2 TRS, children who participated in the intervention exhibited Clinically Significant elevations on the Withdrawal and Social Skills subscales at baseline. The BASC-2 TRS was not completed for children in the waiting list group.

Mazzone et al. (2013) assessed 20 children with Asperger's disorder and 10 children with HFA between the ages of 7 and 16 years for the presence of depressive symptoms or mood disorders; they were compared to typically developing control participants and a clinical control group of children who had major depressive disorder. Multiple measures and multiple informants were incorporated into the study. The major findings included significantly higher self-reported ratings of depression from the HFA/AS group and clinical control group compared with the typically developing children. However, there was no significant difference in scores between the two clinical groups and all three groups were below the cutoff score for significant depressive symptoms. On a broad band measure of social adjustment (i.e., CBCL; Achenbach & Edelbrock, 1983), scores on the overall total score, internalizing composite, and externalizing composite were significantly higher in the clinical groups compared with

the control group. The two clinical groups did not significantly differ in their scores across these three composite scores; average scores for the HFA/AS group were in the clinically significant range for the internalizing composite, but not for the externalizing composite or overall total score. On a self-report measure of anxiety, two children in the HFA/AS group reported clinically significant levels of anxiety (i.e., a T score greater than 75). On average, the HFA/AS group obtained significantly higher scores on the self-report anxiety measure than the control group and the other clinical group, but scores for all three groups were in the average range overall. Overall, the findings provided some support that children with HFA tend to have significant internalizing difficulties.

Semrud-Clikeman, Walkowiak, Wilkinson, and Minne (2010) and Volker et al., (2010) conducted a study that investigated social adjustment among children with a variety of clinical disorders, including children with Asperger's disorder, and among children who were typically developing. These authors used the BASC-2 to assess 52 children with Asperger's disorder (27 of whom had a comorbid diagnosis of ADHD) and 113 typically developing control participants between the ages of 9 and 16. Only certain variables from the BASC-2 were reported. There was a trend across most variables of the parent report form of the BASC-2 wherein the control group obtained scores within the average range (all reported Indexes and subscales), and the Asperger's Disorder group had scores within the At-Risk range (Externalizing Index, Behavioral Symptoms Index, Adaptive Skills Index, Depression subscale, Withdrawal subscale, and Social Skills subscale) that were significantly higher than those of the control group. On the Internalizing composite and the Anxiety subscale, both groups had scores in the average range, with no significant differences among the two groups on the latter scale. On the

teacher report form, a similar trend was not found. Although there were some significant differences between groups, these were less meaningful because it was found that both groups had scores within the average range on all scales that were included in the study, with the exception of the Withdrawal subscale. The average score on the Withdrawal subscale was in the average range for the control group and was significantly lower than that of the Asperger's disorder group, which was in the At-Risk range. On the self-report form of the BASC-2, there were some significant differences in scores between the two groups, but these were less meaningful because the average scores of both groups were within the average range across all included subscales. Overall the findings supported that children with Asperger's disorder were more likely to have social adjustment difficulties compared with typically developing controls. Group data were reported, so it was unclear if a greater proportion of individuals in the Asperger's disorder group had particular areas of adjustment difficulty (e.g., internalizing versus externalizing symptoms).

**Adaptive behavior in HFA**. Children with ASD often demonstrate profiles of adaptive behavior that are characterized by marked difficulty with social skills and intermediate difficulty with communication, in the context of relative strengths in completing activities of daily living (Bölte & Poustka, 2002; Carter et al., 1998). Adaptive behavior profiles have been less extensively studied in children specifically with HFA (Klin et al., 2007). It has often been found that there is a disparity between overall intellectual ability and adaptive behavior in favor of the former. However, other studies have found positive associations between intellectual abilities and adaptive behavior (Freeman, Del'Homme, Guthrie, & Zhang, 1999; Liss et al., 2001; Schatz &

Hamden-Allen, 1995; Szatmari, Bryson, Boyle, Streiner, & Duku, 2003) and a clear pattern has not yet emerged.

DeVries, Bundy, and Gore (2013) investigated the profile of adaptive behavior obtained by 11 children diagnosed with Asperger's disorder between the ages of 4 and 21 on the adaptive scales of the PRS of the BASC-2. Data were also collected for children with autistic disorder and PDD-NOS, but information regarding their overall intellectual abilities was not provided. As such, the absence of a comorbid intellectual disability cannot be verified, so results for those participants are not reviewed here. One of the weaknesses of this study was that a control group was not included and data were not interpreted in light of clinical categories (e.g., At Risk, Clinically Significant) that were developed from the normative data. However, the means and standard deviations for scores on each subscale were reported and can be interpreted clinically. The findings indicated that on average, the children with Asperger's disorder obtained scores in the At-Risk range on the total adaptive score as well as the Social Skills, Leadership, and Communication subscales of the adaptive composite. The average score on the Adaptability and Activities of Daily Living subscales were in the Clinically Significant range. Data at the level of individuals who obtained scores in the various clinical and normative ranges were not reported.

Volker et al. (2010) also used the PRS of the BASC-2 to investigate the presence of adaptive difficulties in a group of children with HFA and a group of typically developing children. Sixty-two participants between the ages of 6 and 16 years were included in each group. Results indicated that the HFA group obtained a mean profile on the BASC-2 that included At-Risk elevations on the Adaptive Skills composite (including

all of the subscales that comprise the composite). Scores on the composite and its subscales were all significantly lower than those obtained by the control group, indicating greater dysfunction in the HFA group. Frequency data at the level of individuals who obtained scores in the clinical or normative ranges were not reported.

Klin et al. (2007) investigated adaptive behavior in children and adolescents between the ages of 7 and 18 who were high functioning (i.e., had a VIQ greater than a standard score of 70). Two samples, each from a different site, were included. One sample included 84 participants and the other included 103 participants. In both groups, scores on the Social, Daily Living, and Composite scores of the Vineland Adaptive Behaviour Scales (VABS; Sparrow, Balla, & Cicchetti, 1984) were at least 2 standard deviations below the normative mean. Furthermore, the scores on the Communication subscale were at least one and a half standard deviations below the mean VIQ for each group, and the discrepancy was even greater with regard to the other subscales of the VABS. It was also found based on a correlational analysis that when the sample from each site was split at the median age, Communication, Socialization, and Composite scores of the VABS were significantly and negatively correlated with age. This means children with HFA were not keeping pace with typically developing peers in these areas of adaptive behavior. No significant correlations were found between age and ADOS scores, indicating similar levels of communication and social symptoms characteristic of autism across age levels. In spite of some significant correlations between ADOS scores and VABS scales, there was no consistent pattern across the two groups, and the authors noted that the overall correlations were low (all were negative and less than .3),

suggesting weak relationships between social and communication symptoms of autism and adaptive behavior in day-to-day life (Klin et al., 2007).

**Pragmatic communication in HFA**. Pragmatic language difficulties are pervasive among children with ASD, including those with HFA (Asperger, 1944/1991; Kanner, 1943; Dewey & Everard, 1974; Tager-Flusberg, 1981; Volkmar et al., 1987; Baron-Cohen, 1988). Although some aspects of pragmatic communication have been investigated in ASD, and specifically in HFA, there have been relatively few studies overall that have systematically investigated pragmatic communication in this population (Landa, 2000).

Tager-Flusberg (1999) reviewed research that investigated pragmatic language difficulties in ASD. She concluded that there was considerable evidence that children with HFA have significant difficulties across verbal and nonverbal aspects of pragmatic language at all stages of development, although not all aspects of pragmatic language tend to be impaired in this population. With regard to the former, they are prone to not using appropriate pronouns when speaking, not properly interpreting figurative language, not appropriately taking context into account during social interaction, and not following tacit rules of conversation. For example, rather than taking turns with conversation partners, they tend to speak at length about their interests with little regard for the listener's interest in the topic. Furthermore, they tend to have significant difficulty adhering to and further developing a particular topic of conversation, instead often making comments that are unrelated or that do not add new information. Overall, they have significant difficulty initiating, maintaining, and ending social interaction in appropriate ways. In terms of nonverbal pragmatic weaknesses, children with HFA have

significant difficulty spontaneously using communicative gestures to accompany their speech. In spite of these difficulties, some aspects of pragmatic communication tend not to be impaired, including asking for items they want or for others to do certain behaviours.

In terms of specific investigations of aspects of pragmatic communication, Loukusa et al. (2007) investigated how well children with HFA were able to take context into account when responding to questions. The sample of children with HFA was divided into two groups based on age, and a control group of typically developing children was also included. Sixteen participants with HFA were between the ages of 7 and 9 years and 23 participants were between the ages of 10 and 12 years. The control group consisted of 23 participants who were between the ages of 7 and 9 years. In comparison to the control group, Children in both HFA groups demonstrated significantly greater difficulty using context to answer questions. Children in both HFA groups were also significantly less adept in comparison to the control group at providing explanations for correct answers when they gave them. These findings supported that children with HFA tend to have difficulty with incorporating relevant information from their immediate context into formulating answers to questions in the context of otherwise intact language abilities.

Similarly, Verté et al. (2006) investigated pragmatic communication using the parent and teacher versions of the CCC in 135 children with HFA, Asperger's disorder, or PDD-NOS and 47 typically developing children who were between the ages of 6 and 13 years. The scores on the scales assessing use of context in day-to-day communications, appropriate initiation, rapport developed during conversation,

coherence, use of stereotyped language, restricted or stereotyped interests, and social relationships on both the teacher and parent report version of the CCC were significantly higher in the control group compared to all three clinical groups, indicating greater dysfunction in the clinical groups.

**Social (Pragmatic) Communication Disorder**

Although not a main focus of the present investigation, social (pragmatic) communication disorder has recently been formally recognized by the DSM-5 (APA, 2013) as a neurodevelopmental disorder that has considerable overlap with ASD, particularly in the area of pragmatic communication. Its roots are in the speech and language academic literature, and this disorder is relevant to the discussion of differential diagnosis and symptoms overlap between HFA and NLD. The diagnostic criteria for social (pragmatic) communication disorder as outlined in the *Diagnostic and Statistical Manual of Mental Disorders* will be briefly described. Information pertaining to the descriptive epidemiology of social (pragmatic) communication disorder will be presented. This section will close with a summary of available evidence of social adjustment and pragmatic language difficulties that may occur in children with social (pragmatic) communication disorder.

Social (pragmatic) communication disorder is defined by four main criteria in the DSM-5 (APA, 2013). The first criterion is that a child must experience pragmatic communication difficulties, including difficulty with nonverbal aspects of communication, such as informational gestures, as well as verbal aspects of communication, such as initiating, maintaining, and ending a conversation in a manner that is appropriate to the situation. These difficulties must negatively impact functioning

in social relationships, scholastic achievement, occupational performance, or a combination of these areas. The symptoms must first manifest early in childhood development and not be better accounted for by another medical condition, ASD, an intellectual impairment, a global developmental delay, or another psychiatric disorder.

Swineford et al. (2014) notes that social (pragmatic) communication disorder is still under investigation and that contention among researchers and clinicians remains regarding the way in which this disorder fits with or overlaps with other neurodevelopmental disorders. Evidence supporting the inclusion of this disorder in the DSM-5 was provided by field trials that were completed before DSM-5 was published. These trials indicated that the fluctuation in the number of people meeting criteria for ASD was largely due to people from moving to the social (pragmatic) communication disorder category (Regier et al., 2013). Many aspects of social (pragmatic) communication disorder, including its relationship to other disorders, its validity, the course of this disorder, and its prognosis require further research (Swineford et al., 2014). There are currently no available peer reviewed studies that investigate the heritability of this disorder, although some studies have shown that difficulties with pragmatic communication tend to occur in family members of children with ASD (Ben-Yizhak et al., 2011; Whitehouse, Barry, & Bishop, 2007). Additionally, prevalence rates for semantic (pragmatic) communication disorder have not yet been reliably estimated. Much of the basis for semantic (pragmatic) communication disorder has come from findings pertaining to pragmatic language impairments in the speech and language literature (Swineford et al., 2014). Further research is required to clarify if there is perfect overlap between pragmatic language impairment and semantic (pragmatic) communication

disorder, as well as the ratio of males to females who meet criteria for the disorder (Swineford et al., 2014).

In terms of the associated social features of social (pragmatic) communication disorder, pragmatic difficulties have been found in one longitudinal study to have a negative impact on forming and maintaining close relationships, including friendships and romantic attachments in adulthood (Whitehouse, Line, Watt, & Bishop, 2009).

**Measuring and Evaluating Social Behaviour**

Unfortunately, in spite of substantial developments in the field of social neuroscience, research in the domain of social functioning, including social outcomes, social motivation, social competence, social cognition, and social skills, has been plagued by a number of issues. They include difficulty quantifying and measuring complex social interactions, which are often not readily observable in clinical and assessment contexts, and subsequent difficulties in the development of theories of social function and dysfunction (Beauchamp & Anderson, 2010), including the use of terms that are vague or used interchangeably to describe aspects of the domain of social functioning in clinical and research settings. These difficulties have hindered not only theoretical development but also advancement of research in this area to some extent. These obstacles must be addressed and dealt with in order to sufficiently investigate, and potentially identify reliable differences in, the social functioning of children with NLD and HFA.

There are a number of issues that complicate the evaluation of social functioning, as well as the interpretation of findings that indicate social dysfunction. For example, there are relatively little data on the prevalence of social dysfunction among the general population of children, predictors of social dysfunction, psychological and biological

bases of social function and dysfunction, and developmental pathways of social function and dysfunction (Beauchamp & Anderson, 2010). Many complications arise in this area of research because problems with social behaviour can exist in the absence of a defined psychological disorder. Alternatively, social dysfunction can be a consequence of a variety of different medical conditions or psychological disorders (e.g., neurologic disorders, developmental disorders, chronic medical problems, psychiatric problems) or due to environmental factors (e.g., few social opportunities, social stigma, psychiatric conditions present in parents, an impoverished learning environment), making the interpretation of underlying causes of the social dysfunction ambiguous in many cases (Gerhardt & Mayville, 2010). This relates to the idea of multifinality, in which the particular factors predisposing a particular person to psychopathology can result in many different forms of psychopathology across different people (Cicchetti & Rogosch, 1996). Added to this, social dysfunction can manifest in a variety of ways, such as behaviour problems (such as those seen in Conduct Disorder), psychopathology, or psychological distress that is milder in nature. In the event that social dysfunction is recognized as a problem, the accurate identification of the nature of the problem and appropriate target for intervention is hindered by the relative dearth of well-validated assessment tools of social functioning (Gerhardt & Mayville, 2010).

In order to complete a comprehensive assessment of social skills and social functioning that takes into account the full range of relevant factors, Gerhardt and Mayville (2010) argue that several methods are required. Specifically, rating scales are useful for identifying the excess or paucity of certain important social behaviours (e.g., frequently using stereotyped phrases when responding to others in conversation, or

infrequent eye contact, respectively). However, rating scales generally do not adequately assess the role of context as particular social behaviours occur. Moreover, there is some evidence that standardized rating scales that use normative comparisons to evaluate social functioning do not fully capture some important qualitative aspects of social functioning that provide valuable insights into the individual's daily functioning. Many qualitative aspects can be identified through clinical observation and interpretation, the validity of which is derived from a clinician's experience and knowledge of clinical research and child development (Grodzinsky, Forbes, & Bernstein, 2010). Behavioural observation and functional assessment are useful for directly evaluating social behaviour while taking context into account, but due to a more limited time window these methods may not capture and measure the full range of everyday social behaviour. Thus, it is prudent to employ a multimodal approach to assessment of social behaviour that involves rating scales, direct behavioural observation, and functional assessment (Gerhardt & Mayville, 2010). For example, when completing a diagnostic assessment for ASD in a clinical context, it is recommended that the assessment include several measures that evaluate broad aspects of social functioning as well as specific social behaviours that constitute diagnostic features of autism (e.g., a pragmatic language or social-communicative assessment; Gerhardt & Mayville, 2010).

The evaluation of social behaviour is most appropriately completed in the context of a broad theoretical framework that attempts to comprehensively capture the complexity and multifactorial nature of the domain of social functioning (Ozols & Rourke, 1985) For example, a comprehensive theory should ideally adopt a biopsychosocial and developmental approach as well as identify and organize

interrelationships between the multiple abilities, cognitive processes, and behaviours that are relevant to social functioning (Beauchamp & Anderson, 2010). The practitioner in clinical practice uses conceptual tools, including knowledge of theory-driven models, to organize the pertinent data and generate hypotheses that will be evaluated over the course of the assessment (Grodzinsky et al., 2010). Similarly, in the context of clinical research, theoretical frameworks from the scholarly literature, and at times clinical expertise of clinical researchers, are relied upon to help researchers generate hypotheses, organize data, and interpret the findings.

There are few theories of social functioning that incorporate both a multidimensional and developmental approach. That is, a number of theories address the biological bases of social behaviour, the environmental factors that impact social behaviour, and the psychological factors that impact social behaviour, but few take into account all of these dimensions in the context of human development and from a multidisciplinary perspective (Beauchamp & Anderson, 2010). Indeed, it is difficult to find one theory that is sufficient in its scope to account for the multitude of factors that contribute to social development and identify the mechanisms that contribute to, or account for, social functioning or dysfunction. Such a substantial task requires the integration of a number of theories. Although no theory can be completely comprehensive in its scope to explain social function and dysfunction, several will be reviewed, commented upon, and integrated to provide context for the problem under investigation, namely the social functioning of children with NLD or HFA.

The socio-cognitive integration of abilities (SOCIAL) model proposed by Beauchamp and Anderson (2010) is a biopsychosocial model that incorporates views

from neuropsychology, clinical psychology, social psychology, and developmental psychology while incorporating a developmental perspective to outline the factors that impact the development of social skills and social competence of individuals during childhood and adolescence. This theory provides a useful framework for identifying variables relevant to social functioning as well as their purported relationship to each other, and will be reviewed first. The Social Motivation Theory of Autism (Chevallier, Kohls, et al., 2012) complements the first theory by expanding upon the role of social motivation in the development of social cognition and its role in ASD. Third, the International Classification of Functioning, Disability and Health (ICF; World Health Organization, 2001) and its adaptation for children and youth (the International Classification of Functioning, Disability and Health Children and Youth Version or ICF-CY; World Health Organization, 2007), form a framework used by the World Health Organization for conceptualizing and describing health and disability of an individual or on a broader scale (i.e., of a population; World Health Organization, 2001). The ICF and the ICF-CY provide a link between the theoretical constructs discussed in the first two theories and clinical practice in terms of defining the functional impact of the disorders under investigation on children's daily lives as well as informing assessment and intervention procedures. Together, these three theories provide a context in which to conceptualize ways that the two groups under investigation, NLD and the high functioning variant of ASD, may differ based on aspects of social functioning and dysfunction that characterize each disorder. Each theory is discussed in more detail in the following sections.

**The Socio-Cognitive Integration of Abilities Model**

Beauchamp and Anderson (2010) sought to develop a theory of social functioning, the SOCIAL model that extended and integrated, rather than replaced, previous theories of this domain, such as the ones put forth by Piaget (1952) and by Crick and Dodge (1994). Beauchamp and Anderson's (2010) model provides a conceptual framework for understanding the typical development of social skills and the development of social dysfunction. It adopts a biopsychosocial approach, and assumes that development of intact social skills depends on typical brain development as well as typical development of cognitive skills and behaviour in the context of a supportive environment. This theory is composed of three main components that are hypothesized to interact dynamically (which is visually represented by bidirectional arrows between components) to determine how well individuals are able to meet social demands and achieve their social goals (i.e., their level of social competence), as per the authors' graphic representation of the model shown in Figure 2. The first component consists of mediators that may indirectly impact the development of social functioning: internal factors (e.g., personal characteristics, including temperament, personality traits, and physical characteristics), external factors (i.e., environmental factors that may impact the nature or quality of social interactions, including culture, socio-economic status, relationship dynamics within the family, and influences of family members on children's social networks), and brain development and integrity.

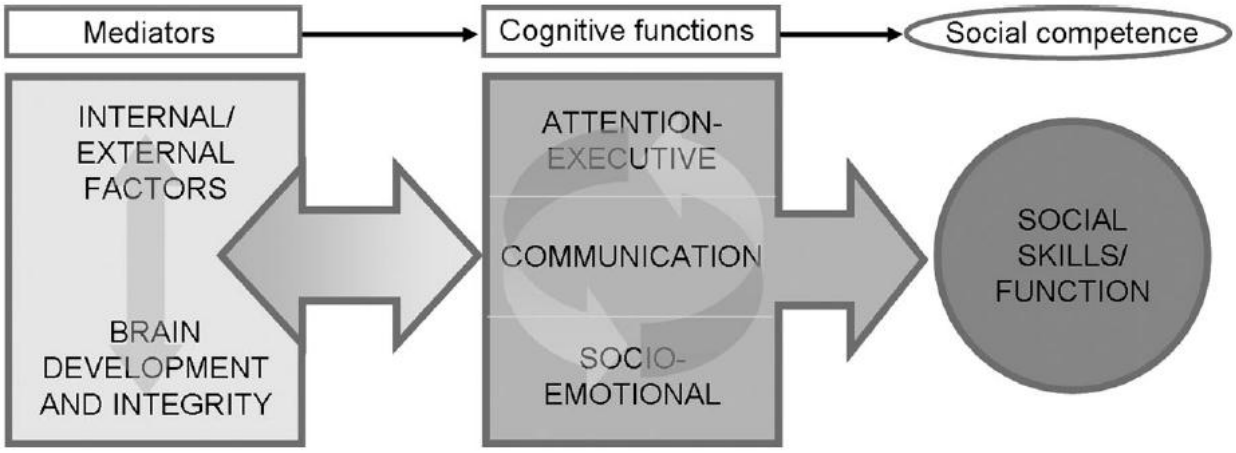


*Figure 2*. The socio-cognitive integration of abilities model (SOCIAL) by Beauchamp and Anderson (2010). Reprinted with permission.

The second component of the theory includes cognitive and affective factors that directly impact how well individuals meet social demands and achieve their social goals. Specifically, this component includes social cognition and it incorporates the cognitive processes identified by Crick and Dodge's (1994) Social Information Processing model. The SOCIAL model (Beauchamp & Anderson, 2010) notes the dynamic interaction among cognitive processes involved in social functioning.

At the level of initial perception, recognition and interpretation of faces and facial expressions (e.g., emotions) are critical processes in social functioning. In particular, they are important for social reciprocity (McClure, 2000). Perceiving and correctly interpreting the body language of others is also important (Beauchamp & Anderson, 2010). Attribution of another's intentions and causes of the other person's behaviour mediates the relationships between basic perception of facial expressions and higher order cognitive processes, such as theory of mind (i.e., understanding another person's mental state, including their beliefs, intentions, or desires; Harris, Todorov, & Fiske, 2005; Kolb & Whishaw, 2009). Social attribution (i.e., ascribing social meaning such as

emotional state and mental state of another) is an important foundational process for basic social cognitive skills (i.e., perception) and higher level social cognitive skills (i.e., theory of mind and empathy; Blair, 2005; Campbell et al., 2006).

Beauchamp and Anderson (2010) described a number of cognitive functions that are critically important to social functioning and social competence, including aspects of executive functioning and attention. Adequate joint attention and attentional control (i.e., selective and sustained attention) are necessary for perception of social cues and facial expressions (e.g., emotions). Cognitive flexibility and goal setting are important for maintaining positive social relationships and positive social functioning. That is, there are negative social consequences (e.g., for relationships at work or for personal relationships) for not adapting smoothly to novel social situations or to novel conversation topics, and for being consistently late to social engagements. Self-monitoring, inhibition of inappropriate responses, and self-regulation are other aspects of executive functioning that are important for turn-taking in social interactions. There are also social consequences if children do not perform these executive functions well, for example peers tends to react negatively to those participating in activities that are governed by rules who violate those rules (e.g., games children play on the playground). In fact, Crick and Dodge's (1994) model asserts that self-regulation is the critical final step in formulating a response during a social interaction.

Social communication is a broad construct that involves joint attention, perceiving and processing of non-linguistic social cues (including emotions conveyed through facial expressions and body language, as well as prosody), pragmatics, attributing intentions to the other person, inferring reasons for another's behaviour (Beauchamp & Anderson,

2010). Expressive and receptive language are also critical aspects of communication that involve formulating a verbal response to what the other person has said and to interpreting the speech of another person during social interactions, respectively. With respect to pragmatics, this refers to the (strategic) way in which body language and speech are used to convey social information and achieve social goals (Ciccia, 2011). There are linguistic and non-linguistic aspects of pragmatics including word choice and prosody (i.e., tone of voice, pitch, loudness, rate, rhythm, and stress patterns; Beauchamp & Anderson, 2010), respectively. Pragmatics also include specific behaviours, such as using appropriate facial expressions, initiating a social interaction, maintaining a social interaction, terminating a social interaction, taking turns during conversation, monitoring relevance of utterances to the current topic, gauging the appropriateness of utterances with respect to the current topic and the members involved in the social interaction based on feedback from others, and correcting misjudgements made during a conversation (Ciccia, 2011).

The third component of the theory reflects the outcome of the dynamic interaction of the factors involved in the first two components—namely the level of social skills and social function, which determine one's overall level of social competence as well as social outcomes. This third component is not discussed by the authors in detail; they note that this component of the model will be borne out through further research and the development of reliable and valid standardized measures that tap social functioning and social competence. Further to that, they note that there is a paucity of reliable and valid standardized measures that tap this domain, and the ones that are available have significant shortcomings. For example, they rely solely on parent report (and as such are

indirectly measuring the area of interest and are subject to potential rater bias), have inadequate norms, are limited to older age ranges or younger age ranges, or are research-based measures that are not yet sufficiently validated to be used as clinical tools. Overall, they conclude that this component of the model requires further development in terms of availability of sound assessment measures as well as additional research to operationalize and more fully explore all of its facets (Beauchamp & Anderson, 2010). An important contribution of SOCIAL (Beauchamp & Anderson, 2010) is the compiling of clear, research-based definitions of many common terms pertaining to social functioning.

Additionally, the SOCIAL model outlines proposed interrelationships among various component abilities and other variables that culminate in a person's level of social competence and their social outcomes, providing a framework in which to define and situate components of social cognition and social functioning as they relate to NLD and HFA. Specifically, a number of aspects of the SOCIAL model are useful for conceptualizing the social difficulties experienced by children with ASD and NLD. For example, there is a body of literature that fits with the second component of the model, which includes cognitive and affective factors that play a role in social functioning, and indicates specific areas of difficulty for many children with ASD or NLD. A large body of research investigates 'social cognition' in individuals with ASD and a smaller body of literature investigates social cognitive abilities in individuals with NLD. Some of the major findings from this research include that children with ASD have been found to have impairments in attributing intentions of others correctly (Baron-Cohen, 1989) and in showing appropriate emotional reactions to the emotional state of another person (Sabbagh, 2004). Additionally, there is considerable evidence that children with NLD

experience perceptual impairments, which may fundamentally alter the way in which they experience their surroundings (Casey, 2012; Johnson & Myklebust, 1967). In line with this, several empirical studies have found that children with NLD or features of NLD are weak in the areas of perceiving and interpreting nonverbal social cues (Dimitrovsky, Spector, Levy-Shiff, & Vakil, 1998; Petti et al., 2003). There is also some evidence that children with NLD have difficulty recognizing appropriate assertive responses they have generated in social situations and correctly predicting which option for managing a social situation will result in optimal social outcomes (Galway & Metsala, 2011). Research investigating strengths and weaknesses in social cognition in each of these two disorders is ongoing.

Children diagnosed with ASD often have significant social communication difficulties (APA, 2013), another factor included in the second component of the SOCIAL model. With respect to pragmatic aspects of communication, children with ASD have often been found to have impaired prosody (i.e., an unusual or monotonous tone of voice), and impaired detection of sarcasm (Peppé, McCann, Gibbon, O'Hare, & Rutherford, 2007; Philofsky, Fidler, & Hepburn, 2007). Some children with ASD have little motivation to engage in social interactions with others, while others have an interest in social interaction, but they interact in ways that are inappropriate or awkward, often due to impaired pragmatics (Beauchamp and Anderson, 2010).

Children diagnosed with NLD tend to have impaired pragmatics as well. Specifically they tend to have weak speech prosody and they tend to over-rely on language content to relate to others; they also tend to be impaired in performing the specific behavioural aspects of pragmatics that enable the successful management of

social interactions (Casey, Rourke, & Picard, 1991). They appear to have interest in interacting with others socially, but impairments in pragmatics seem to interfere with achieving social competence.

The SOCIAL model (Beauchamp & Anderson, 2010) offers a useful framework in which to situate the present study, although there are certain gaps in the model and areas that require further development. The authors note that the SOCIAL model is a work in progress that requires further research to operationalize and refine its components (Beauchamp & Anderson, 2010). The separation of brain development and integrity in the first component of the model from cognitive, affective, and social abilities in the second component of the model requires further discussion and clarification. The model tends to focus heavily on the thinking abilities that underlie social cognition and social skills, viewing the physical brain as a mediator of those thinking abilities as opposed to emphasizing that the physiological reactions in the brain are the same as those thinking processes—the position currently supported by nearly all philosophers and neuroscientists (Kalat, 2004) and the SOCIAL model. Although the authors acknowledge that brain development and integrity are the foundation of cognition and emotion and also that cognitive and affective processes are linked at the behavioural and neural levels, the separation between these variables in the model is visually confusing. There are bidirectional arrows indicating the dynamic interaction between the first two components of the model, but it arguably is simpler and more consistent with the underlying tenets of the SOCIAL model to include the structures of the body and the cognitive and affective processes within the same component of the model.

Perhaps the most significant gap occurs in the first component of the model which describes mediators that interact dynamically with other components of the model to determine social competence. Specifically, in the discussion of internal factors, the authors include a number of personal characteristics, including temperament, personality traits, and physical characteristics, but there is no mention of social motivation, or the role it plays as a potential mediator in the development of social cognition, social skills, and overall social competence.

**The Social Motivation Theory of Autism**

The Social Motivation Theory of Autism (Chevallier, Kohls, et al., 2012) is a recently developed theory of ASD that provides information about the importance of the concept of social motivation as a mediator of typical and impaired social development from a multidisciplinary perspective. It holds considerable promise for conceptualizing and investigating potential differences in social motivation as well as overall social functioning between HFA and NLD. The Social Motivation Theory of Autism (Chevallier, Kohls, et al., 2012) provides a framework for understanding and explaining the role of social motivation in typical development of social cognition, social functioning, and social competence, as well as the root of impairment in these areas experienced by children and adults with ASD; this is achieved by integrating perspectives from social psychology, behavioural economics, social neuroscience, and evolutionary biology. In short, this theory posits that ASD can be conceptualized as a disorder characterized by significantly reduced and impaired social motivation, with secondary impact to the development of social cognition, which is stunted due to reduced social opportunities and stimulation that result from reduced motivation to seek and participate

in social interactions. The authors note that this theory represents a divergence from the more traditional theories of ASD that focus more heavily on cognitive impairments (e.g., executive dysfunction, including difficulties with theory of mind) that impact social cognition with little consideration of motivational factors.

Chevallier, Kohls, et al. (2012) purport that social motivation has three levels (i.e., behavioural, biological, and evolutionary) and multiple facets within those levels. At the behavioural level, there are three means by which social motivation is expressed: social orienting, wanting and liking, and social maintaining. Social orienting involves prioritizing and paying attention to socially relevant information, such as direct gaze. A number of studies have found that humans tend to orient to information with social implications more quickly and more strongly than many other types of information (Kikuchi, Senju, Tojo, Osanai, & Hasegawa, 2009; Ro, Russell, & Lavie, 2001; Senju & Johnson, 2009).

In terms of wanting and liking, this theory fits well with other drive theories, and asserts that humans have an innate drive to seek acceptance and not experience rejection, and that social interactions are inherently rewarding; liking is one component of the reward and wanting is the other. In general, individuals with ASD tend to find social interaction and close friendships to be less pleasurable than individuals who are not on the autism spectrum (Baron-Cohen & Wheelwright, 2003; Demurie, Roeyers, Baeyens, & Sonuga-Barke, 2011) and they initiate interaction spontaneously less frequently (and less skillfully) than individuals who are not on the autism spectrum (Leekam & Ramsden, 2006; Liebal, Colombi, Rogers, Warneken, & Tomasello, 2008; Mundy, Sullivan, & Mastergeorge, 2009).

In terms of social maintaining, individuals on the autism spectrum are purported to be less concerned with appearing favourably to others and use fewer strategies to maintain a positive reputation in the eyes of others compared to typically developing populations. For example, Izuma, Matsumoto, Camerer, and Adolphs (2011) found that the amount adults on the autism spectrum donated to a charitable cause was not influenced by whether others were aware how much they donated (i.e., they were not concerned about how generous they appeared to others). Other research studies found that individuals on the autism spectrum were less likely to alter their behaviour (e.g., hide their mood or show social emotions such as shame when in the presence of others) to maintain a certain presentation of themselves compared to typically developing control participants (Barbaro & Dissanayake, 2007; Hobson et al., 2006).

At the biological level, Chevallier, Kohls, et al. (2012) note the differences in neuroanatomy, neurochemistry, and brain functioning with regard to processing and responding to socially relevant information, including the experience of a reward in the context of social interaction, that have been found in individuals with ASD. The orbitofrontal-striatum-amygdala circuit has been implicated as functioning atypically in individuals with ASD, as has the brain's regulation of oxytocin to some extent (Bachevalier & Loveland, 2006; Modi & Young, 2012). Research is ongoing in the areas of genetic differences and cytoarchitectural differences (e.g., the structure of receptors for certain neurotransmitters in synapses in particular brain areas) in individuals with ASD, but this area shows considerable promise for identifying links between developmental changes in social cognition and behavior with those that occur structurally and functionally in the brain (Munakata, Casey, & Diamond, 2004).

Overall, this theory provides a useful conceptualization of ASD and is compatible with SOCIAL as well as the International Classification of Functioning, Disability and Health (described below). One of the shortcomings of the Social Motivation Theory of Autism is that not all individuals with ASD have reduced motivation to engage in social interaction, despite having a qualitative impairment in social communication and interaction (Chevallier, Kohls, et al., 2012). Another shortcoming, which is acknowledged by the authors, is that difficulties with social motivation or social interest occur in the context of other disorders as well, not only ASD (e.g., schizophrenia). The authors counter this acknowledgement with a note that it only presents a problem if it is expected that one theory can explain ASD in its entirety. However, if the study of ASD is approached from multiple perspectives and from a study of multiple impairments as well as some areas of strength, it becomes more of a matter of choosing which theory or set of theories best accounts for the impairments or strengths. The Social Motivation Theory of Autism primarily addresses impairments in the domain of social functioning, and thus competes with other theories that also seek to explain impairments in this area (e.g., the Theory of Mind account for ASD [Baron-Cohen, 1995], or on a more general level, the relative weight of social motivation and social cognition in accounting for impairments in social functioning in ASD). This theory is also a useful standpoint from which to examine NLD because it speaks to an area which is thought to differ between the two disorders under investigation and thus may be useful in conceptualizing, examining, and delineating differences between the two. Based on a literature search at the time of this study, it appears that no empirical studies to date have systematically investigated the construct of social motivation in children diagnosed with NLD, although it has been

hypothesized by some clinical psychologists based on their experience that social motivation is relatively spared in NLD (Mamen, 2002).

The SOCIAL model and the Social Motivation Theory of Autism identify and define important theoretical variables involved in social functioning, as well as their purported relationships to each other. To complement the terms that are clearly defined by the SOCIAL model, the ICF similarly provides clear definitions of some terms that have been used variably in the scientific literature, including "impairment" and "disability." Such definitions aid in interpreting results from standardized psychological measures of social functioning in both clinical and research contexts. Furthermore, the ICF and the ICF-CY enable the identification of the functional profile of a typically developing person as well as a person with a mental disorder or other health condition. In the case of the latter, a functional profile enables a health professional to identify the impact of the condition on an individual's daily life as well as targets for intervention. Additionally, the ICF and ICF-CY codes have been mapped onto the dimensions of some well-validated clinical tools, including those typically used to diagnose ASD, allowing clinicians and researchers to know which theoretical constructs are evaluated by which measures. This also aids health professionals in identifying targets for intervention.

**The International Classification of Functioning, Disability and Health (ICF)**

The ICF (World Health Organization, 2001), and its subsequent adaptation (the ICF-CY; World Health Organization, 2007), were created for several purposes, including the development of a comprehensive framework to describe positive and negative aspects of health-related functioning of individuals as well as to provide a standardized vocabulary and assessment of such functioning across a variety of contexts (Bölte et al.,

2014), and to act as a complement to the etiological framework provided by the ICD-10 (WHO, 2004). A major goal of the ICF and the ICF-CY is to provide a way for health-care professionals to classify the health and level of functioning of children. Other purposes include facilitating case conceptualization to guide treatment planning, creating a shared understanding of clients' functioning among professionals of different health-related disciplines, and facilitating the development of a more complete formulation of an individual's or a population's functioning that includes both positive aspects and restrictions or limitations in functioning (Peterson, 2005; World Health Organization, 2001).

The ICF-CY (World Health Organization, 2007) was created in order to capture the developmental context specific to children and youth. This was accomplished by adding categories as well as expanding the descriptions of some existing categories in order to better capture developmental issues, including the increasing competence, societal participation, and independence associated with this stage of life (World Health Organization, 2007).

The ICF and the ICF-CY are underpinned by the same framework, which is shown in Figure 3. Within this conceptual approach, there are a number of components that are considered to interact with one another dynamically to determine the health and functioning of a person or a population, reflecting a biopsychosocial approach that integrates a medical model and social model of disability (Peterson, 2005). The medical model views an individual's disability as a characteristic of that person due to disease, injury, or another health condition. The disability requires medical intervention by the appropriately trained medical staff (World Health Organization, 2002). In contrast, the

social model of disability views disability as a social phenomenon. The primary focus of intervention is the political and social climate of society. That is, the disability exists because society has created a physical and social environment that does not properly accommodate all individuals, resulting in barriers for some. The ICF incorporates both the medical and social model of disability in a complementary way, conceptualizing disability (i.e., any impairments in Body Structures or Functions that lead to limitations in Activities or restrictions in Participation) as reciprocal interactions between impairments, functioning, and the environment (Peterson, 2011). The inclusion of Contextual Factors enables clinicians and researchers to account for variability in the functional profiles of individuals with the same health condition (e.g., individuals may have vastly different environmental factors impacting their functioning; Peterson, 2011). It asserts that intervention is needed at the political level and the individual level to reduce the impact of impairments at the levels of Activities and Participation (World Health Organization, 2002). The ICF does not focus on the etiology of impairments; instead, it focuses on the positive aspects of functioning and the functional consequences of impairments, in terms of limitations in Activities or restrictions in Participation (Peterson, 2011). An impairment refers to any deviation from the normative standard for the population, and having an impairment does not necessarily indicate that a disease or disorder is present (Peterson, 2011). In contrast, functioning focuses on positive aspects of health.

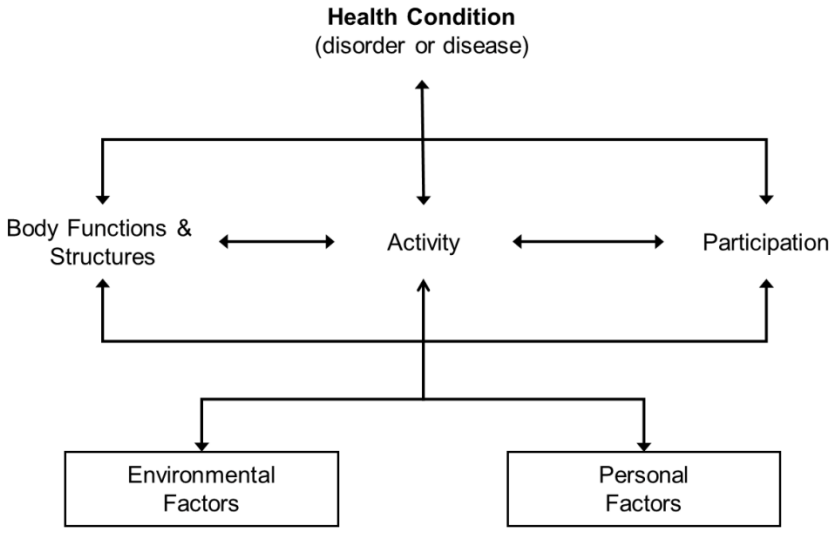


*Figure 3*. The ICF model (World Health Organization, 2001).

The ICF and ICF-CY model includes two main parts (each with two components). The first part is referred to as Functioning and Disability; it subsumes "Body Structures and Functions" component (e.g., biological systems, cognitive processes, psychological aspects of mental health) and "Activities and Participation" component (i.e., ability to carry out tasks and to be involved in situations that are important for daily living and include social interactions, respectively). The second part is referred to as Contextual Factors; it subsumes the Environmental Factors (e.g., attitudes within a particular society, accepted social norms within a particular society, and/or the physical environment in which people live) and Personal Factors (individual characteristics, such as race or religion, which are currently not systematically classified by the ICF, although it is acknowledged that these factors can impact functioning on an individual basis). Contextual Factors serve to either hinder or facilitate a person's health and functioning (Peterson, 2011).

The clinical and research utility of the ICF and the ICF-CY lies in their ability to supplement diagnostic information with functional information. The ICF and ICF-CY are complementary to existing diagnostic systems, including the DSM-IV-TR, DSM-5 and the ICD-10. Diagnostic systems are most often used to determine if a child meets criteria for a categorical label or diagnosis, whereas the ICF and ICF-CY provide information about children's functioning in their day-to-day environment, including the impact of one or more diagnoses on functioning and quality of life (i.e., the emotional reactions to limitations in Activities and Participation as a result of the diagnosis or health condition; Bölte et al., 2014; Castro, Ferreira, Dababnah, & Pinto, 2013). Although diagnostic systems may classify individuals with diverse backgrounds under one diagnostic label, the ICF and the ICF-CY allow a clinician to identify unique profiles of positive and negative aspects of functioning among individuals with the same diagnostic label (Castro et al., 2013). Furthermore, the ICF and the ICF-CY provide additional information that can fill in gaps in the case conceptualization of health (including mental health) and functioning that may exist if only the DSM-IV-TR, DSM-5, or the ICD-10 is used and can allow interventions to be tailored to individuals' functional profiles (Bruyère, Van Looy, & Peterson, 2005). For example, the ICF presents information regarding positive aspects of functioning (e.g., activities and tasks that can be performed in spite of a particular impairment) as well as the way in which intervention (i.e., Environmental Factors that can facilitate functioning) can help to improve independence. Diagnostic systems tend to focus on specific limitations in activities and participation faced by the individual (prior to, during, or after intervention has occurred). Both types of information

are important to understanding a specific person's potential for improvement and level of current functioning.

In the present study, the standardized terms provided by the ICF and the ICF-CY are used in combination with normative data to identify and compare the functional impact of HFA and NLD on social competence and social functioning. The ICF and the ICF-CY help to organize relevant social variables and help clinicians as well as researchers to interpret the functional impact of health conditions and disorders. Using standardized terms and principles for interpretation allow the direct comparison of the two disorders under investigation, facilitating the investigation of differential diagnosis.

The ICF has been applied to several childhood disorders, including ASD. The ICD-10, the DSM-IV-TR, and the DSM-5 identify three areas in which significant difficulties occur in ASD: language-based communication, social interaction, and behaviours or interests that are restricted or repetitive in nature. Using the terms of the ICF and the ICF-CY, the first two areas of difficulty represent limitations in Activities and the last area represents impairments in Body Functions that are associated with ASD. A variety of restrictions in participation can result from impairments and limitations in Activities that occur in ASD, such as significant difficulty fulfilling social roles in the family or community, significant difficulty functioning in a classroom setting, or significant difficulty integrating with peers at school or in the community (Humphrey & Symes, 2011; Scheuermann & Webber, 2002; Wing, 1981). Many other limitations are possible or some of the aforementioned ones may not be present, depending on the other aspects of the functional profile of a person with ASD.

Castro et al. (2013) analysed diagnostic measures most often used in establishing a diagnosis of ASD to link component scales of the measures to the ICF-CY and to identify aspects of functioning captured by each measure. Castro et al. (2013) argued that diagnostic systems are relevant to this process because they identify the domains in which limitations are most likely to occur and, as such, provide a starting point for identifying problems in functioning. Furthermore, Castro et al. (2013) acknowledged that diagnostic labels are often required for children to access special education services or rehabilitation services. The content of three measures that are widely used in establishing a diagnosis of ASD in children was analysed in their study: the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 2001) the Autism Diagnostic Interview Revised (ADI-R; Rutter, Le Couteur, & Lord, 2003), and the Childhood Autism Rating Scale (CARS; Schopler, Reichler, DeVellis, & Daly, 1980). The study used qualitative content analysis to identify words used in the measures that were meaningful for assessing functioning and that could be coded according to the categories of the ICF-CY. Words for each measure were linked to ICF-CY categories and codes using the linking rules outlined by Cieza et al. (2005). The codes were subsequently quantified. Of the functional concepts measured by the items of the CARS, 96.1% assessed Body Functions and 43.1% assessed Activities and Participation, with some concepts fitting into multiple categories. The ADOS was found to primarily assess Body Functions (47.7% of the meaningful concepts identified) followed by Activities and Participation (43.2%). No Environmental Factors were assessed by either the CARS or the ADOS. The ADI-R was found to assess meaningful concepts in the areas of Body Functions (28.9%), Activities and Participation (31.3%), and Environmental Factors

(0.5%). A previous study by Castro and Pinto (2013) identified a group of ICF-CY codes that were found to be crucial areas of assessment and intervention for children with ASD. The identified codes spanned Activities and Participation (i.e., learning and applying knowledge, general tasks and demands communication, self-care, interpersonal interactions, major life domains, and community, social, and civic life); Body Functions (i.e., mental functions); and Environmental Factors (i.e., support and relationships, attitudes, and services, systems and policies). Of those categories that were identified as essential to the assessment process for ASD, the ADOS reflected most areas, including six out of seven categories under Activities and Participation, all categories included under Body Functions, and one of three categories under Environmental Factors. Overall, the ADOS covered more areas than either of the other two measures that were included in the study, although the authors concluded that all three measures were focused on the assessment of children, diagnostically oriented, and clinically useful.

NLD has also been analyzed from the perspective of the ICF and the ICF-CY, with a particular focus on the neuropsychological aspects of the disorder as well as the diagnostic criteria for the disorder. Casey (2012) highlighted the usefulness of the standardized language provided by the ICF for conceptualizing NLD. Specifically, the neuropsychological assets and deficits outlined in Rourke's (1989) model were linked to, and placed within the category of, Body Functions in the context of the ICF. The profile of social, academic, and adaptive functioning associated with NLD were identified as falling within the Activities and Participation component of the ICF and ICF-CY model. The neuropsychological deficits or weaknesses were specifically identified as impairments in Body Functions (i.e., abilities that are below average based on

comparisons with normative data), whereas difficulties with social, adaptive, or academic functioning associated with NLD were linked to the ICF by defining them in terms of limitations in Activities and restrictions in Participation. Rourke (1989) asserted that the neuropsychological deficits evident in NLD give rise to the difficulties with social, adaptive, or academic functioning. If this assertion is accepted, then the limitations in Activities and Participation identified for NLD would constitute a disability from the standpoint of the ICF and the ICF-CY. Furthermore , Casey (2015) underscored the utility of the ICF in identifying the role Contextual Factors play in explaining the variability of presentations of NLD, including variations in functional profiles across children with this diagnosis, and the importance of an idiographic approach in case conceptualization and intervention that is tailored to meet the needs of each person with this diagnosis.

**Integration of Three Frameworks in the Present Study**

The ICF and the ICF-CY can be integrated with the SOCIAL model and the Social Motivation Theory of Autism, while also adding and accounting for other relevant variables, such as additional health conditions. A visual representation of the integration of the three theories that have been discussed is provided in Figure 4. The ICF and the ICF-CY were chosen as the most appropriate template to organize the categories and variables as it is sufficiently broad to encompass the other approaches. To avoid the confusion that seems to be produced from the SOCIAL model's separation of brain development and integrity from cognitive and affective functions, these constructs have been combined under Body Structures and Functions in the integrated model. This model can also be used to describe daily functioning using standardized terms when multiple

health conditions are present. The Body Structures and Functions category subsumes the construct of "motivation" (including the aspects of social motivation as they are used in the Social Motivation Theory of Autism) and the other cognitive and affective functions defined by SOCIAL, all of which are classified by the ICF and the ICF-CY as Mental Functions within this category. The constructs of the SOCIAL model that pertain to a person's ability to carry out specific tasks, such as formulating and executing an appropriate response during a social interaction and adeptly carrying out day-to-day activities that include interpersonal interactions as a component, are included within the Activity component of the integrated model. Similarly, the constructs of the SOCIAL model that relate to involvement in situations that are important for daily living, such as fulfilling social roles in society and adequately managing the demands of social situations in order to reach one's social goals in a given context, are included within the Participation component of the integrated model. Internal factors, as they are defined by the SOCIAL model, are essentially equivalent to Personal Factors of the ICF and the ICF-CY, while External Factors of the former model are essentially equivalent to environmental factors in the latter models. The integrated model will be used to guide the interpretation of the results in the areas of social competence and social functioning as well as differential diagnosis of the two disorders being examined in the present study.

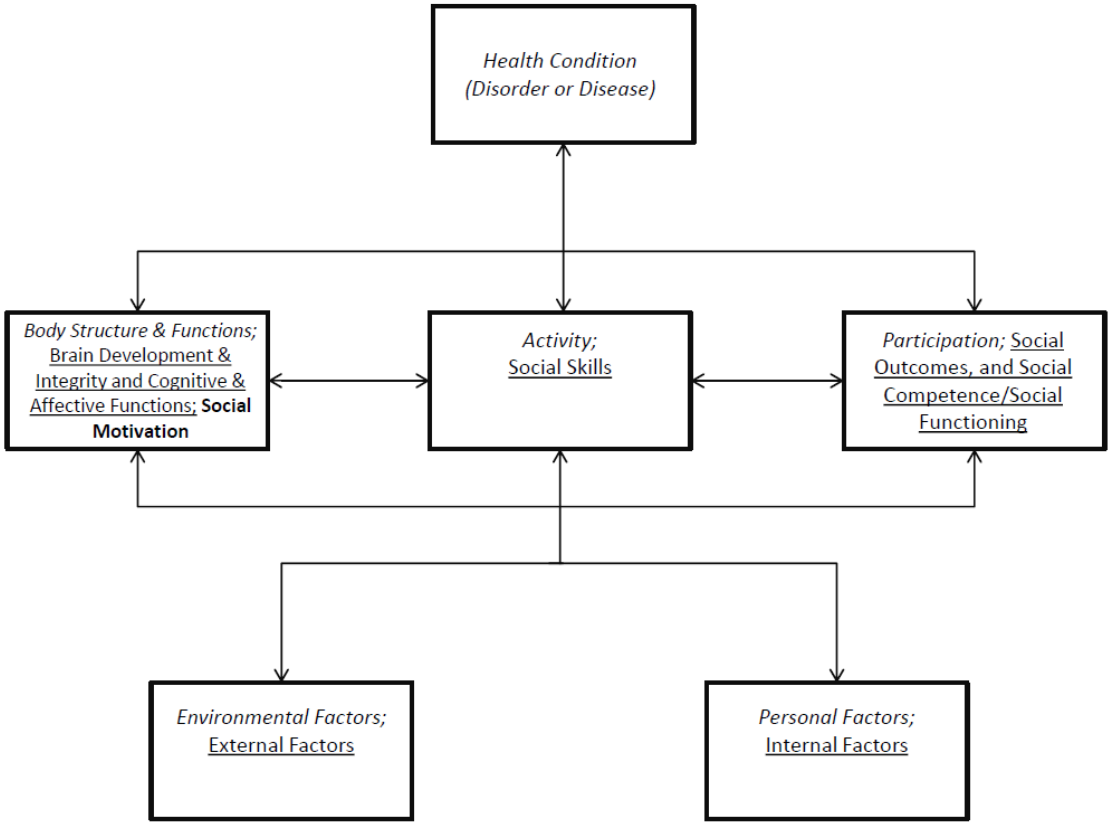


*Figure 4*. The integrated model. Components off the socio-cognitive integration of abilities model (SOCIAL; Beauchamp and Anderson, 2010) are underlined. Components of the Social Motivation Theory of Autism (SMTA; Chevallier, Kohls, et al., 2012) are formatted in bold. Components of the International Classification of Functioning, Disability and Health (ICF; World Health Organization, 2001) are formatted in an italic font.

In addition to collecting functional information, it is equally important to collect and verify diagnostic information. In the present study, diagnostic information will be critical for group assignment, but clear criteria for establishing a diagnosis of NLD must be identified, given the variety of criteria and approaches to diagnosing NLD that have been reported in the scientific literature, as well as the fact that NLD is not currently included in a formal diagnostic system. Furthermore, a recent update from the DSM-IV-TR to the DSM-5 has altered the diagnostic labels and categories used for ASD, particularly the high functioning variant.

**Differential diagnosis between HFA and NLD**

HFA and NLD are two disorders that have often been difficult to separate from a diagnostic standpoint, with some overlap evident in the characteristics of the two disorders (e.g., Davis & Broitman, 2011). There is controversy surrounding the nature of the relationship between the two disorders, with some arguing that NLD occupies a position on the milder end of the autism spectrum (Brumback, Harper & Weinberg, 1996; Semrud-Clikeman, 2007; Semrud-Clikeman, Walkowiak, Wilkinson, & Minne, 2010). In contrast, others argue that they are essentially the same disorder, but that they are identified by different methods and defined by different systems (i.e., psychiatric evaluations are used to assess ASD and neuropsychological evaluations are used to assess NLD; Klin et al., 1995; Volkmar & Klin, 1998). Still others argue that the two disorders are distinct in nature (e.g., Casey, 2012; Rourke & Tsatsanis, 2000).

Overlap between these two disorders has been identified from a variety of perspectives, including behavioural, social, emotional, and neuropsychological paradigms. For example, both children with Asperger's disorder and children with NLD have been noted to have similar patterns of social difficulties and behaviour, including tangential and pedantic speech, difficulties with social reciprocity, and weak abilities to form and maintain friendships with peers (Rourke and Tsatsanis, 2000). Both children with NLD and children with HFA have been found to be at increased risk for anxiety disorders and depression (Simonoff et al., 2008), although such findings have been less consistent for children with NLD (Bigler, 1989; Rourke & Tsatsanis, 2000). Additionally, there is evidence that some children with Asperger's disorder have a neuropsychological

profile that is similar to that typically found in children with NLD (Ehlers et al., 1997; Klin et al., 1995; Semrud-Clikeman, Walkowiak, Wilkinson, & Christopher, 2010).

Some of the evidence that supports that these are two distinct disorders is based on the experience and acumen of clinicians with expertise in diagnosing and working with children who have HFA or NLD. For instance, there is some evidence that different treatment approaches are appropriate to remediate the difficulties identified in each disorder. Specifically, Early Intensive Behavioural Intervention (EIBI) is an empirically supported treatment often used with children who have ASD (Reichow, 2012). In contrast, a variety of treatments is often used to treat children with NLD, including educational accommodations tailored to neuropsychological impairments associated with NLD (Marshall, 2013). The literature pertaining to treatments for NLD relies largely on clinical experience and acumen, with very few published empirical studies available that investigate the efficacy or effectiveness of such interventions for children diagnosed with NLD (Marshall, 2013).

There is a relatively sparse literature addressing the extent to which the nature of social dysfunction differs between children with NLD and children with HFA (and, indeed, the extent to which these two disorders can be reliably differentiated from each other). Although few studies have investigated social functioning in NLD and differential diagnosis on the basis of social or adaptive functioning, a number of studies have investigated differences between NLD, HFA, and other disorders using case study or neuropsychological approaches. These studies are reviewed next.

Bishop and Norbury (2002) compared the performance of children between the ages of 6 and 9 years (inclusive) with specific language impairment, pragmatic language

impairment (which the authors noted was synonymous with semantic pragmatic disorder from the DSM-IV-TR), HFA, or no language impairments (i.e., typically developing children) on Module 3 of the Autism Diagnostic Observation Schedule Generic (ADOS-G) as well as other measures often used to diagnose autism. The groups were identified and defined based on a combination of their performance on the Children's Communication Checklist (CCC) and the diagnostic measures (i.e., the Social Communication Questionnaire, the ADI-R, and the ADOS-G). It was noted that two typically developing children out of 18 were misdiagnosed as having an ASD by the ADOS-G (i.e., they exceeded the threshold for ASD on the ADOS-G in the absence of any other current or remote symptoms of ASD). These researchers highlighted this finding because the validation samples of the ADOS and the ADOS-2 had a mixed comparison group of individuals that included typically developing individuals without any clinical diagnoses as well as individuals who had one or more diagnoses that were not on the autism spectrum (e.g., a language disorder, oppositional defiant disorder, etc.; Lord et al., 2012). Due to the heterogeneous composition of the comparison group, it was not possible to isolate the findings for typically developing children from other non-ASD clinical populations to see how often they were misdiagnosed by their score on the ADOS (Bishop & Norbury, 2002).

Klin et al. (1995) sought to differentiate between HFA and Asperger's disorder on the basis of neuropsychological measures. The sample was composed of children and adolescents, 21 of whom were diagnosed with HFA and 19 of whom were diagnosed with Asperger's disorder. The major finding of the study was that the vast majority of the participants who were diagnosed with Asperger's Disorder (18 out of 21) presented with

neuropsychological profiles that corresponded to the prototypical NLD profile. In contrast, only one out of 19 of the participants diagnosed with HFA presented with a neuropsychological profile that corresponded to the typical NLD profile. It was concluded that HFA and Asperger's Disorder could be reliably differentiated on the basis of neuropsychological profiles. However, this study was criticized by Szatmari (1998) who noted that one of the inclusion criteria was also reported as one of the findings of the study. That is, Szatmari noted that Klin et al. (1995) used motor clumsiness as a selection criterion for the study (a symptom defined by Gillberg, 1991 as a symptom of Asperger's Disorder, but not formally recognized in the DSM-IV-TR as a symptom), and it was reported that HFA and Asperger's Disorder differ on the basis of motor clumsiness.

Stein et al. (2004) approached the issue of differential diagnosis between Asperger's disorder and NLD from a case study perspective. The presenting problems and a brief developmental history of a seven year-old boy are described, and then several experts in the field of developmental behavioural pediatrics (i.e., pediatricians and psychologists) each separately describe the processes they would use to establish a differential diagnosis among attention-deficit/hyperactivity disorder (ADHD), NLD, and Asperger's disorder based on previous research studies as well as clinical experience. Dr. Klin, a child psychologist, and Dr. Miller, a pediatrician, were both consulted by Stein and were each credited with writing a discrete section of the paper. Dr. Klin and Dr. Miller stated that a standard psychoeducational assessment is not sufficient for establishing a differential diagnosis between Asperger's disorder and NLD. To fully explore the diagnosis of an ASD, Dr. Klin emphasized the importance of an evaluation of social and communication behaviours with a standardized instrument that involves direct

observation of the child's behaviour (i.e., the ADOS-2; Lord et al., 2012) as well as a semistructured interview (using an instrument such as the Autism Diagnostic Interview; Le Couteur, Lord, & Rutter, 2003) to gather information about the child's behaviour at home, at school, and in any other relevant environments. Assessment of adaptive behaviour is also critical. Dr. Goulden, another pediatrician who was consulted and wrote a section of the article, noted that the purpose of these assessments is to determine if a child engages in appropriate reciprocal social interactions. Dr. Klin also highlighted the different diagnostic perspectives used to establish a diagnosis of HFA and NLD. Since different diagnostic systems are used for each disorder (i.e., only ASD is in the DSM-5 and NLD is diagnosed based on criteria outlined in published research literature), the disorders may not be mutually exclusive and it is theoretically possible for the two disorders to co-occur (Stein et al., 2004). Dr. Miller stated that the main differences are the presence of stereotyped interests in Asperger's disorder (and the absence of these in NLD; Stein et al., 2004), although this is not necessarily a widely held view.

Children with NLD may present with social dysfunction similar to that of HFA, due to the weak adaptability to complex social situations, overreliance on rote verbal skills during social interactions, difficulty with perceiving and correctly interpreting social cues, and overly literal interpretation of information (which may result in failing to appreciate nuances in social interaction and to therefore respond appropriately). However, the way in which a child interacts with adults may be of particular importance to differentiating these disorders. For example, both children with NLD and children with HFA tend to interact relatively more successfully with adults than with peers (Krantz, Land, & McClannahan, 1989; Krantz & McClannahan, 1993; Semrud-Clikeman, 2007;

Stein et al., 2004). Children with HFA, however, may deviate considerably more than children with NLD from social norms, and display more atypical behaviour during social interactions with adults than children with NLD.

From data culled from medical records and neuropsychological assessments, Cederlund and Gillberg (2004) investigated the characteristics of a sample of 100 boys who presented at a specialized autism clinic and who were diagnosed with Asperger's disorder. Participants were between the ages of five and eleven years. On average, participants obtained below average scaled scores (i.e., 7 or less) on several Wechsler subtests (although the average overall Full Scale Intelligence Quotient score of the sample was 101, within the Average range). Fifty-four percent of the sample obtained scaled scores of 7 or less on the Digit Symbol (Coding) subtest. Additionally, scaled scores of 7 or less were obtained on Digit Span by 40 percent of the sample, on Object Assembly by 38 percent of the sample, on Arithmetic by 35 percent of the sample, and on Picture Arrangement by 34 percent of the sample. Performance IQ was significantly higher than Verbal IQ in more than half of the sample; only 6 percent of participants showed the opposite pattern of discrepancy. Although NLD has been hypothesized to be associated with dysfunction of the right hemisphere, the sample of participants did not show right hemisphere dysfunction on functional neuroimaging performed with SPECT more often than bilateral or left hemisphere dysfunction (although not all participants had neuroimaging data available for review). Cederlund and Gillberg (2004) stated that right hemisphere dysfunction has been hypothesized to be associated with a particular pattern of performance across Wechsler subtests, namely unexpectedly weak performance on Arithmetic, Digit Symbol (Coding), and Digit Span. This pattern of results was found for

the participants of this study in the absence of systematic or consistent evidence of right hemisphere dysfunction based on functional neuroimaging data (Cederlund & Gillberg, 2004).

Additionally, Semrud-Clikeman, Walkowiak, Wilkinson, and Christopher (2010) sought to differentiate among children diagnosed with NLD, Asperger's disorder, ADHD (Inattentive and Combined types), and control participants based on the results of behaviour rating inventories and neuropsychological measures of cognitive functioning. The study involved 345 participants between the ages of 9 and 17 and referred from a variety of sources including parents, teachers, medical doctors, psychologists, and organizations in the local community. The cognitive domains that were assessed included visual-spatial perception, academic achievement, and motor functioning. Of note, inclusion criteria for the NLD group included a stipulation that children must have scores on the parent rating form of the Social Skills Rating Scale and the Visual Motor-Integration Test that are at least one standard deviation below average. This was not required, however, for children who were included in the Asperger's disorder group. In terms of the specific differences that were found between children diagnosed with NLD versus Asperger's disorder, it was found that children diagnosed with NLD performed significantly lower on a measure of visual-motor integration than all other groups included in the study. However, this was not entirely unexpected, given that it was one of the inclusion criteria for children in the NLD group. The NLD group had lower performance than all other groups included in the study on the Judgment of Line Orientation task (Benton, Hamsher, Varney, & Spreen, 1983). On the Purdue Pegboard (Tiffin, 1968), a measure of fine motor functioning, the performance of the NLD group

could not be distinguished from the performance of the Asperger's disorder group when using the left hand, the right hand, or both hands together. The control group's performance was better than the NLD and Asperger's disorder groups in all three conditions (i.e., right hand, left hand, and both hands). On the Grooved Pegboard test (Matthews & Kløve, 1964), there were no significant differences between the NLD group and the Asperger's disorder group. On the Social Skills Rating Scale (Gresham & Elliott, 1990), a behaviour rating inventory filled out by caregivers of participants, there were no significant differences between the NLD group and the Asperger's disorder group, with both of these groups performing significantly lower than the control group and the two ADHD groups. On a measure of mathematical calculations and a measure of mathematical reasoning, the performance of the NLD group did not differ significantly from the performance of the Asperger's disorder group. Both groups performed significantly lower than the control group on both measures. The NLD group was also found to perform lower than the Asperger's disorder group on the performance composite of the Wechsler Abbreviated Scale of Intelligence (WASI; Psychological Corporation, 1999) which includes the Block Design and Matrix Reasoning subtests). Effect sizes associated with these findings were not reported in the study.

**The Present Study**

Studies investigating multiple aspects of social functioning, including social motivation and pragmatic aspects of communication, and that also make direct comparisons between HFA and NLD are still lacking the literature. Although a large body of literature has studied social functioning in HFA, much work remains to be done in systematically investigating social functioning in NLD. The focus of the present study

was to investigate similarities and differences in observable social behaviour, specifically tapping into social functioning by measuring multiple aspects of communication and social motivation between these two clinical groups. Specifically, the study evaluated characteristics of social adjustment in each group, and whether subscale scores on behavioural rating inventories and the Overall Total score of the ADOS-2 (Lord et al., 2012) significantly predicted diagnostic group membership. This approach was taken because it fits with researchers' previous assertion that a more comprehensive investigation of social functioning, including multiple component abilities instead of only certain abilities in isolation, will result in a more complete and enriched understanding of this domain as well as better prediction of children's overall social adjustment (Crick & Dodge, 1994; Galway & Metsala, 2011). Furthermore, the present study was a pilot study; the aim was first to establish differences at the broadest level of social behaviour (i.e., to examine the third level of the model by investigating multiple components of the SOCIAL model simultaneously) with an eye to informing future research and eventually clinical practice among clinicians who face the difficult task of establishing a differential diagnosis between these two disorders. For example, it would be helpful to know if these two disorders can be reliably differentiated on the basis of social functioning and the clinical instruments with which differences can be reliably demonstrated. There are five specific hypotheses that were investigated:

1. Based on previous research that has found children with NLD tend to have social adjustment difficulties that are of an internalizing nature, it was predicted that the average scores of the NLD group would be elevated (i.e., have a T score of at

least 70) on the Withdrawal, Anxiety, and Depression subscales of the PRS of the second edition of the Behavior Assessment System for Children (BASC-2).

2. Based on previous research that has found children with HFA tend to have significant social adjustment difficulties that are of an internalizing or externalizing nature, it was predicted that, the average scores in the HFA group would be elevated on the Atypicality subscale, the Withdrawal subscale, and the Behavioural Symptoms Index of PRS of the BASC-2.
3. Given the research findings that children across the autism spectrum often have low social motivation and anecdotal reports that children with NLD tend to have intact social motivation, the Reduced Contact and Social Interest subscale of the Children's Social Behaviour Questionnaire Revised (CSBQR) was predicted to significantly differentiate between groups, with children diagnosed with NLD showing higher social contact and interest compared to the HFA group.
4. Research has found that children with HFA have a number of very weak pragmatic skills in the context of relatively intact structural language skills. Observational reports using qualitative data and some empirical studies support that children with NLD tend to have intact structural language skills but weak pragmatic skills (e.g., Petti et al., 2003), although the severity of their difficulty with the latter is unclear. Given the differential diagnosis research that supports the utility of the Social Interaction Difference Index of the second edition of the Children's Communication Checklist (CCC-2) in identifying ASD based on disparity between structural and pragmatic language functioning, it was predicted that the SIDI would significantly differentiate between groups, with the HFA

group displaying lower scores, indicating greater pragmatic difficulties, than the NLD group.

5. Given the available research identifying significant social motivation and pragmatic difficulties in children with HFA, observational reports that children with NLD tend to have intact social motivation, as well as the differential diagnosis research that supports the utility of the second edition of the Autism Diagnostic Observation Schedule in identifying ASD, it was predicted the Overall Total score of Module 3 of the ADOS-2 would differentiate between the NLD and HFA groups, with the HFA group displaying a higher score.

# Chapter 2: Method

## Participants

Participants were children and adolescents between the ages of 9 and 17 years. This age range was largely chosen because the age at which NLD is most commonly diagnosed is nine years (Gragg, Casey, Drummond, & Kayfitz, 2004). In addition to the meeting the age criteria, children must have had a standard score of at least 70 on either the Verbal Comprehension or Perceptual Reasoning Indexes of the fourth edition of the Wechsler Intelligence Scale for Children (WISC-IV), a criterion that was adapted from previous research investigating NLD (e.g., Ris et al., 2007); not have previously been diagnosed with an intellectual disability; not have a history of traumatic brain injury; and not have significant physical impairments related to vision, hearing, or movement (e.g., cerebral palsy) to be included in the study. Children also had to be able to speak fluently in sentences, with evidence of some complex speech (i.e., having the majority of utterances contain two or more clauses; Lord et al., 2012). Children with appropriately managed attention and mood problems were not excluded since this exclusion would not be consistent with the presentation of many children seen in a clinical practice setting and such children have been included in other clinical research studies (e.g., Grodzinsky et al., 2010). Specifically, two participants in the NLD group and one participant in the HFA group had been previously diagnosed with attention-deficit/hyperactivity disorder and were stable on medication. None of the participants in either group were taking medication for anxiety or mood management. Attention-deficit/hyperactivity disorder was not overrepresented in either of the two groups. Demographic characteristics for

participants in the NLD and HFA groups, including information about the health professionals who rendered any previous diagnoses, are included in Table 1.

Table 1

*Demographic characteristics of participants*

| | NLD Group (n = 10) | | HFA Group (n = 12) | | Total Sample (n = 22) | |
|---|---|---|---|---|---|---|
| Gender | | | | | | |
| Males | 6 | | 11 | | 18 | |
| Females | 4 | | 1 | | 5 | |
| Age in years *M(SD)* | 12.8 (2.4) | | 12.3(2.3) | | 12.5(2.3) | |
| Race | | | | | | |
| Caucasian | 9 | | 9 | | 18 | |
| Latino/Latina | 0 | | 2 | | 2 | |
| Indian | 1 | | 1 | | 2 | |
| Multiple diagnoses | 3 | | 3 | | 6 | |
| | Previously diagnosed by | | | | | |
| Previous diagnoses | Physician | Psychologist | Physician | Psychologist | Physician | Psychologist |
| ADHD | 2 | 0 | 0 | 1 | 2 | 1 |
| LD | | | | | | |
| Reading | 0 | 0 | 0 | 1 | 0 | 1 |
| Math | 0 | 5 | 0 | 0 | 0 | 5 |
| Written Expression | 0 | 0 | 0 | 1 | 0 | 1 |
| NLD | 0 | 5 | 0 | 0 | 0 | 5 |
| ASDs | | | | | | |
| PDD-NOS | 0 | 1[a] | 0 | 5 | 0 | 6 |
| Autistic disorder | 0 | 0 | 0 | 1 | 0 | 1 |
| Asperger's disorder | 0 | 0 | 0 | 2 | 0 | 2 |
| ASD | 0 | 0 | 0 | 4 | 0 | 4 |

*Note*. *M(SD)* = mean (standard deviation); all other scores are reported as frequencies; ADHD = attention-deficit/hyperactivity disorder; LD = learning disorder ASD = autism spectrum disorder; NLD = nonverbal learning disorder; PDD-NOS = pervasive developmental disorder not otherwise specified

[a] One participant in the NLD group was given a provisional diagnosis of PDD-NOS at the age of 19 months by a psychologist. When he was reassessed, he did not meet the threshold on the ADOS-2 for PDD-NOS and met the criteria for NLD, so he was assigned to the NLD group.

Specific criteria for the NLD group were adapted from Casey et al. (1991) and are listed in Table 2. These criteria reflect the primary neuropsychological strengths and weaknesses outlined in Rourke's (1989, 1995) model of NLD, and were used in a manner that is similar to that of Casey et al. (1991) as a means of identifying potential participants. That is, these criteria do not include all defining features of NLD; for example, nonverbal problem-solving and concept formation as well as adaptation to unfamiliar situations were not used as inclusion criteria because these data were not available for all participants.

Table 2

*Criteria for inclusion in the NLD group*

| Functional Domain | Test based criteria |
|---|---|
| Bilateral tactile perceptual impairments | Performance on the Fingertip Number Writing Test of the Sensory Perceptual Exam at least 1 SD below the norm |
| Bilateral psychomotor impairments | Performance on the Grooved Pegboard test at least 1 SD below the norm |
| Visuospatial/organizational impairments | Performance on the Judgment of Line Orientation Test at least 1 SD below the norm and VCI > PRI by 10 or more standard score points |
| Adequate verbal capacities | Performance on the VCI of the WISC-IV > 70 |
| Mechanical arithmetic impairments | Performance on the WIAT-III Word Reading and Spelling subtests exceeded that of the Numerical Operations subtest by 10 or more standard score points |

*Note.* SD = standard deviation; VCI = Verbal Comprehension Index; PRI = Perceptual Reasoning Index; WISC-IV = Wechsler Intelligence Scale for Children Fourth Edition (Wechsler, 2003); WIAT-III = Wechsler Individual Achievement Test Third Edition (Wechsler, 2010)

Children included in the HFA group must have had a previous diagnosis of an ASD under the criteria outlined in DSM-IV-TR (APA, 2000) or DSM-5 (APA, 2013) that was made by a psychologist or physician, including PDD-NOS, Asperger's disorder, autistic disorder, or ASD. There were no specific inclusion criteria pertaining to neuropsychological functioning for the HFA group.

Not all children of the parents who contacted the principal investigator were eligible to participate in the study. Demographic characteristics of participants who did not meet initial screening and eligibility criteria, including reported previous clinical diagnoses, are presented in Table 3.

Table 3

*Demographic characteristics of participants who were not eligible to continue participating in the study*

| Demographic variable | | | |
|---|---|---|---|
| Total participants not included in analysis | 9 | | |
| Gender (frequency) | | | |
| Males | 6 | | |
| Females | 3 | | |
| Age in years *M(SD)* | 13.01 (2.95) | | |
| Race (frequency) | | | |
| Caucasian | 9 | | |
| FSIQ *M(SD)* | 101.33(11.81) | | |
| Previous diagnoses (frequency) | | Diagnosed by a Physician | Diagnosed by a Psychologist |
| ADHD | 6 | 3 | 3 |
| Learning Disorder | | | |
| Reading | 3 | 0 | 3 |
| Math | 2 | 0 | 2 |
| Executive Function | 2 | 0 | 2 |
| Written Expression | 4 | 0 | 4 |
| Participants with multiple diagnoses (frequency) | 6 | | |

*Note*. *M(SD)* = mean (standard deviation); ADHD = attention-deficit/hyperactivity disorder; FSIQ = Full Scale Intelligence Quotient

**Procedure**

Approval for this study was obtained from the University of Windsor Research Ethics Board prior to participant recruitment and data collection. Participants were recruited from a variety of sources in the Windsor-Essex community, including advertisements placed in newsletters; advertisements posted online; fliers placed at various locations and organizations geared toward children with learning disorders or ASD in the community; fliers distributed by the Special Education Coordinators of the local public school board; in-person recruitment at community events geared toward children with learning disorders or ASDs; and word of mouth. Purposive sampling, a type of nonrandom sampling, was used (Shadish, 2002). That is, participants from the specific diagnostic groups under investigation were sought and invited to participate, and their eligibility was confirmed through a review of developmental history, previous diagnoses, and assessment results. Purposive sampling may or may not lead to samples that are representative of the population to which the researchers wish to generalize (Bluman, 2006). For a sample to be representative, it must be similar to the population of interest on variables relevant the defining characteristics of that population (Bluman, 2006; Shadish, 2002), such as ratio of males to females, core diagnostic characteristics of the disorder of interest, and adequate overall intellectual ability for the populations under investigation in the present study.

Approximately 50 parents of potential participants contacted the principal investigator by phone or email regarding participation in the study. Parents responded to screening questions (Appendix A) to determine if their child was eligible to participate in the study. That is, a child must have met inclusion criteria for the HFA group or have

been likely to meet inclusion criteria for the NLD group (i.e., parents must have endorsed several of the items listed in screening question 6 in Appendix A and their child must have met all other inclusion criteria), the latter of which could be definitively determined only after neuropsychological testing had been completed. Of those 50 potential participants, 33 met initial screening criteria and were invited to participate in the study. Of those 33 participants, two did not attend any appointments on campus and declined to participate in the study when contacted again. Thirty-one participants attended the first appointment. Two participants who did not meet criteria for either group were lost to follow-up after the first appointment and the remaining seven participants also did not meet criteria for either group. A diagram of the flow of participants through the study is presented in Figure 5.

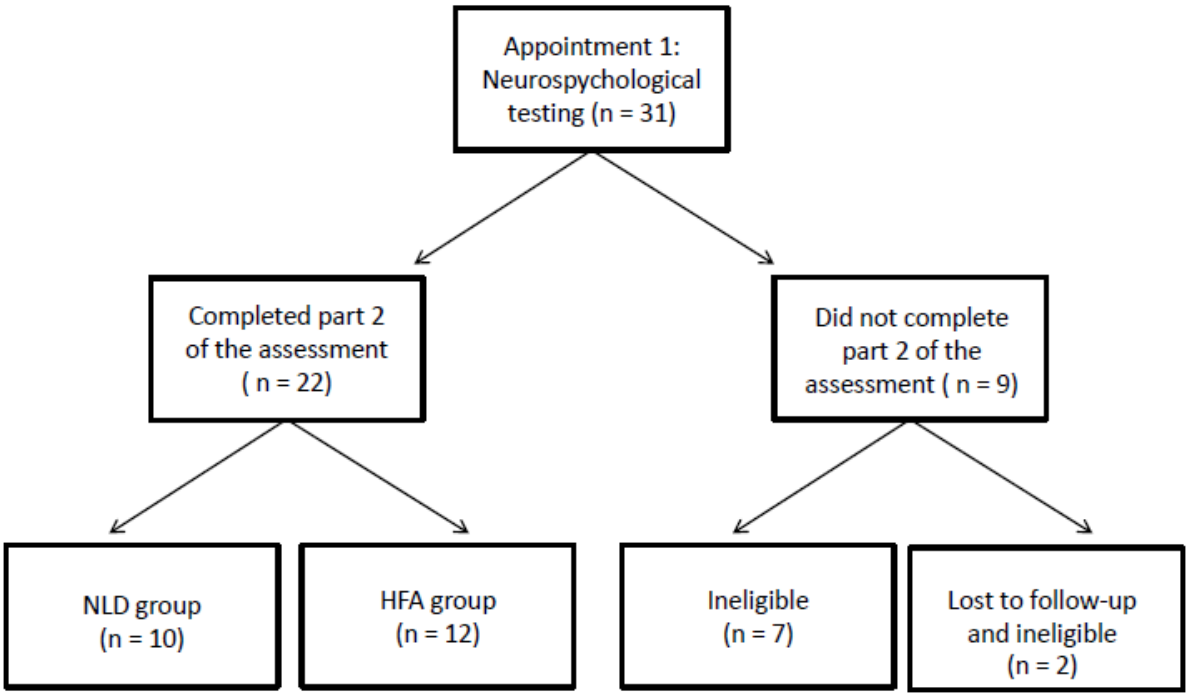


*Figure 5.* Diagram of the flow of participants through the study. Participants were deemed to be ineligible to continue participating in the study if they did not meet criteria for the NLD group or the HFA group.

After enrolling in the study, participants were invited for two appointments on the University of Windsor campus, with the first lasting about six and a half hours and the second lasting about two hours. Participants were given a five dollar gift card to Tim Horton's for each appointment that they attended as compensation for their participation. Information provided by participants and their parents was kept confidential within the research team. Written informed consent from guardians and assent from child participants was obtained during the first in-person contact with the principal investigator or the graduate student research assistant. Participants were provided with a letter of information that described the purpose, procedure, anticipated risks and benefits, and the extent of the time commitment involved in participating in the research study (Appendix B) and the graduate student investigator retained a copy of the signed informed assent and consent forms (Appendix C). Participants were made aware that they could withdraw from the study at any time without incurring any adverse consequences. Parents completed a developmental history form (Appendix D) and behavior rating inventories while their children completed neuropsychological testing in a separate quiet room. Child participants were tested by either the principal investigator or a clinically trained graduate student research assistant.

After the initial testing appointment, test data were compiled into a summary of the major findings that included recommendations to support participants' learning. Each case was reviewed during supervision with the faculty supervisor. During the second appointment, feedback was provided to child participants and their guardians regarding the assessment results, diagnostic impressions, recommendations, and eligibility to continue participating in the study. It was beyond the scope of the measures included in

the present study to establish a diagnosis of ASD. If participants who had not previously been diagnosed with an ASD exceeded the threshold for ASD on the ADOS-2 and on the CCC-2, which has been used to screen for ASD (Bishop, 2006), families were told of the potential diagnosis and given referral information for local psychologists who complete diagnostic assessments for ASD. A summary of the child's performance was provided to parents. The ADOS-2 (Lord et al., 2012) was administered to participants who were eligible to complete the study. The principal investigator attended an ADOS-2 (Modules 1 – 4) Introductory Clinical Workshop that was facilitated by a certified independent ADOS-2 and Autism Diagnostic Interview Revised trainer prior to administering the ADOS-2 to participants. Participants were videotaped when completing the ADOS-2 unless they declined to be recorded due to extreme anxiety or self-consciousness, which occurred for two participants.

Participants were assigned to groups on the basis of developmental history, neuropsychological test results, and previous diagnoses. Parents of participants provided copies of diagnostic reports indicating the previous diagnoses that their children had received, when they were made, and by whom. Only participants with a previous diagnosis of ASD were included in the HFA group. Only one participant could potentially be assigned to either group. This ten year old boy presented with a provisional diagnosis of PDD-NOS from a clinical psychologist made at the age 19 months on the basis of his mother's responses to several questionnaires (i.e., the Screening Tool for Autism in Two-Year Olds, the Infant/Toddler Symptoms Checklist, Autism Behaviour Checklist, Autism Screening Questionnaire, and the Childhood Autism Rating Scale. At the time of participation in this study, he met experimental criteria for the NLD group and

did not meet the threshold for an ASD on the ADOS-2. As a result of these findings, he was assigned to the NLD group and this was communicated to him and his family.

**Measures**

Participants in both groups completed the same measures. All included measures were standardized and had normative data available except in the case of the NLD scale, which was used qualitatively, and the ADOS-2, from which raw scores were used. The measures were divided into two groups: those used to determine eligibility (i.e., neuropsychological and screening measures) and those used to compare the groups and operationalize the dependent variables included in the present study. Including a comprehensive battery of neuropsychological measures served three purposes: it allowed the investigators to assign participants to the appropriate group, write a neuropsychological assessment report for each participant as an incentive to participate in the study, and collect data for subsequent research projects that were under development at the time of this study. Neuropsychological and screening measures were chosen based on research findings supporting their usefulness in establishing the diagnosis of NLD or learning disorders more generally. The constructs measured, the reason for inclusion, available information pertaining to reliability and validity, and a description of tasks or activities involved are presented in Appendix E for the neuropsychological and screening measures, and Appendix F for the group comparison measures. In the following section, the variables operationalized by the group comparison measures, which assessed aspects of social and language functioning, are briefly reviewed.

## Group Comparison Measures

**Autism Diagnostic Observation Schedule Second Edition.** To ensure consistency throughout the present study, all participants completed Module 3 of the ADOS-2. The Overall Total score of Module 3 of the ADOS-2 was used to investigate whether two clinical groups performed differently relative to the cut-off for ASD. It was also used to operationalize the constructs of social motivation and pragmatic aspects of communication, due to the fact that these abilities are evaluated by the coding system and contribute to the Social Affect composite score.

**Behavior Assessment System for Children Second Edition.** The BASC-2 was used to operationalize social adjustment and adaptive functioning. As a broad-band measure that is capable of detecting and quantifying overall behavior patterns and symptoms, such as those consistent with internalizing or externalizing symptomatology and adaptive behavior difficulties, it is suited to operationalizing social adjustment and adaptive behavior. The frequency of individuals who had elevated scores and elevated scores in the average profiles of each clinical group were compared using the interpretive categories outlined in the BASC-2 manual to define the severity of the elevations (Reynolds & Kamphaus, 2004).

**The Children's Communication Checklist Second Edition (CCC-2; Bishop, 2006).** In the present study, the SIDI of the CCC-2 was used to operationalize pragmatic aspects of communication, which tend to be an area of difficulty for children in both clinical groups under investigation. Specifically, the SIDI was used to investigate whether two clinical groups performed differently relative to the cut-off for ASD.

**Children's Social Behaviour Questionnaire Revised.** The Reduced Contact and Social Interest subscale of the CSBQR was used in the present study to operationalize social motivation, which tends to be unusually low in children with ASD (Chevallier, Kohls, et al., 2012). In contrast, children with NLD have been reported to desire friends and social connections (i.e., to be socially motivated), but often they are not able to achieve these goals due to difficulties with social skills. However, no research studies to date have systematically investigated social motivation in children with NLD. The construct of social motivation is of interest for both groups and may be useful in differentiating between them.

**Research Design and Statistical Methods**

A between-subjects quasi-experimental design was used. Examiners were aware of participants' previous clinical diagnoses prior to testing, resulting in them having a reasonably good idea of the experimental group in which participants would be placed.

All measures included in the analyses were standardized. Participants' scores were transformed into standard scores, scaled scores, or T scores based on normative data for all measures except the ADOS-2. Linearly transforming raw scores into standardized scores is appropriate when a normal curve approximates the distribution of a population (Strauss, Sherman, & Spreen, 2006). Transforming scores enables comparisons between measures, controls for age (Strom, Gray, Dean, & Fischer, 1987), and indicates an individual's relative standing in comparison to other members of the population (Strauss et al., 2006). Raw scores were used from the ADOS-2 because it has been found that Module 3 scores have low correlations with age, VIQ, and PIQ (Gotham, Risi, Pickles, & Lord, 2007; Gotham, Pickles, & Lord, 2009). T scores, which have a mean of 50 and a

standard deviation of 10, scaled scores, which have a mean of 10 and a standard deviation of 3, or raw scores (in the case of the ADOS-2) were used in the analyses. Additionally, interpretive ranges have been developed for the standardized scores of the BASC-2 and CCC-2 and the raw scores of the ADOS-2 from their respective normative data sets. Descriptive statistics (e.g., means) of clinical groups have been compared to normative data and pre-established categories of impairment in a number other studies that have not included a control group (e.g., Kashluba, Hanks, Casey, & Millis, 2008; Stern & Morris, 2013). Hypotheses 1 and 2 were investigated using a similar approach, including comparing the means and standard deviations of group profiles as well as the frequency of individual scores in each group in certain interpretive ranges for selected subscales of the BASC-2.

Hypothesis 3, 4, and 5 were investigated using binary logistic regression. This is the most appropriate form of regression analyses when a dichotomous dependent variable and continuous, ordinal, or categorical independent variables are included in the model (Hosmer & Lemeshow, 2000). Logistic regression allows for a simultaneous overall evaluation of the model (e.g., model fit), calculation of effect size based on odds ratios, and determination of which predictors included in the model significantly add to prediction of diagnostic status. Wald statistics and likelihood ratio tests were used to determine the significance of predictors because the former allows an effect size to be calculated and the latter is more reliable when analyzing small samples (Bewick, Cheek, & Ball, 2005). Investigation of hypotheses 3, 4, and 5 involved separate statistical analyses using logistic regression, each with one predictor entered into the model. The predictors were treated as continuous variables, as is often done with categorical

variables that that have seven or more categories and quantitative attributes (Tabachnick & Fidell, 2007). A model that uses nominal outcome categories was tested for each hypothesis.

The logistic regressions from hypotheses 3, 4 and 5 were followed by Receiver Operating Characteristic (ROC) curve analyses to further assess the fit of the model (Hosmer & Lemeshow, 2000). The area under a ROC curve, which ranges in value from zero to one, is an indicator of the binary logistic regression's ability to differentiate between participants who have a certain outcome (i.e., those in the ASD group in the context of the present study) versus those who do not (i.e., those in the NLD group in the present study, since no other groups were included in the analysis; Hosmer & Lemeshow, 2000). Hosmer and Lemeshow (2000) offer interpretive guidelines for ROC curves that state an area under the curve (AUC) that is between 0.7 less than 0.8 indicates acceptable discrimination, an AUC between 0.8 less than 0.9 indicates excellent discrimination, and an AUC equal to or greater than 0.9 indicates outstanding discrimination.

Two-way contingency table analyses were also used to investigate hypotheses 4 and 5. Two-way contingency table analyses were done to investigate if there is a relationship between diagnostic group and SIDI, as well as between diagnostic group and the Overall Total from the ADOS-2, respectively.

In terms of statistical assumptions, binary logistic regression does not make assumptions about the distributions of the predictors. However, it does require the absence of perfect separation (i.e., that membership in the outcome categories is perfectly predicted); that the ratio of cases in the smaller group to predictor variables included in the model is at least ten to one; the absence of multicollinearity among the predictors

when multiple predictors are entered into the model; the absence of outliers; that continuous predictors are linear in the logit; and independence of errors (i.e., each case is unrelated to the other cases included in the analysis; Hosmer & Lemeshow, 2000; Tabachnick & Fidell, 2007). Assumptions that needed to be met in order to use a two-way contingency table were that data were obtained from a random sample, that observations were independent (i.e., that each participant is in only one experimental group) and that the expected value in each cell is at least 5 (Bluman, 2006). No data were missing for the dependent variables included in all analyses. Statistical analyses were carried out using IBM SPSS Statistics 21 (IBM, 2012) and R (R Development Core Team, 2015). A criterion of an alpha level of .05 was adopted to determine significance.

# Chapter 3: Results

## Participant Characteristics

A total of 31 participants enrolled in the study after speaking with the principal investigator and answering screening questions (Appendix A). The recruitment period began in March 2013 and ended in May 2015. Data collection began in April 2013 and concluded in May 2015. Of the 31 participants who enrolled, 10 met criteria for the NLD group based on the results of neuropsychological testing and 12 met criteria for the HFA group. These 22 participants were included in all statistical analysis. Means and standard deviations for the inclusion criteria for the HFA and NLD groups are presented in Table 4. The NLD group obtained significantly lower scores on several neuropsychological variables in comparison to the HFA group (*p* values are provided in Table 4), which had inclusion criteria that required only a restriction on VCI and none of the other neuropsychological variables.

Table 4

*Descriptive statistics for the neuropsychological measures used to define inclusion criteria for the HFA and NLD groups*

| Inclusion Criterion | NLD Group (n = 10) *M(SD)* | HFA Group (n = 12) *M(SD)* | *p* value |
|---|---|---|---|
| Fingertip Number Writing Test (Right)[a] | 20.3(13.8) | 36.5(16.8) | .05* |
| Fingertip Number Writing Test (Left) [a] | 18.6(9.4) | 39.1(14.4) | .003** |
| Grooved Pegboard (Dominant) [a] | 25.2(14.0) | 32.6(15.2) | .25 |
| Grooved Pegboard (Nondominant) [a] | 23.8(13.9) | 28.7(14.2) | .43 |
| JOLO [a] | 30.0(10.0) | 45.8(9.9) | .001** |
| WISC-IV Composite Scores[b] | | | |
| FSIQ | 80.8(11.8) | 94.5(19.2) | .05* |
| VCI | 96.4(13.2) | 98.8(22.6) | .76 |
| PRI | 78.4(14.5) | 96.7(22.0) | .04* |
| WIAT-III Subtests[b] | | | |
| Word Reading | 94.7(13.1) | 99.8(18.3) | .47 |
| Spelling | 95.9(13.9) | 101.0(23.0) | .53 |
| Numerical Operations | 74.5(6.7) | 98.9(17.5) | < .001** |

*Note*. *M(SD)* = mean (standard deviation); JOLO = Judgement of Line Orientation Test; WISC-IV = Wechsler Intelligence Scale for Children Fourth Edition; FSIQ = Full Scale Intelligence Quotient; VCI = Verbal Comprehension Index; PRI = Perceptual Reasoning Index; WIAT-III = Wechsler Individual Achievement Test Third Edition

[a] T scores

[b] Standard scores

* $p < .05$

** $p < .01$

To investigate the presence of differences between the clinical groups, an independent samples *t* test found that the groups did not differ significantly with respect to age, $t(20) = .58$, $p = .57$, or scores on the VCI of the WISC-IV, $t(18.10) = .30$, $p = .76$. In contrast, the groups differed significantly on the PRI of the WISC-IV, $t(20) = 2.24$, $p = .04$, which contributed to a significant difference on the FSIQ, $t(18.59) = 2.05$, $p = .05$. A two-way contingency table analysis was conducted to evaluate whether the proportion of Caucasian, Latino/Latina, and Indian participants was the same across the two groups. The proportions were not found to differ significantly, $\chi^2$ (2, N = 22) = 1.83, $p = .40$. A direct statistical comparison of the proportion of males to females between experimental groups was not able to be completed due to violations of the assumptions that must be met to conduct the chi-square test of homogeneity, including the small sample size and the unequal group size (Bluman, 2006; Green & Salkind, 2005). However, it was found that the proportion of males and females in the NLD group did not significantly differ from the approximately equal proportion of males and females noted in the literature (Casey, 2015), $\chi^2(1, N = 10) = .40$, $p = .53$. In terms of the HFA group, the proportion of males to females did not significantly differ from the 4 to 1 ratio of males to females noted in the literature (Rice, 2009), $\chi^2(1, N = 12) = 1.02$, $p = .31$. These findings support that the two groups were representative of their respective clinical populations in terms of the proportion of males to females.

**Data Analysis**

**Hypothesis 1.** To interpret the results obtained on the forms of the BASC-2, raw scores were converted into T scores by using a scoring software program. On the BASC-2, T scores of 60 through 69 inclusive on the clinical scales and composites indicate areas

that are "At Risk" and T scores of 70 or higher indicate an area that is "Clinically Significant." On the adaptive scales and composite, T scores of 31 through 40 inclusive indicate areas that are "At-Risk" and of concern, and T scores of 30 or less indicate areas in which there are "Clinically Significant" difficulties (Reynolds & Kamphaus, 2004). The norms available for the PRS include norms for a clinical group and a general group. The nonclinical norms were used to provide a comparison to the normative population and to act as the "control group" in the present study. Specifically, using the nonclinical norms allowed the frequency of participants with "At Risk" and "Clinically Significant" elevations to be calculated, providing information regarding psychosocial adjustment in comparison to the normative population.

The first hypothesis predicted that the average scores of the NLD group would be elevated (i.e., have a T score of at least 70) on the Withdrawal, Anxiety, and Depression subscales of the second edition of the Behavior Assessment System for Children (BASC-2). This was investigated with descriptive statistics to determine whether the NLD group tended to have clinically elevated scores on the Withdrawal, Depression, and Anxiety subscales on the PRS of the BASC-2. The proportion of participants in the NLD group who demonstrated clinically elevated scores was also of interest, given the previous findings that only some children with NLD have internalized difficulties. Means and standard deviations for performance on the PRS of the BASC-2 for both the HFA group and the NLD group are presented in Table 5. On average, it was found that the NLD group demonstrated At-Risk elevations (i.e., a T score between 60 and 69) on the Withdrawal and Anxiety subscales, but the average score on the Depression scale was within normal limits compared to peers. Additional At-Risk elevations were present on

the Behavioural Symptoms Index (including the Atypicality, Withdrawal, and Attention Problems subscales, three of the six subscales that comprise this composite), as well as on the Adaptive Skills composite (including the Leadership, Activities of Daily Living, and Functional Communication subscales). The means of the subscales and composites did not reach the level of clinical significance. At the individual level, it was found that five participants in the NLD group had At-Risk elevations and three participants had Clinically Significant elevations (i.e., a T score of 70 or greater) on the Withdrawal subscale, meaning that 8 out of 10 participants in the NLD group experience at least some social dysfunction due to a tendency to withdraw from others. Five participants in the NLD group had At-Risk elevations, and one participant had a Clinically Significant elevation on the Anxiety subscale, meaning that 6 out of 10 participants in the NLD group were reported by their parents to have at least some difficulty with anxiety. Similarly, four participants in the NLD group had At-Risk elevations, and one participant had a Clinically Significant elevation on the Depression subscale. Overall, 5 out of 10 participants in the NLD group were reported by their parents to be having at least some depressive symptoms. The number of individual participants with At-Risk and Clinically Significant elevations on all other subscales and composites is listed in Table 5.

Table 5

*Descriptive statistics for the PRS of the BASC-2 for the HFA and NLD groups*

| | NLD Group (n = 10) | | HFA Group (n = 11)[a] | |
|---|---|---|---|---|
| BASC-2 Composite or Subscale | *T* score *M(SD)* | Elevations (frequency) | *T* score *M(SD)* | Elevations (frequency) |
| Externalizing Problems | 51.60(8.09) | 2 AR, 0 CS | 55.64(8.76) | 3 AR, 1 CS |
| Hyperactivity[b] | 58.70(18.43) | 2 AR, 2 CS | 61.45(9.97) | 4 AR, 2 CS |
| Aggression[b] | 48.80(5.65) | 1 AR, 0 CS | 52.91(8.10) | 3 AR, 0 CS |
| Conduct Problems | 46.70(6.27) | 0 AR, 0 CS | 51.09(9.32) | 0 AR, 1 CS |
| Internalizing Problems | 59.40(14.82) | 2 AR, 2 CS | 54.18(10.96) | 2 AR, 1 CS |
| Anxiety | 60.80(7.77) | 5 AR, 1 CS | 59.45(12.53) | 3 AR, 2 CS |
| Depression[b] | 55.80(14.61) | 4 AR, 1 CS | 53.27(12.52) | 1 AR, 1 CS |
| Somatization | 56.40(17.77) | 1 AR, 2 CS | 47.36(9.76) | 2 AR, 0 CS |
| Behavioural Symptoms Index | 63.10(9.30) | 4 AR, 3 CS | 63.82(10.23) | 2 AR, 4 CS |
| Atypicality[b] | 68.40(11.61) | 2 AR, 5 CS | 72.18(19.19) | 2 AR, 6 CS |
| Withdrawal[b] | 67.50(13.83) | 5 AR, 3 CS | 63.55(15.24) | 5 AR, 3 CS |
| Attention Problems[b] | 60.80(7.87) | 6 AR, 1 CS | 61.45(8.14) | 5 AR, 1 CS |
| Adaptive Skills | 39.30(8.14) | 5 AR, 1 CS | 39.55(9.71) | 3 AR, 2 CS |
| Adaptability | 44.60(9.56) | 2 AR, 1 CS | 41.36(10.84) | 4 AR, 1 CS |
| Social Skills | 44.20(8.55) | 4 AR, 0 CS | 42.64(11.70) | 3 AR, 2 CS |
| Leadership | 37.50(6.57) | 5 AR, 2 CS | 40.82(10.75) | 6 AR, 1 CS |
| Activities of Daily Living | 37.40(10.45) | 4 AR, 2 CS | 39.00(12.63) | 5 AR, 3 CS |
| Functional Communication | 40.60(7.32) | 5 AR, 1 CS | 41.27(7.09) | 3 AR, 1 CS |

*Note*. *M(SD)* = mean (standard deviation); AR = At-Risk elevation on the BASC-2, defined as a T score between 60 and 69 (inclusive) on subscales of the Externalizing Problems, Internalizing Problems, and Behavioural Symptoms Index, and a T score between 31 and 40 (inclusive) on the Adaptive Skills composite; CS = Clinically Significant elevation on the BASC-2, defined as a T score of 70 or higher on the subscales of the Externalizing Problems, Internalizing Problems, and Behavioural Symptoms Index, and a T score of 30 or less on the Adaptive Skills composite.

[a] The BASC-2 was not available for one participant in the HFA group.

[b] Subscales that comprise the Behavioural Symptoms Index.

**Hypothesis 2.** Hypothesis 2 was that the HFA group would have mean scores on the PRS of the BASC-2 that would be elevated (i.e., have a T score of at least 70) on the Atypicality subscale, the Withdrawal subscale, and the Behavioural Symptoms Index. This was investigated with descriptive statistics; means and standard deviations for all clinical scales, adaptive scales, and composite scores are presented in Table 5. On average, it was found that the HFA group demonstrated a Clinically Significant elevation on the Atypicality subscale. At-Risk elevations (i.e., a T score between 60 and 69) were present on the Behavioural Symptoms Index (including the Withdrawal, Hyperactivity, and Attention Problems subscales, three of the six subscales that comprise this Index), as well as on the Adaptive Skills composite (including the Activities of Daily Living and Leadership subscales). At the individual level, it was found that two participants had At-Risk elevations and six participants had Clinically Significant elevations on the Atypicality subscale, meaning that 8 out of 10 participants in the HFA group were reported by their parents to display unusual behaviours. Similarly, two participants had At-Risk elevations and four participants had Clinically Significant elevations on the Behavioural Symptoms Index. The Withdrawal subscale is a component of the Behavioural Symptoms Index. On this scale, five participants had At-Risk elevations and three participants had Clinically Significant elevations. The number of individual participants with At-Risk and Clinically Significant elevations on all other subscales and composites is listed in Table 5.

**Hypothesis 3.** The third hypothesis was that the Reduced Contact and Social Interest subscale of the revised version of the Children's Social Behaviour Questionnaire (CSBQR) would significantly differentiate between diagnostic groups, with children

diagnosed with NLD showing significantly higher social contact and interest compared to the HFA group. Descriptive statistics for the Reduced Contact and Social Interest subscale are provided in Table 6. This hypothesis was investigated using simple logistic regression followed by a ROC curve analysis. In the simple logistic regression analysis, experimental group was the outcome and the Reduced Contact and Social Interest subscale of the CSBQR was entered into the model as a predictor.

Statistical assumptions for this analysis were met. There were ten cases in the NLD group and one predictor variable included in the model, meeting the minimum requirements for a ten to one ratio of cases to predictor variables. Perfect separation was not found (refer to the classification rate in the following paragraph). Outliers were assessed using Cook's distance, with values greater than one being identified as outliers (Tabachnick & Fidell, 2007), and standardized residuals, with values that have an absolute value greater than three, being identified as outliers. Based on these criteria, no outliers were identified. To assess whether the predictor was linearly related to the logit of the dependent variable, a Box-Tidwell transformation was performed. The interaction term for the transformed variable and the predictor, as well as the predictor were simultaneously entered into the model for the Box-Tidwell test. The Box-Tidwell test was nonsignificant, indicating that the predictor is linearly related to the logit of the dependent variable. The independence of errors assumption was also met because each participant included in the analysis was unrelated to the other participants.

Data from all 22 participants were available for analysis. An overall test of the fit of the model including the constant and the CSBQR subscale as a predictor was not statistically significant, $\chi^2$ (1, N = 22) = .001, $p$ = .98, indicating that the model did not

reliably differentiate between the two groups. Classification was unimpressive, with an overall success rate of 54.5%. Specifically, the model predicted that all participants would be in the HFA group, resulting in a 0% correct classification rate for the NLD group and a 100% correct classification rate for the HFA group. The CSBQR subscale score did not reliably predict group membership according to the Wald criterion, $\chi^2$ (1, N = 22) = .001, $p$ = .98, and a likelihood ratio test $\chi^2$ (1, N = 22) = .001, $p$ = .98. The odds ratio of .999 shows little change in the likelihood of being assigned to the HFA group on the basis of a one unit change in the Reduced Contact and Social Interest subscale of the CSBQR. Based on this odds ratio, an alpha level of .05, and a sample size of 22, the power for the analysis was .1. Table 7 shows regression coefficients, Wald statistics, odds ratios, 95% confidence intervals for odds ratios for the predictor and the constant, and likelihood ratio test statistics.

Table 6

*Descriptive statistics for the independent variables for the HFA and NLD groups*

| Dependent Variable | NLD Group (n = 10) *M(SD)* | HFA Group (n = 12) *M(SD)* |
|---|---|---|
| Reduced Contact and Social Interest[a] | 21.7(16.02) | 21.5(15.97) |
| SIDI[b] | -3.60(5.10) | -12.33(6.64) |
| Overall Total[c] | 5.10(3.21) | 10.25(5.10) |
| Social Affect[d] | 3.4(2.46) | 6.75(3.74) |

*Note*. *M(SD)* = mean (standard deviation); SIDI = Social Interaction Difference Index
[a] T score from the Reduced Contact and Social Interest subscale of the Children's Social Behaviour Questionnaire Revised. Lower scores indicate greater dysfunction.
[b] Raw score of the Social Interaction Difference Index of the Children's Communication Checklist Second Edition. Lower scores indicate greater dysfunction. A SIDI score of less than -10 tends to be obtained by children with a diagnosis of ASD.
[c] Raw score of the Overall Total score of the Autism Diagnostic Observation Schedule Second Edition. Higher scores indicate greater dysfunction. A cut-score of 7 is used in combination with other information to establish a diagnosis of ASD (Lord et al., 2012).
[d] Raw score of the Social Affect composite of the Autism Diagnostic Observation Schedule Second Edition. Higher scores indicate greater dysfunction.

Table 7

*Logistic Regression Results for Hypotheses 3, 4 and 5, as well as post-hoc analyses*

| Variables | *B* | Wald Chi-Square | Odds Ratio | 95 % CI for Odds Ratio *Lower* | *Upper* | G | df |
|---|---|---|---|---|---|---|---|
| Hypothesis 3: | | | | | | | |
| Reduced Contact and Social Interest[a] | -.001 | .001 | .999 | .946 | 1.056 | <.001 | 1 |
| Constant | .201 | .073 | | | | | |
| Hypothesis 4: | | | | | | | |
| SIDI[b] | -.245* | 5.890 | .783 | .643 | .954 | 9.61** | 1 |
| Constant | -1.718 | 3.458 | | | | | |
| Hypothesis 5: | | | | | | | |
| Overall Total[c] | .326* | 4.154 | 1.385 | 1.013 | 1.894 | 7.35** | 1 |
| Constant | -2.181 | 3.456 | | | | | |
| Post-Hoc Analysis: | | | | | | | |
| Social Affect[d] | .386 | 3.793 | 1.471 | .998 | 2.168 | 5.90* | 1 |
| Constant | -1.694 | 2.732 | | | | | |

*Note*. CI = confidence interval; SIDI = Social Interaction Difference Index; G = likelihood ratio test statistic

[a] T score from the Reduced Contact and Social Interest subscale of the Children's Social Behaviour Questionnaire Revised

[b] Raw score of the Social Interaction Difference Index of the Children's Communication Checklist Second Edition

[c] Raw score of the Overall Total score of the Autism Diagnostic Observation Schedule Second Edition

[d] Raw score of the Social Affect composite of the Autism Diagnostic Observation Schedule Second Edition

* $p < .05$

** $p < .01$

To further investigate how well the model discriminates between groups, ROC curve analysis was used; the ROC curve is shown in Figure 6. The area under the curve was .51, indicating discrimination that is no better than chance (Hosmer & Lemeshow, 2000).

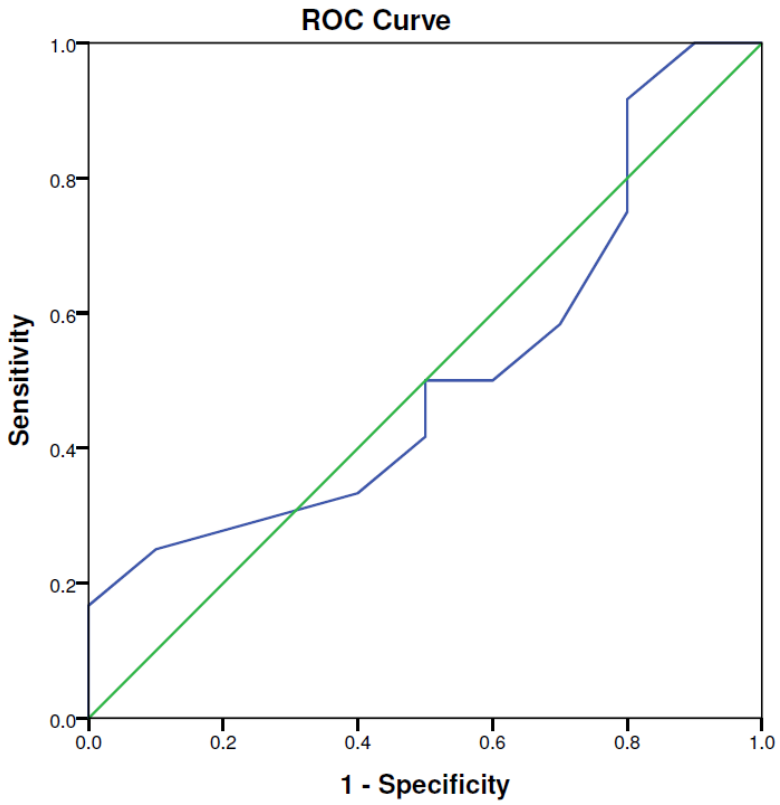


*Figure 6.* Receiver-operator characteristic curve for logistic regression model investigating the differential diagnosis between HFA and NLD using the Reduced Contact and Social Interest subscale of the Children's Social Behaviour Questionnaire Revised.

**Hypothesis 4.** The fourth hypothesis was that the Social Interaction Difference Index of the second edition of the Children's Communication Checklist (CCC-2) would significantly differentiate between diagnostic groups, with the HFA group displaying lower scores than the NLD group. This hypothesis was investigated using simple logistic regression followed by a ROC curve analysis and a 2 x 2 contingency table analysis. Descriptive statistics are presented in Table 8 for the subscales of the CCC-2 and Table 7 for the SIDI of the CCC-2. A simple binary logistic regression analysis was performed with experimental group as the outcome and one predictor entered into the model (i.e., SIDI of the CCC-2).

Statistical assumptions for the binary logistic regression analysis were met. There were ten cases in the NLD group and one predictor variable included in the model, meeting the minimum requirements for a ten to one ratio of cases to predictor variables. Perfect separation was not found (refer to the classification rate in the following paragraph). Outliers were assessed using Cook's distance, with values greater than one being identified as outliers (Tabachnick & Fidell, 2007), and standardized residuals, with values that have an absolute value greater than three being identified as outliers. Based on these criteria, no outliers were identified. To assess whether the predictor was linearly related to the logit of the dependent variable, a Box-Tidwell transformation was performed. The interaction term for the transformed variable and the predictor, as well as the predictor were simultaneously entered into the model for the Box-Tidwell test. The Box-Tidwell test was nonsignificant, indicating that the predictor is linearly related to the logit of the dependent variable. The independence of errors assumption was also met because each participant included in the analysis was unrelated to the other participants.

Data from all 22 participants were available for analysis. An overall test of the fit of the model including the constant and SIDI as a predictor was statistically significant, $\chi^2$ (1, N = 22) = 9.61, $p$ = .002, indicating that the model is useful in differentiating between the two clinical groups. Classification was adequate, with 70% of the NLD group and 75% of the HFA group correctly predicted, for an overall success rate of 72.7%. Table 7 shows regression coefficients, Wald statistics, odds ratios, 95% confidence intervals for odds ratios for the predictor and the constant, and likelihood ratio test statistics. The SIDI score reliably predicted group membership according to the Wald criterion, $\chi^2$ (1, N = 22) = 5.90, $p$ = .02, and the likelihood ratio test $\chi^2$ (1, N = 22) = 9.61,

$p < .01$. As a measure of effect size based on the Wald statistic, the odds ratio shows that for a unit change in SIDI, the odds of being assigned to the HFA group are expected to change by a factor of 1.28. Based on this odds ratio, an alpha level of .05, and a sample size of 22, the power for the analysis was .1.

Table 8

*Descriptive statistics for the CCC-2 for the HFA and NLD groups*

| CCC-2 Scale | NLD Group (n = 10) *M(SD)* | HFA Group (n = 12) *M(SD)* |
|---|---|---|
| Structural Language Skills | | |
| Speech[a] | 47.50(5.56) | 48.25(9.35) |
| Syntax[a] | 47.40(6.36) | 47.08(8.16) |
| Semantics[a] | 44.00(6.58) | 45.00(7.02) |
| Coherence[a] | 41.60(11.74) | 38.42(8.70) |
| Average across structural language scales | 45.13(7.56) | 44.69(8.31) |
| Pragmatic Language Skills | | |
| Initiation[b] | 42.40(7.85) | 32.17(7.25) |
| Scripted Language | 45.20(8.05) | 36.42(8.36) |
| Context | 38.70(8.34) | 37.67(8.97) |
| Nonverbal Communication[b] | 43.60(7.03) | 35.17(5.92) |
| Social Relations[b] | 40.50(7.15) | 39.67(9.41) |
| Interests[b] | 42.10(9.04) | 30.17(7.87) |
| Average across pragmatic language scales in the SIDI | 42.15(7.77) | 34.30(7.61) |
| Average across all pragmatic language scales | 42.08(7.91) | 35.21(7.96) |
| General Communication Composite | 42.00(5.85) | 36.42(3.55) |

*Note*. *M(SD)* = mean (standard deviation); SIDI = Social Interaction Difference Index; all scores are T scores

[a] Structural language skills subscales that are included in the SIDI

[b] Pragmatic language skills subscales that are included in the SIDI

As a further investigation of how well the model discriminates between groups, ROC curve analysis was used; the ROC curve is shown in Figure 7. The area under the

curve was .87, indicating excellent discrimination (Hosmer & Lemeshow, 2000); the optimal cut-off was found to be -8, yielding a sensitivity of .70 and a specificity of .75.

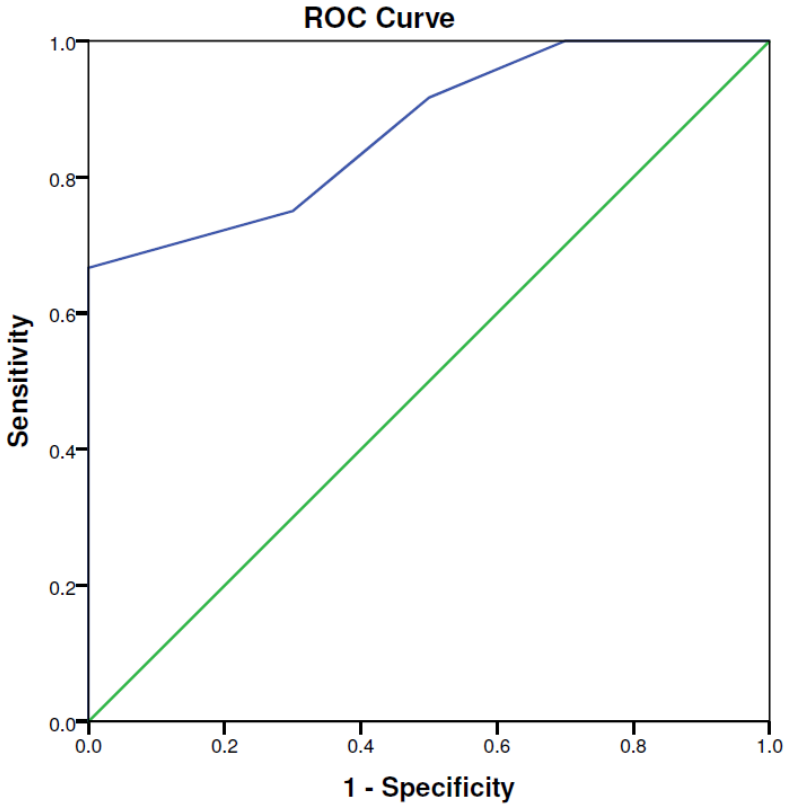


*Figure 7.* Receiver-operator characteristic curve for logistic regression model investigating the differential diagnosis between HFA and NLD using the Social Interaction Difference Index of the Children's Communication Checklist-2.

A two-way contingency table analysis was also completed to investigate whether the proportion of individuals who scored in the ASD range on the SIDI of the CCC-2 was the same in the two groups. The variables were group membership (i.e., NLD or HFA group) and scores of less than -10 on the SIDI (i.e., scores that were consistent with the range in which children with ASD typically fall, based on a well-established cut-off identified through research; Bishop, 2006). The levels for the latter variable were "yes" and "no." Assumptions of the two-way contingency table were met. Group was found to be significantly related to performance on the SIDI of the CCC-2, Pearson $\chi^2$ (1, N = 22)

= 7.24, $p$ = .007, Φ = .57. The phi value, which is a special case of the Pearson-product moment correlation coefficient when used with a 2 x 2 contingency table, indicates a large effect size (Cohen, 1992; Green & Salkind, 2005). The proportion of participants who scored less than -10 (i.e., the optimal cut-off on the CCC-2), falling in the autism spectrum range, was .10 (1 out of 10) of the NLD group and .67 (8 out of 12) of the HFA group. That is, the probability of a participant scoring within the ASD range on the SIDI of the CCC-2 was 6.7 times more likely when the participant was in the HFA group.

**Hypothesis 5.** The fifth hypothesis was that the Overall Total score of Module 3 of the ADOS-2 would differentiate between the NLD and HFA groups, with the HFA group displaying a higher score. It was deemed appropriate for all included participants to complete this module based on adequate fluency of their expressive language. This hypothesis was investigated using simple logistic regression followed by a ROC curve analysis and a 2 x 2 contingency table analysis. A simple logistic regression analysis was performed with experimental group as the outcome and one predictor entered into the model (i.e., Overall Total from Module 3 of the ADOS-2). Descriptive statistics for the Overall Total from the ADOS-2 are displayed in Table 6.

Statistical assumptions for the binary logistic regression analysis were met. There were ten cases in the NLD group and one predictor variable included in the model, meeting the minimum requirements for a ten to one ratio of cases to predictor variables. Perfect separation was not found (refer to the classification rate in the following paragraph). Outliers were assessed using Cook's distance, with values greater than one being identified as outliers (Tabachnick & Fidell, 2007), and standardized residuals, with values that have an absolute value greater than three being identified as outliers. Based on

these criteria, no outliers were identified. To assess whether the predictor was linearly related to the logit of the dependent variable, a Box-Tidwell transformation was performed. The interaction term for the transformed variable and the predictor, as well as the predictor were simultaneously entered into the model for the Box-Tidwell test. The Box-Tidwell test was nonsignificant, indicating that the predictor is linearly related to the logit of the dependent variable. The independence of errors assumption was also met because each participant included in the analysis was unrelated to the other participants.

Data from all 22 participants were available for analysis. An overall test of the fit of the model including the constant and the Overall Total of the ADOS-2 as a predictor was statistically significant, $\chi^2$ (1, N = 22) = 7.35, $p$ = .007, indicating that the model is useful in differentiating between the two groups. Classification was adequate, with 70% of the NLD group and 75% of the HFA group correctly predicted, for an overall success rate of 72.7%. Table 7 shows regression coefficients, Wald statistics, odds ratios, 95% confidence intervals for odds ratios for the predictor and the constant, and likelihood ratio test statistics. The ADOS-2 Overall Total score reliably predicted experimental group membership according to the Wald criterion, $\chi^2$ (1, N = 22) = 4.15, $p$ = .042, and a likelihood ratio test $\chi^2$ (1, N = 22) = 7.35, $p$ < .01. As a measure of effect size based on the Wald statistic, the odds ratio shows that for a unit change in the Overall Total of the ADOS-2, the odds of being assigned to the HFA group are expected to change by a factor of 1.385. Based on this odds ratio, an alpha level of .05, and a sample size of 22, the power for the analysis was .2.

As a further investigation of how well the model discriminates between groups, ROC curve analysis was used; the ROC curve is shown in Figure 8. The area under the

curve was .79, indicating acceptable discrimination (Hosmer & Lemeshow, 2000); the optimal cut-off was found to be 7, yielding a sensitivity of .75 and a specificity of .70.

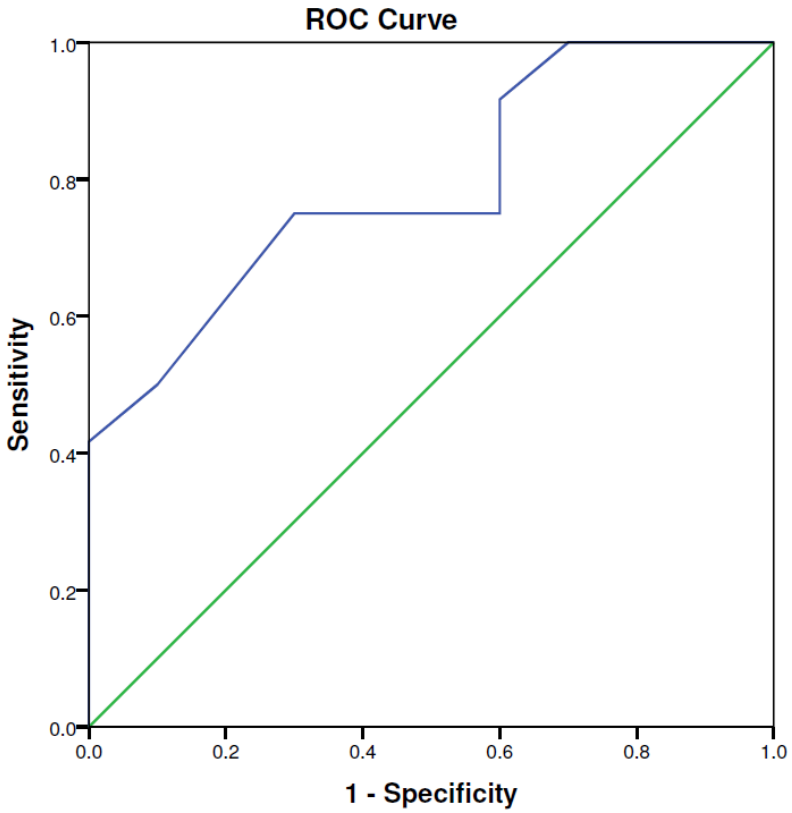


*Figure 8.* Receiver-operator characteristic curve for logistic regression model investigating the differential diagnosis between HFA and NLD using the Overall Total of the Autism Diagnostic Observation Schedule-2.

A two-way contingency table analysis was also completed to evaluate whether the proportion of participants who obtained an Overall Total score on ADOS-2 that was within the ASD range was the same for each experimental group. Of note, group membership was established independent of scores on the ADOS-2 during the present study. Specifically, the two variables were group membership (i.e., NLD or HFA group), and scores meeting or exceeding the clinical cut-off of 7 for the Overall Total score of the ADOS-2 Module 3 (i.e., the levels were “yes” or “no”). The cut-off of 7 was used based on the research literature that has supported that a score of 7 or greater on Module 3 is the

optimal cut-off in terms of sensitivity and specificity to differentiate between individuals who are on the autism spectrum and those who are not (Gotham et al., 2007; Gotham et al., 2008). Assumptions of the two-way contingency table were met. Group and performance on the ADOS-2 were found to be significantly related, Pearson $\chi^2$ (1, N = 22) = 4.46, $p$ = .035, $\Phi$ = .45. The phi value indicates a medium to large effect size (Cohen, 1992; Green & Salkind, 2005). The proportion of participants who scored above the cut-off of 7 on Module 3, falling in the autism spectrum range, was .30 (3 out of 10) of the NLD group and .75 (9 out of 12) of the HFA group. That is, the probability of a participant scoring within the ASD range on the Overall Total of the ADOS-2 was 2.5 times more likely when the participant was in the HFA group.

**Post-hoc analyses.** Given that the significant findings pertaining to the Overall Total of the ADOS-2 reliably differentiating the groups could primarily be driven by scores on the Restricted Repetitive Behaviours composite of the ADOS-2 rather than the Social Affect composite score (which is more of interest because it was used to operationalize the constructs of social motivation and pragmatic aspects of communication), the performance on the Social Affect composite score for each of the groups was of further interest. An additional binary simple logistic regression and ROC curve analyses were conducted using only the Social Affect composite score as a predictor in the model and experimental group as the outcome. Descriptive statistics for the Social Affect composite are presented in Table 6.

Statistical assumptions for the binary logistic regression analysis were met. There were ten cases in the NLD group and one predictor variable included in the model, meeting the minimum requirements for a ten to one ratio of cases to predictor variables.

Perfect separation was not found (refer to the classification rate in the following paragraph). Outliers were assessed using Cook's distance, with values greater than one being identified as outliers (Tabachnick & Fidell, 2007), and standardized residuals, with values that have an absolute value greater than three being identified as outliers. Based on these criteria, no outliers were identified. To assess whether the predictor was linearly related to the logit of the dependent variable, a Box-Tidwell transformation was performed. The interaction term for the transformed variable and the predictor, as well as the predictor were simultaneously entered into the model for the Box-Tidwell test. The Box-Tidwell test was nonsignificant, indicating that the predictor is linearly related to the logit of the dependent variable. The independence of errors assumption was also met because each participant included in the analysis was unrelated to the other participants.

Data from all 22 participants were available for analysis. An overall test of the fit of the model including the constant and the Social Affect composite of the ADOS-2 as a predictor was statistically significant, $\chi^2$ (1, N = 22) = 5.90, $p$ = .015, indicating that the model is useful in differentiating between the two groups. In terms of classification, group membership was correctly predicted for 60% of the NLD group and 67% of the HFA group, giving rise to an overall success rate of 63.6%. Table 7 shows regression coefficients, Wald statistics, odds ratios, 95% confidence intervals for odds ratios for the predictor and the constant, and likelihood ratio test statistics. The Social Affect composite score was not significant according to the Wald criterion, although it approached significance in predicting group membership, $\chi^2$ (1, N = 22) = 3.79, $p$ = .051. However, it was significant in predicting group membership according to a likelihood ratio test $\chi^2$ (1, N = 22) = 5.9, $p$ = .02, which is the preferred statistic with small samples (Bewick et al.,

2005). As a measure of effect size based on the Wald statistic, the odds ratio shows that for a unit change in the Social Affect composite of the ADOS-2, the odds of being assigned to the HFA group are expected to change by a factor of 1.471, which is larger than the factor of 1.385 that was found for the Overall Total score on the ADOS-2, suggesting that the Social Affect composite is largely driving the difference in performance on the ADOS-2 between the groups. Based on the odds ratio of 1.471, an alpha level of .05, and a sample size of 22, the power for the analysis was .2.

As a further investigation of how well the model discriminates between groups, ROC curve analysis was used; the ROC curve is shown in Figure 9. The area under the curve was .75, indicating acceptable discrimination (Hosmer & Lemeshow, 2000); the optimal cut-off for the Social Affect composite score was found to be 5, yielding a sensitivity of .67 and a specificity of .60.

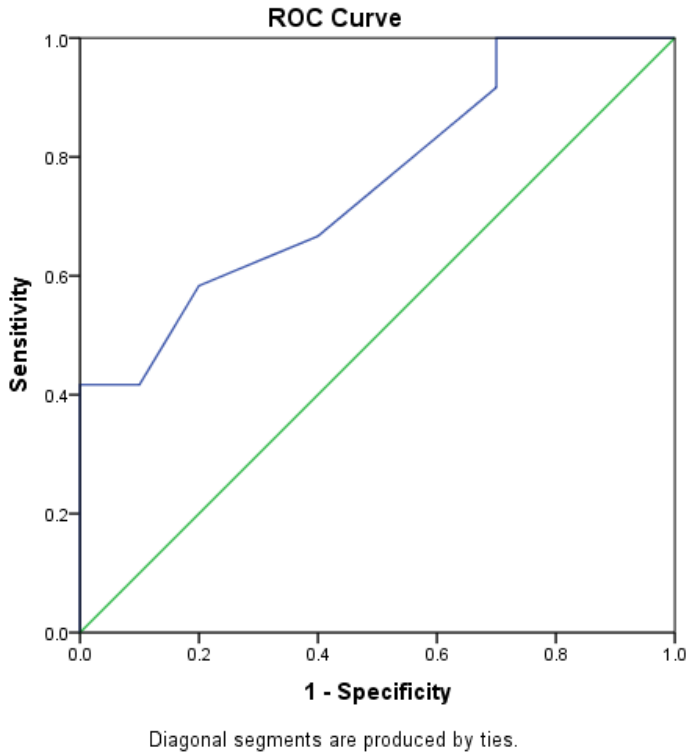


*Figure 9.* Receiver-operator characteristic curve for logistic regression model investigating the differential diagnosis between HFA and NLD using the Social Affect composite score of the Autism Diagnostic Observation Schedule-2.

# Chapter 4: Discussion

The purpose of the present study was to investigate social competence of children in two groups, the high functioning variant of ASD and NLD. This was achieved through the examination of multiple facets of social functioning, including pragmatic aspects of communication, social motivation, and social adjustment, in order to obtain the most comprehensive picture of social competence possible in the context of a pilot study while using diverse methods that included behaviour rating forms and direct observations of social behaviour. This study also aimed to provide preliminary information regarding reliable ways in which to establish a differential diagnosis between NLD and the high functioning variant of ASD. The latter is a practical issue faced by clinicians and other health professionals in many communities who diagnose a variety of learning and other neurodevelopmental disorders, and will help clarify the recommended course of treatment and educational accommodations. Five specific hypotheses were investigated. The major findings included that the SIDI of the CCC-2 and the Overall Total score of the ADOS-2 proved to be useful in reliably differentiating between the two groups under investigation, and that, on average, both the NLD group and the HFA group were reported by parents to have some behavioral and adaptive difficulties on the BASC-2. On average, the NLD group was reported by parents to experience some difficulty with anxiety, while the HFA group was reported to exhibit unusual behaviors that have a clinically significant impact on daily functioning.

## Hypothesis 1

Hypothesis 1 predicted that the average scores of the NLD group would be elevated (i.e., have a T score of at least 70) on the Withdrawal, Anxiety, and Depression

subscales on the PRS of the BASC-2, and this prediction was partially supported. That is, it was found that 8 out of 10, 6 out of 10, and 5 out of 10 children who met experimental criteria for NLD showed At-Risk or Clinically Significant elevations on the Withdrawal, Anxiety, and Depression subscales on the PRS of the BASC-2, respectively. In terms of overlap of elevations among the three scales, two participants in the NLD group had At-Risk or Clinically Significant elevations on all three scales, six participants had At-Risk or Clinically Significant elevations on two scales, and one had only one At-Risk elevation. Additionally, only one participant did not have any elevations across the three scales. These findings are consistent with previous research indicating that many children with NLD show internalized forms of psychopathology (Rourke & Tsatsanis, 2000; Bigler, 1989).

It was not specifically predicted that children in the NLD group would demonstrate difficulties with adaptive behaviors. However, there are a number of sources that note adaptive behavior difficulties that are associated with NLD (e.g., Casey, 2015; Rourke, 1989; Woods, Weinborn, Ball, Tiller-Nevin, & Pickett, 2000). Such research has identified specific areas of difficulty to often include functional communication, daily living skills, leadership skills, and skills pertaining to effectively wielding social influence over others. In line with such findings, the present results indicated that on average the NLD group demonstrated an At-Risk elevation on the Adaptive Skills composite (including At-Risk elevations on the Leadership, Activities of Daily Living, and Functional Communication subscales).

Another unpredicted finding was that on average children in the NLD group had At-Risk elevations on three of the six subscales and the composite score of the

Behavioral Symptoms Index, indicating difficulties associated with unusual behaviors, a tendency to withdraw from peers, as well as difficulties maintaining their attention. The finding of a tendency to exhibit unusual behaviors is consistent with the finding from the CSBQR that was investigated as part of hypothesis 3 (i.e., one of the items most often endorsed by parents was that children with NLD tend to act as if they are in a world of their own). Since the same rater completed both the BASC-2 and the CSBQR for each child, the correspondence between the two measures is not unexpected. There are also some research reports that suggest children with NLD are prone to behavioral difficulties (e.g., Bender & Golden, 1990; Fuerst, Fisk, and Rourke, 1990; Rourke, 1989).

Similar to the present study, Semrud-Clikeman, Walkowiak, Wilkinson, and Minne (2010) found an At-Risk elevation on the Behavioural Symptoms Index of the PRS of the BASC-2, as well as on the Adaptive Skills composite. However, in contrast to the present findings, these researchers found the Depression subscale on average to be elevated within the At-Risk range. The number of individual participants with At-Risk and Clinical elevations on the aforementioned subscales and composites was not reported.

Overall, the present results fit well with research reports indicating that behavioral and adaptive difficulties are common among children with NLD. These difficulties are not specific to this population. However, the general consistency of such findings across research studies indicates that these tend to be areas of weakness that should be included in comprehensive intervention strategies used to help children with NLD.

**Hypothesis 2**

Hypothesis 2 predicted that the average scores would be elevated on the Atypicality subscale, the Withdrawal subscale, and the Behavioural Symptoms Index of the PRS of the BASC-2 in the HFA group. This hypothesis was also partially supported. Specifically, the mean score for the HFA group was within the Clinically Significant range on the Atypicality subscale as predicted (with 8 out of 11 participants in the HFA group having scores in the At-Risk or Clinically Significant ranges), and the At-Risk range for the Withdrawal subscale (with 8 out of 11 participants having scores in the At-Risk or Clinically Significant range) as well as the Behavioural Symptoms Index (with 6 out of 11 participants having scores in the At-Risk or Clinically Significant range). Overall, four of the six subscales that comprise the Behavioural Symptoms Index were in the At-Risk or Clinically Significant ranges (i.e., the Atypicality, Withdrawal, Attention Problems, and Hyperactivity subscales). In terms of overlap of elevations among the Behavioural Symptoms Index, Atypicality subscale and Withdrawal subscale, five participants in the HFA group had At-Risk or Clinically Significant elevations on all three scales; three participants had At-Risk or Clinically Significant elevations on two of the three scales, and one had only one At-Risk elevation. Two participants did not have any elevations across the three scales. Additional At-Risk elevations that were not specifically predicted were found on the Adaptive Skills composite, including the Leadership and Activities of Daily Living subscales.

The present findings fit well with Semrud-Clikeman, Walkowiak, Wilkinson, and Minne (2010) and Volker et al., (2010). Semrud-Clikeman, Walkowiak, Wilkinson, and Minne (2010) used direct and indirect measures of social functioning of 52 children with

Asperger's disorder (27 of whom had a comorbid diagnosis of ADHD). Specifically, on average they found At-Risk elevations on the Behavioural Symptoms Index, the Adaptive Skills composite, and the Withdrawal subscale of the PRS of the BASC-2.

Similarly, Volker et al. (2010) investigated the profile obtained on the PRS of the BASC-2 by 62 children and adolescents between the ages of 6 and 16 years diagnosed with HFA (including participants who were diagnosed with autistic disorder, PDD-NOS, or Asperger's disorder). The pattern of elevations that was found is largely similar to that reported in the present study. Specifically, The Behavioural Symptoms Index was elevated within the At-Risk range, with elevations noted on five out of the six scales that comprise this index (i.e., the Atypicality, Hyperactivity, Depression, Withdrawal, and Attention Problems subscales). Of note, the Depression subscale was not elevated in the present study. In line with the present study, there was also an At-Risk elevation on the Adaptive Skills Index (including At-Risk elevations on all subscales that comprise that Index).

Overall, the two clinical groups included in the present study tended to show similar profiles on the BASC-2, particularly in terms of adaptive and behavioral difficulties, and these findings are similar to findings reported in previous research. Collection of additional data with the PRS of the BASC-2 for both clinical groups would enable statistical comparisons of the profiles between the groups, and go beyond the descriptive analysis that was carried out in the present study due to the limited sample size. Although the difficulties reported by parents on the BASC-2 in the present study may reflect symptoms that are secondary to the core diagnostic features of each disorder, past research and the present findings support that multiple areas of psychosocial

adjustment and adaptive behavior are often affected in both disorders and that broad based measures of psychosocial adjustment that assess areas of strength and weakness are warranted in diagnostic assessments (Klin, Sparrow, Marans, Carter, & Volkmar, 2000). The inclusion of such measures in diagnostic assessments as well as future research studies can potentially identify specific profiles that characterize each disorder as well as aid the development of targeted interventions and enable the monitoring of progress over time (Klin, Saulnier, Tsatsanis, & Volkmar, 2005).

**Hypothesis 3**

The third hypothesis was that the Reduced Contact and Social Interest subscale of the CSBQR would significantly differentiate between diagnostic groups, with children diagnosed with NLD showing significantly higher social contact and interest compared to the HFA group. Hypothesis 3 was not supported. That is, it was found that both groups showed low scores on the Reduced Contact and Social Interest subscale, and that this variable was not effective in differentiating between these two groups. It was expected that children in the HFA group would tend to have impaired social motivation that resulted in reduced social contact with others, given that reduced social motivation is a feature that has been found in most children with ASD (Chevallier, Kohls, et al., 2012). However, it was unexpected that children in the NLD group would also demonstrate a low score on this subscale, given that clinical experience has often suggested that children with NLD tend to have intact social motivation (Mamen, 2002).

In terms of interpreting the findings for the CSBQR in greater detail, the name of the subscale in question was derived from a factor analysis of the original CSBQ's item pool. Hartman, Luteijn, Serra, and Minderaa (2006) labelled the factor that included the

items of this subscale "reduced social interest." These researchers noted that one of the major reasons for refining the subscales of the original CSBQ was to make all of the subscales homogeneous to improve their interpretability (Hartman et al., 2006). An item analysis was done to clarify the areas in which children in the NLD group were reported to have particular difficulty (i.e., items most often endorsed as a "2 – clearly or often applies" by parents of participants in the NLD group). Of the 12 items included in the scale, the 3 items most often rated as a 2 by parents were "lives in a world of his/her own" (6 out of 10 participants); "does not initiate play with other children" (5 out of 10 participants); and "does not appreciate it when someone else is hurt or sad" (5 out of 10 participants). It is possible that the latter item is related to the findings from studies that indicate children with NLD have difficulty perceiving (and subsequently interpreting) emotional information from others (e.g., Dimitrovsky et al., 1998 and Petti et al., 2003) and may reflect misunderstanding social information rather than disinterest. It would be helpful for future studies investigating social motivation in NLD to examine the relationship between social perception difficulties and social motivation in this population.

Given that the present study is a quasi-experiment that included pre-existing clinical groups, several factors cannot be ruled out as contributing to the finding that the NLD group on average obtained a low score on the CSBQR subscale under investigation. For example, fewer opportunities for social interaction may have been available to children in the NLD group for a variety of reasons, such as their families may come from a lower socioeconomic status, or children from the NLD group may have had to abide by parental rules that allowed fewer social outings or that allowed interactions with fewer

children. It is also possible that the children included in the present study, who were in middle childhood or adolescence, had accumulated enough negative social experiences to contribute to negative expectations about their ability to execute appropriate social skills and be successful in social situations, resulting in reduced social contact and interest. For example, Little (1993) and Rourke and Tsatsanis (2000) reported findings that children with NLD tend to become withdrawn following negative social experiences with peers. In addition to the possible alternative explanations for low scores on the Reduced Contact and Social Interest subscale in the NLD group, a potential referral bias for the present study also cannot be ruled out. For example, it is possible that parents who perceived their children to have more internalizing difficulties (i.e., withdrawal, anxiety, and depression) may have been more concerned and motivated to participate, and more likely to follow through with participation in the study.

Based on a review of the research literature, it appears that social motivation in children with NLD has not been systematically studied, and caution should be exercised in generalizing the present findings to the population of children with NLD given the small sample size. The ADOS-2 has been found to tap into aspects of social motivation at the level of individual items (Castro et al., 2013), although the specific items that measure this construct were not listed by these researchers. It would be helpful to gather data from a larger number of participants who meet experimental criteria for NLD than were available at the time this pilot study was conducted to look at the relationship between items of the ADOS-2 and of the Reduced Contact and Social Interest subscale of the CSBQR. From a descriptive standpoint, the items listed under the heading Reciprocal Social Interaction in the ADOS-2 that appear to tap similar areas as items that were most

often endorsed on the subscale of the CSBQR under investigation include item B5 "Comments on Others' Emotions/Empathy" and item B8 "Amount of Social Overtures/Maintenance of Attention." Of note, item B5 was rated as a 2 (i.e., "no or minimal identification/communication of understanding of emotions in others") for four participants in the NLD group, and three of those participants were also rated 2 (i.e., "does not appreciate it when someone else is hurt or sad") on the CSBQR item, providing some preliminary support for reduced social motivation across measures for these particular participants. With regard to item B8, five participants in the NLD group obtained a rating of 1 "some attempts at getting, maintaining, or directing the examiner's attention, but reduced in frequency or the number of different activities in which they are used." Of these five participants, three also received a rating of 2 on the CSBQR item "does not initiate play with other children". The correspondence between the ratings on similar items from two measures completed by different raters also helps to corroborate that six participants in the NLD group had low social motivation, but again, the generalizability of such a finding is tentative until further data can be collected. Additional data from the CSBQR and the ADOS-2 would provide additional empirically based information pertaining to whether children with NLD, as a group, tend to have low motivation to interact with and seek relationships with others. It may also be valuable to collect self-report data using an inventory that specifically investigates social motivation, such as the Rush NeuroBehavioural Center Social Interest Scale (Balthazor, McKown, Lipton, and Wood, 2007) to help rule out or clarify the role of other factors impacting performance on the ADOS-2 and the CSBQR.

**Hypothesis 4**

Hypothesis 4 was supported. Specifically, hypothesis 4 predicted that the Social Interaction Difference Index of the CCC-2 would significantly differentiate between diagnostic groups, with the HFA group displaying lower scores than the NLD group. It was found that the two groups could be reliably differentiated on the basis of the SIDI of the CCC-2 (i.e., pragmatic aspects of communication relative to structural language skills), with excellent discrimination found based on the ROC curve analysis. Furthermore, the SIDI has a well-established clinical cut-off of less than -10 to indicate the ASD range; 8 out of 12 participants in the HFA group had a SIDI score within the ASD range, while no participants in the NLD group had a SIDI score in the ASD range. Similarly, Bishop and Norbury (2002) found that difficulty with the pragmatics of language is pervasive in ASD. However, they also found that there were children who had difficulty with pragmatics and did not meet criteria for autism or PDD-NOS. In line with this, the present findings demonstrated that on average participants in the NLD group were reported by parents to show mild to moderate difficulties across the pragmatic skills assessed by the CCC-2 and that pragmatic difficulties tended to be more severe for participants in the HFA group.

**Hypothesis 5**

Hypothesis 5 was also supported. Specifically, hypothesis 5 predicted that the Overall Total score of Module 3 of the ADOS-2 would differentiate between the NLD and HFA groups, with the HFA group displaying a higher score. The Overall Total of the ADOS-2 reliably differentiated between the groups, with acceptable discrimination found based on the ROC curve analysis. The well-established clinical cut-off for the Overall

Total score of Module 3 of the ADOS-2 is 7, with scores of 7 or greater being consistent with the ASD range; 3 out of 10 participants in the NLD group were above this threshold and 9 out of 12 participants in the HFA group were above this threshold. Although it is a limitation that not all participants in the HFA group exceeded the threshold for ASD on the Overall Total of the ADOS-2, making it difficult to confirm their previous diagnoses, it also makes the present findings more compelling in that group differences could be reliably predicted in spite of some low scores in the HFA group.

In terms of published studies that incorporated a previous version of the ADOS as an instrument to investigate differential diagnosis among clinical groups, Bishop and Norbury (2002) compared children with a specific language impairment, a pragmatic language impairment, HFA, or no language impairments (i.e., typically developing children) on Module 3 of the Autism Diagnostic Observation Schedule Generic (ADOS-G). It was noted that two typically developing children out of 18 were misdiagnosed as having an ASD by the ADOS-G (i.e., they exceeded the threshold for ASD on the ADOS-G in the absence of any other current or remote symptoms of ASD). Those findings were somewhat similar to those of the present study in that three participants in the NLD group exceeded the threshold for ASD on the ADOS-2, and these were all deemed to be a misdiagnosis on the basis of a lack of remote or current symptoms of ASD as per parent report as well as the clinical judgement of the principal investigator and clinical supervisor. In terms of relevant observations during the ADOS-2 administration that may help to explain the scores, one child indicated that he felt self-conscious about being video-recorded during the ADOS-2. He required several minutes of reassurance before he agreed to be recorded, and he subsequently appeared anxious

and made extremely limited eye contact with the examiner. Another child presented as very shy with a flattened affect (i.e., the child directed minimal facial expressions to the examiner). He had a reduced amount of reciprocal social interaction with the examiner compared with what is typical for the child's age, which appeared to be at least partly due to shyness. The third participant also appeared to be highly anxious and reticent; he did not initiate any interactions with the examiner.

**Implications of the Findings**

To date, few studies have compared and contrasted social functioning in NLD and the high functioning variant of ASD. The present study found the Overall Total score of the ADOS-2 to be useful in differentiating the groups, and the Social Affect domain showed a greater odds ratio (i.e., effect size) than the Overall Total score, suggesting that it is a major contributing factor to the ability of the Overall Total score to differentiate between the groups.

The present study is the first of its kind to investigate the differential diagnosis of these two disorders using an instrument that was designed to diagnose ASD (i.e., the ADOS-2) and is one of the few studies focusing on aspects of social functioning to differentiate the two disorders. Other studies have investigated the use of the ADOS in differentiating ASD from one or more other disorders.

Overall, there are a number of implications that arise from the present findings, particularly for clinicians and other health professionals who are responsible for the assessment, diagnosis, and treatment of children with a variety of neurodevelopmental disorders. The present study demonstrated that the CCC-2 and the ADOS-2, two widely-used and well-validated clinical tools typically used in the context of a diagnostic

assessment for ASD, are useful in differentiating between NLD and ASD. Despite the small sample size in this pilot study, reliable discrimination between the two clinical groups was found on two measures that have been empirically and clinically validated in establishing a diagnosis of ASD, thus providing good evidence for using such measures in a diagnostic assessment of NLD if there are indications or concerns that a child has features of ASD. Conversely, the present findings provide support that children undergoing diagnostic assessment for ASD who do not meet criteria for ASD should be evaluated for NLD, since both disorders were found to be characterized by low social motivation and difficulties with pragmatic communication. In short, it would be prudent for clinicians and health professionals to include the CCC-2 and the ADOS-2 in their battery of tests for diagnostic assessments of both of these clinical groups.

Additionally, the results of the present study provide further support for the validity of NLD. Although not all domains critical to the diagnosis of NLD could be used to define the NLD group, the findings indicate that, functionally, aspects of social competence of children in the ASD group were separable from those of children in the NLD group. Although there were similarities between the groups in terms of low social interest, this is not a diagnostic criterion for either group. Overall, the findings support that NLD is separable from ASD—that NLD cannot be better accounted for or explained by ASD, a well-validated disorder (Pennington, 2008). The diagnostic criteria for ASD in DSM-5 note that social (pragmatic) communication disorder should be considered when an individual has significant impairments in social communication, but this individual does not otherwise meet criteria for ASD (APA, 2013). The present results support including NLD as an additional diagnostic consideration in such a differential diagnosis.

Amending formal diagnostic systems to include NLD as a diagnostic category and a consideration in differential diagnosis is an important step to broadening the awareness of NLD, as well as appropriate ways in which to diagnose it. Hopefully, the dissemination of the findings of the present study will help to further increase awareness of NLD, its main characteristics, and its relevance to establishing a differential diagnosis for children undergoing evaluation for ASD or social (pragmatic) communication disorder.

**Strengths of the Study**

A number of strengths characterized the present study. First, the study was prospective in nature and did not use data that had been collected primarily for another purpose. It employed techniques to verify the diagnoses of participants, including neuropsychological testing and a clinical interview to confirm that participants met experimental criteria for NLD, and a review of previous diagnostic reports. Additionally, the study incorporated the ADOS-2, a well-validated diagnostic instrument that is widely used by clinicians and researchers who work with the ASD population. This study also systematically examined the nature of the impairments in social functioning in children who met experimental criteria for NLD with measures used to diagnose ASD, which has not been reported in the literature to date.

**Limitations of the Present Study**

Although the present study has a number of strengths, including the examination of the differential diagnosis between NLD and ASD in a way that has not previously been reported in the literature, there are several limitations. The major limitation was the small sample size included in the present study. Data were collected over a period of more than two years and other studies have reported similar difficulties in recruiting large numbers

of participants with NLD. For example, Semrud-Clikeman, Walkowiak, Wilkinson, and Christopher (2010) reported requiring seven years to recruit a sample of 26 children with NLD in a large metropolitan area. In spite of the low power for the statistical analyses, a number of significant findings were evident. However, generalizing the findings should be done with caution until a larger sample has been accumulated through continued data collection or the findings have been replicated with a larger sample. With the effect sizes reported in the logistic regression analyses, a sample of at least approximately 420 would be needed in order to achieve adequate power of .80 (Faul, Erdfelder, Buchner, & Lang, 2009). To conduct additional studies with adequate power, it may be necessary to collect data over a number of years, to collaborate with other institutions in order to engage in a multicenter study, to use archival data, or to combine one or more of these approaches.

A limitation with regard to the NLD group was that participants met experimental criteria for NLD that were adapted from the criteria outlined in Casey et al. (1991). In the present study, these liberal criteria were adopted as the defining criteria for the NLD group because scores on some neuropsychological tests assessing aspects of executive functioning that are important in establishing the diagnosis of NLD were not available for all participants (i.e., these were missing data points). Although participants in the NLD group did demonstrate a variety of clinical symptoms often associated with NLD as reported by their parents (e.g., difficulty fastening buttons or bread bag ties, difficulty making inferences about passages that have been read, a tendency to interpret statements literally), it is not certain that all participants manifested all features of the disorder.

A limitation with regard to the HFA group was that the methods used to diagnose ASD varied in terms of the health professional who made the diagnosis (e.g., physicians

or psychologists) and the methods used to establish the diagnosis. That is, not all participants were diagnosed using the same methods, or received the "gold standard" in assessment to establish a diagnosis of ASD, that being a combination of the most up-to-date versions of the ADOS and the Autism Diagnostic Interview that were available at the time of their diagnostic assessment (Kanne, Randolph, & Farmer, 2008; Zander, Sturm, & Bölte, 2015). The diagnosis of ASD was verified in the present study (i.e., they received an Overall Total score on Module 3 of the ADOS-2 that was 7 or greater) for 9 out of 12 participants in the HFA group. Even though all participants in the HFA group provided a copy of the report they received indicating an ASD diagnosis, three participants did not score 7 or higher on the Overall Total score of the ADOS-2.

Completing a comprehensive diagnostic assessment for ASD was beyond the scope of the resources available for and the purpose of the present study. As such, the possibility that these three participants no longer met criteria for ASD when they participated in the study cannot be ruled out. It is possible that participants did not display some of their typical behaviours that would be coded by the examiner of the ADOS-2 as contributing to the Overall Total score, or it is also possible that a combination of factors contributed to them no longer meeting criteria for an ASD. A general trend of improvement between childhood and adulthood has been found for the core symptoms of ASD (Seltzer et al., 2004). There is evidence that some children with ASD can achieve an "optimal outcome" in which they are found to no longer meet criteria for a diagnosis of ASD during an assessment subsequent to their initial diagnosis. Helt et al. (2009) defined an optimal outcome as no longer meeting the behavioural criteria in the DSM-IV-TR or DSM-5 for ASD, not exceeding the threshold for ASD on diagnostic instruments (e.g.,

the ADOS-2 and the ADI-R), receiving special education services (if needed) that focus solely on cognitive or academic difficulties as opposed to managing the symptoms of ASD (e.g., an Educational Assistant is not needed by the child), and having scores on the FSIQ, VCI, and PRI of the WISC-IV that are greater than 79. An optimal outcome is more likely to occur in individuals who are cognitively higher functioning, whose initial diagnosis was PDD-NOS as opposed to autistic disorder, and who received EIBI (Fein et al., 1999; Helt et al., 2009; Sutera et al., 2007). The first participant had all three of these characteristics, while the second and third participants had two of these characteristics.

To further explore why three participants in the HFA group did not meet the threshold for ASD on the ADOS-2, each case was reviewed in depth, including the method of diagnosis, the age at diagnosis, the health professional who rendered the diagnosis, and the behavioural or social skills interventions that each child received. In particular, all three participants received a diagnosis of Pervasive Developmental Disorder, Not Otherwise Specified by a psychologist who administered the ADOS-2 and the ADI-R during a diagnostic assessment. The first participant was diagnosed at age two and received EIBI for two years after he was diagnosed. During the present study, he obtained a FSIQ of 115. The second participant was diagnosed with PDD-NOS at 9 years of age, and participated in multiple social skills groups geared toward children with developmental disabilities for four years following his diagnosis. These courses were organized and hosted by the Regional Children's Centre and Autism Services Incorporated in Windsor. During the present study, he obtained a FSIQ of 120. The third participant was diagnosed with PDD-NOS at age 10, and his parents did not report that he received any specific behavioural or social skills interventions.

Sutera et al. (2007) found that 7 out of 18 participants (39%) who received an initial diagnosis of PDD-NOS at age 2 no longer met criteria for an ASD at age 4 when using a comprehensive diagnostic evaluation at both time points, and EIBI has been shown to be effective in improving adaptive behaviours of children with autism (Eldevik et al., 2009; Reichow, 2012). When Magiati, Moss, Charman, and Howlin (2011) evaluated 36 children diagnosed with ASD who had received EIBI over a seven year period, three were found to fall below the cut-offs for ASD on two or all three of the ADI-R scales at the last time point at which they were evaluated, even though they had met criteria when they initially began participating in the study; the authors noted that the severity of autism behaviours tended to decrease during the first two years of EIBI and to then remain quite stable over the study period, but some participants were found to have autistic behaviours reduce significantly over time.

Additionally, although multiple methods were used to assess social functioning in the present study, the behaviour rating scales were limited to responses from parents and did not include self-ratings or teacher ratings. It should be noted that parent report can be vulnerable to rater bias, such as stereotyping or adopting particular response styles (e.g., viewing problematic behaviours as more or less severe than is appropriate; Bartels et al., 2003). Such biases, when employed by parents, contribute to error variance in their ratings and could have impacted the results of the present study. Out of the four dependent measures included in the present study, the PRS of the BASC-2 contains three validity scales to identify potential response bias and to evaluate whether the rater was attentive to the content of the items. Parents of all participants produced valid profiles for their children on the PRS of the BASC-2. Only one parent's responses resulted in a

Consistency Index score that was in the Caution range, and this was interpreted as being due to the mother not speaking English as her first and primary language.

Furthermore, several studies support that the impact of bias from parents' ratings of their children on a broad based measure of psychosocial functioning (i.e., the parent report form of the Child Behavior Checklist [Achenbach, 1991], which is moderately to strongly correlated with the PRS of the BASC-2; Reynolds & Kamphaus, 2004) accounts for a relatively small percentage of the variance. Specifically, Bartels et al. (2003) used structural equation modeling to compare the behaviour ratings on the Child Behavior Checklist (Achenbach, 1991) made by mothers and fathers of twelve year old monozygotic and dyzygotic Dutch twins. The sample consisted of 1156 pairs of twins who had ratings from both mothers and fathers, as well as 325 pairs of twins who had ratings from only mothers. One of the major findings of the study was that the combination of error variance and rater bias accounted for no more than 13% of the variance in the internalizing and externalizing scales of the Child Behavior Checklist (Achenbach, 1991). Similar findings that indicated relatively small impacts of rater bias on parental ratings were also obtained for 3 and 7 year old Dutch twins (Van der Valk, Van den Oord, Verhulst, & Boomsma, 2001; Van der Valk, Van den Oord, Verhulst, & Boomsma, 2003).

Although a number of studies support that parental ratings of typically developing children tend not to be overly impacted by biases of parents, there is some evidence that teacher ratings on certain scales (e.g., anxiety, depression) of the Child Behavior Checklist (Achenbach, 1991) are more useful than parent ratings in predicting self-reported problems in children between the ages of 11 and 14, and in predicting significant

affective difficulties 4 to 5 years later (Verhulst, Dekker, & Van der Ende, 1997). In terms of the measures used in the present study, the CSBQR was designed to be completed by parents or caregivers (a teacher form was not available) and ratings on the BASC-2 were limited to parent report due to a number of assessments being completed during the summer months when children and adolescents were not attending school. Future research should include behaviour ratings from multiple informants.

It is notable that the two groups differed in their scores on the PRI of the WISC-IV, and that the groups may have differed in the ratio of males of females (although this could not be directly tested due to violation of assumptions that must be met to conduct a chi-square test of homogeneity). Given that one of the selection criteria for the NLD group mandated that the PRI score be at least 10 standard score points lower than the VCI, which also would impact the FSIQ score, the difference between the two clinical groups might be a direct consequence of the inclusion criteria that were used. It is also possible that this difference may be a characteristic that differs between these two diagnostic groups. Given that this is a quasi-experimental study in which random assignment could not be used, there is no attempt to infer causation regarding the differences observed between these two groups on the independent variables. Several articles argue against using covariate procedures to equate clinical groups (Adams, Brown, & Grant, 1985; Dennis et al., 2009; Miller & Chapman, 2001). In the present study, covariate procedures have not been used to equate groups due to the arguments outlined by these articles. Hartman et al. (2006) similarly elected to not equate groups on demographic variables, but evaluated the similarity of demographic variables of groups included in the study to their respective clinical groups to support the generalizability of

the findings, and the present study has adopted the same approach. As data continues to be collected for this study, it will be important to attempt to have equal group sizes so that demographic variables, including the ratio of males to females, can be directly compared, allowing more confidence that the results are representative of the clinical groups under investigation.

**Directions for Future Research**

To determine the reliability of the present findings, as well as how well they generalize to children with NLD and ASD, a replication or extension of the present study with a larger sample size is essential. Additionally, a number of issues have been raised by the present results that warrant further investigation. Bishop and Norbury's (2002) study investigated the overlap between pragmatic language impairment (which they noted was included under the diagnostic category of semantic pragmatic disorder), and found a fair amount of overlap with ASD. DSM-5 ushered in a number of changes to existing psychological disorders, and resulted in social (pragmatic) communication disorder, which has been described as essentially equivalent to semantic pragmatic disorder, being added (APA, 2013). Given the pragmatic difficulties identified in the NLD group in the present study as well as past research, and that pragmatic difficulties are a defining feature of social (pragmatic) communication disorder, it would be of interest for future research to investigate the extent to which overlap exists between NLD and social (pragmatic) communication disorder, including whether the profile of pragmatic difficulties and neuropsychological abilities are similar.

Importantly, the present study has contributed to the program of research within the University of Windsor research laboratory investigating the nature, characteristics,

and differential diagnosis of NLD. This line of research should be extended to include comparisons of multiple areas between NLD and HFA, including neuropsychological, social and academic functioning, while also including a population of children and youth with ADHD, another disorder often considered in the differential diagnosis of these disorders, for comparison.

## References

Achenbach, T. M. (1991). *Manual for the Child Behavior Checklist/4–18 and 1991 profile*. Burlington, VT: University of Vermont, Department of Psychiatry.

Achenbach, T. M., & Edelbrock, C. S. (1983). *Manual for the child behavior checklist and revised child behavior profile*. Burlington, VT: University of Vermont.

Achenbach, T. M., & Rescorla, L. A. (2001). *Manual for the ASEBA school-age forms & profiles: An integrated system of multi-informant assessment*. Burlington, VT: University of Vermont, Research Center for Children, Youth, & Families.

Adams, K. M., Brown, G. G., & Grant, I. (1985). Analysis of covariance as a remedy for demographic mismatch of research subject groups: Some sobering simulations. *Journal of Clinical and Experimental Neuropsychology, 7*, 445–464. doi: 10.1080/01688638508401276

Adolphs, R. (2002). Recognizing emotion from facial expressions: Psychological and neurological mechanisms. *Behavioral and Cognitive Neuroscience Reviews, 1*(1), 21-61. doi: 10.1177/1534582302001001003

Adolphs, R. (2003). Cognitive neuroscience of human social behavior. *Nature Reviews Neuroscience*, *4*, 165-178. doi: 10.1038/nrn1056

Adolphs, R. (2006). What is special about social cognition? In J. T. Cacioppo, P. S. Visser, & C. L. Pickett (Eds.), *Social neuroscience: People thinking about people* (pp. 269-286). Cambridge, MA: MIT Press.

American Association on Intellectual and Developmental Disabilities. (2010). *Intellectual disability: Definition, classification, and systems of supports* (11th ed.). Washington, DC: AAIDD.

American Psychiatric Association. (1980). *Diagnostic and statistical manual of mental disorders: DSM-III* (3 ed.). Washington, DC: American Psychiatric Publishing.

American Psychiatric Association, (1987). *Diagnostic and Statistical Manual of Mental Disorders: DSM-III-R* (3rd ed., rev.). Washington, DC: American Psychiatric Association.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders: DSM-IV* (4th ed.). Washington, DC: American Psychiatric Publishing.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders: DSM-IV-TR* (4th ed., rev.). Washington, DC: American Psychiatric Association.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5* (5 ed.). Washington, D.C.: American Psychiatric Association.

Andrews, T.K., Rose F.D., and Johnson, D.A. (1998). Social and behavioural effects of traumatic brain injury in children. *Brain Injury, 12*, 133–138.

Arias, B., Verdugo, M. Á., Navas, P., & Gómez, L. E. (2013). Factor structure of the construct of adaptive behavior in children with and without intellectual disability. *International Journal of Clinical and Health Psychology, 13*(2), 155-166. doi: 10.1016/S1697-2600(13)70019-X

Asperger, H. (1991). "Autistic psychopathy" in childhood. In U. Frith (Ed. & Trans.), *Autism and Asperger syndrome* (pp. 37–92). Cambridge, UK: Cambridge University Press. (Original work published 1944)

Axelrod, R., & Hamilton, W. D. (1981). The evolution of cooperation. *Science, 211*(4489), 1390–1396. doi: 10.1126/science.7466396

Bachevalier, J., & Loveland, K. A. (2006). The orbitofrontal–amygdala circuit and self-regulation of social–emotional behaviour in autism. *Neuroscience & Biobehavioural Reviews, 30*(1), 97-117.

Baio, J. (2014). Prevalence of autism spectrum disorder among children aged 8 years - autism and developmental disabilities monitoring network, 11 sites, United States, 2010. *MMWR Surveillance Summaries, 63*(2), 1-21.

Baker, J. P. (2013). Autism at 70—redrawing the boundaries. *New England Journal of Medicine, 369*(12), 1089-1091. doi: 10.1056/NEJMp1306380

Balthazor, M., McKown, C., Lipton, M., & Wood, L. (April, 2007). *Development of a social interest scale for children ages 8- 12.* Poster session presented at the annual meeting of the Society for Research in Child Development, Boston, MA.

Barbaro, J., & Dissanayake, C. (2007). A comparative study of the use and understanding of self-presentational display rules in children with high functioning autism and Asperger's disorder. *Journal of Autism and Developmental Disorders, 37*(7), 1235-1246.

Baron, I. S. (2004). *Neuropsychological evaluation of the child.* New York: Oxford University Press.

Baron-Cohen, S. (1988). Social and pragmatic deficits in autism: Cognitive or affective? *Journal of Autism and Developmental Disabilities, 18*, 379-402. doi: 10.1007/BF02212194

Baron-Cohen, S. (1989). The autistic child's theory of mind: A case of specific developmental delay. *Journal of Child Psychology and Psychiatry, 30*, 285-298. doi: 10.1111/j.1469-7610.1989.tb00241.x

Baron-Cohen, S. (1995). Mindblindness: An essay on autism and theory of mind. Cambridge, MA: MIT Press.

Baron-Cohen, S., & Wheelwright, S. (2003). The Friendship Questionnaire: An investigation of adults with Asperger syndrome or high-functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders, 33*(5), 509-517. doi: 10.1023/A:1025879411971

Barr, W. B. (2003). Neuropsychological testing of high school athletes: Preliminary norms and test-retest indices. *Archives of Clinical Neuropsychology, 18*, 91–101. doi: 10.1016/S0887-6177(01)00185-8

Bartels, M., Hudziak, J. J., Boomsma, D. I., Rietveld, M. J., Van Beijsterveldt, T. C. E. M., & Van den Oord, E. J. C. G. (2003). A study of parent ratings of internalizing and externalizing problem behaviour in 12-year-old twins. *Journal of the American Academy of Child & Adolescent Psychiatry, 42*(11), 1351-1359. doi: 10.1097/01.CHI.0000085755.71002.5d

Beauchamp, M. H., & Anderson, V. (2010). SOCIAL: An integrative framework for the development of social skills. *Psychological Bulletin, 136*(1), 39-64. doi: 10.1037/a0017768

Ben-Yizhak, N., Yirmiya, N., Seidman, I., Alon, R., Lord, C., & Sigman, M. (2011). Pragmatic language and school related linguistic abilities in siblings of children with autism. *Journal of autism and developmental disorders, 41*(6), 750-760. doi: 10.1007/s10803-010-1096-6

Bender, W. N., & Golden, L. B. (1990). Subtypes of students with learning disabilities as derived from cognitive, academic, behavioral, and self-concept measures. *Learning Disability Quarterly, 13*, 183-194. doi: 10.2307/1510700

Benton, A. L., Hamsher, K., Varney, N. R., & Spreen, O. (1983). *Contributions to neuropsychological assessment*. New York: Oxford University Press.

Benton, A. L., Sivan, A. B., Hamsher, K. deS., Varney, N. R., & Spreen, O. (1994). *Contributions to neuropsychological assessment* (2nd ed.). Orlando, Fla.: Psychological Assessment Resources.

Berridge, K. C., Robinson, T. E., & Aldridge, J. W. (2009). Dissecting components of reward: 'liking', 'wanting', and learning. *Current opinion in pharmacology, 9*(1), 65-73. doi: 10.1016/j.coph.2008.12.014

Bewick, V., Cheek, L., & Ball, J. (2005). Statistics review 14: Logistic regression. *Critical Care, 9*(1), 112-118. doi: 10.1186/cc3045

Bigler, E. D. (1989). On the neuropsychology of suicide. *Journal of Learning Disabilities, 22*(3), 180-185.

Bishop, D. V. M. (2006). *Children's Communication Checklist-2 United States Edition Manual*. Bloomington, MN: Pearson.

Bishop, D. V. M., & Norbury, C. F. (2002). Exploring the borderlands of autistic disorder and specific language impairment: a study using standardised diagnostic instruments. *Journal of Child Psychology and Psychiatry, 43*(7), 917-929.

Blair, R. J. R. (2005). Responding to the emotions of others: Dissociating forms of empathy through the study of typical and psychiatric populations. *Consciousness and cognition, 14*(4), 698-718.

Bleuler, E. (1950). Dementia praecox or a group within the schizophrenias (J. Zinkin, Trans.). New York, NY: International Universities Press. (Original work published 1911).

Blum, K., Braverman, E. R., Holder, J. M., Lubar, J. F., Monastra, V. J., Miller, D., ... & Comings, D. E. (2000). The reward deficiency syndrome: A biogenetic model for the diagnosis and treatment of impulsive, addictive and compulsive behaviors. *Journal of Psychoactive Drugs, 32*(sup1), 1-112. doi: 10.1080/02791072.2000.10736099

Blum, K., Cull, J. G., Braverman, E. R., & Comings, D. E. (1996). Reward deficiency syndrome. *American Scientist, 84*(2), 132-145.

Bluman, A. G. (2006). *Elementary Statistics: A Step by Step Approach* (3 ed.). New York: McGraw-Hill Higher Education.

Boll, T. (1993). *Manual for the Children's Category Test*. San Antonio, TX: Psychological Corporation.

Bölte, S., & Poustka, F. (2002). The relation between general cognitive level and adaptive behavior domains in individuals with autism with and without co-morbid mental retardation. *Child Psychiatry and Human Development, 33*(2), 165-172. doi: 10.1023/A:1020734325815

Bölte, S., Schipper, E., Robison, J. E., Wong, V. C., Selb, M., Singhal, N., ... Zwaigenbaum, L. (2014). Classification of functioning and impairment: The development of ICF core sets for autism spectrum disorder. *Autism Research, 7*(1), 167-172. doi: 10.1002/aur.1335

Bowirrat, A., & Oscar-Berman, M. (2005). Relationship between dopaminergic neurotransmission, alcoholism, and reward deficiency syndrome. *American Journal of Medical Genetics Part B: Neuropsychiatric Genetics, 132*(1), 29-37. doi: 10.1002/ajmg.b.30080

Braaten, E. (2007). *The child clinician's report-writing handbook*. New York: Guilford Press.

Brown, S. J., Rourke, B. P., & Cicchetti, D. V. (1989). Reliability of tests and measures used in the neuropsychological assessment of children. *The Clinical Neuropsychologist, 3*(4), 353-368. doi: 10.1080/13854048908401484

Broitman, J., & Davis, J. M. (2013). Overview of NLD. In J. Broitman & J. M. Davis (Eds.), *Treating NVLD in children: Professional collaborations for positive outcomes* (pp. 9 - 27). New York, NY: Springer Science & Business Media.

Bruininks, R. H., McGrew, K., & Maruyama, G. (1988). Structure of adaptive behavior in samples with and without mental retardation. *American Journal on Mental Retardation, 93*(3), 265-272.

Brumback, R. A., Harper, C. R., & Weinberg, W. A. (1996). Nonverbal learning disabilities, Asperger's syndrome, pervasive developmental disorder – should we care? *Journal of Child Neurology, 11*, 427–429.

Bruyère, S. M., Van Looy, S. A., & Peterson, D. B. (2005). The International Classification of Functioning, Disability and Health: Contemporary literature overview. *Rehabilitation Psychology, 50*(2), 113.

Bryan, T. H. (April, 1982). *Social cognitive understanding and language*. Paper presented at the meeting of the Ontario Association for Children with Learning Disabilities, Toronto, Ontario, Canada.

Bunker, L. K. (2001). Review of the Wide Range Assessment of Visual Motor Abilities *Fourteenth mental measurements yearbook*. Retrieved from EbscoHost Mental Measurements Yearbook with Tests in Print database.

Bush, S. S. (2010). Determining whether or when to adopt new versions of psychological and neuropsychological tests: Ethical and professional considerations. *The Clinical Neuropsychologist, 24*(1), 7-16. doi: 10.1080/13854040903313589

Buss, D. M. (1995). Evolutionary psychology: A new paradigm for psychological science. *Psychological Inquiry, 6*, 1–30. doi:10.1207/s15327965pli0601_1

Campbell, R., Lawrence, K., Mandy, W., Mitra, C., Jeyakuma, L., & Skuse, D. (2006). Meanings in motion and faces: Developmental associations between the processing of intention from geometrical animations and gaze detection accuracy. *Development and Psychopathology, 18*(1), 99.

Carrow–Woolfolk, E. (1999). *Comprehensive Assessment of Spoken Language*. Circle Pines, MN: American Guidance Service Inc.

Carter, A. S., Volkmar, F. R., Sparrow, S. S., Wang, J., Lord, C., Dawson, G., Fombonne, E., Loveland, K., Mesibov, G., & Schopler, E. (1998). The Vineland Adaptive Behavior Scales: Supplementary norms for individuals with autism. *Journal of Autism and Developmental Disorders, 28*(4), 287–302. doi: 10.1023/A:1026056518470

Casey, J. E. (2012). A model to guide the conceptualization, assessment, and diagnosis of nonverbal learning disorder. *Canadian Journal of School Psychology, 27*(1), 35-57. doi: 10.1177/0829573512436966

Casey, J.E. (2015). Nonverbal learning disorder: Past, present, and future. In B.M. Rissman (Ed.), *Medical and educational perspectives on nonverbal learning disability in children and young adults* (pp. 68-105). Hershey, PA: IGI Global.

Casey, J. E., Rourke, B. P., & Picard, E. M. (1991). Syndrome of nonverbal learning disabilities: Age differences in neuropsychological, academic, and socioemotional functioning. *Development and Psychopathology, 3*(3), 329-345. doi: http://dx.doi.org/10.1017/S0954579400005344

Castro, S., & Pinto, A. I. (2013). Identification of core functioning features for assessment and intervention in autism spectrum disorders. *Disability and Rehabilitation, 35*(2), 125-133.

Cavell, T. A. (1990). Social adjustment, social performance, and social skills: A tri-component model of social competence. *Journal of Clinical Child Psychology, 19*, 111–122. doi: 10.1207/s15374424jccp1902_2

Cavell, T. A., Meehan, B. T., & Fiala, S. E. (2003). Assessing social competence in children and adolescents. In C. R. Reynolds & R. W. & Kamphaus (Eds.), *Handbook of psychological and educational assessment of children: Personality, behavior, and context* (Vol. 2, pp. 433 - 454). New York, NY: Guilford Press.

Cederlund, M., & Gillberg, C. (2004). One hundred males with Asperger syndrome: A clinical study of background and associated factors. *Developmental Medicine & Child Neurology, 46*(10), 652-660.

Cicchetti, D., & Rogosch, F. A. (1996). Equifinality and multifinality in developmental psychopathology. *Development and Psychopathology, 8*(04), 597-600.

Ciccia, A. (2011). Pragmatic communication. In J. S. Kreutzer, B. Caplan & J. DeLuca (Eds.), *Encyclopedia of clinical neuropsychology* (pp. 1994-1995). New York: Springer. doi: 10.1007/978-0-387-79948-3

Cieza, A., Geyh, S., Chatterji, S., Kostanjsek, N., Üstün, B., & Stucki, G. (2005). ICF linking rules: An update based on lessons learned. *Journal of Rehabilitation Medicine, 37*(4), 212-218. doi: 10.1080/16501970510040263

Chevallier, C., Kohls, G., Troiani, V., Brodkin, E. S., & Schultz, R. T. (2012). The social motivation theory of autism. *Trends in Cognitive Science, 16*(4), 231-239. doi: 10.1016/j.tics.2012.02.007

Chevallier, C., Molesworth, C., & Happe, F. (2012). Diminished social motivation negatively impacts reputation management: Autism spectrum disorders as a case in point. *PloS ONE, 7*(1), e31107. doi: 10.1371/journal.pone.0031107

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155.

Constantino, J. N., & Todd, R. D. (2000). Genetic structure of reciprocal social behavior. *American Journal of Psychiatry, 157,* 2043-2045.

Crick, N. R., & Dodge, K. A. (1994). A review and reformulation of social information-processing mechanisms in children's social adjustment. *Psychological Bulletin, 115*(1), 74-101.

D'Amato, R. C., Crepeau-Hobson, F., Huang, L. V., & Geil, M. (2005). Ecological neuropsychology: An alternative to the deficit model for conceptualizing and

serving students with learning disabilities. *Neuropsychology Review, 15*(2), 97-103. doi: 10.1007/s11065-005-7092-5

Damberga, I., Raščevska, M., Koļesovs, A., Sebre, S., & Laizāne, I. (2014). Adaptive behavior in children with specific learning disabilities and language and intellectual impairments. *Baltic Journal of Psychology, 15,* 87-103.

Davis, J. M., & Broitman, J. (2011). *Nonverbal learning disabilities in children: Bridging the gap between science and practice*. New York: Springer Science & Business Media.

Dawson, G., Carver, L., Meltzoff, A., Panagiotides, H., McPartland, J., &Webb, S. (2002). Neural correlates of face and object recognition in young children with autism spectrum disorder, developmental delay, and typical development. *Child Development, 73*, 700–717. doi: 10.1111/1467-8624.00433

Dawson, G., Webb, S. J., & McPartland, J. (2005). Understanding the nature of face processing impairment in autism: Insights from behavioral and electrophysiological studies. *Developmental neuropsychology, 27*(3), 403-424. doi: 10.1207/s15326942dn2703_6

Deci, E. L., & Ryan, R. M. (2000). The ‘‘what’’ and ‘‘why’’ of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11,* 227–268. doi: 10.1207/S15327965PLI1104_01

Demurie, E., Roeyers, H., Baeyens, D., & Sonuga-Barke, E. (2011). Common alterations in sensitivity to type but not amount of reward in ADHD and autism spectrum disorders. *Journal of Child Psychology and Psychiatry, 52*(11), 1164-1173. doi: 10.1111/j.1469-7610.2010.02374.x

Dennis, M., Francis, D. J., Cirino, P. T., Schachar, R., Barnes, M. A., & Fletcher, J. M. (2009). Why IQ is not a covariate in cognitive studies of neurodevelopmental disorders. *Journal of the International Neuropsychological Society, 15*(3), 331-343. doi: 10.1017/S1355617709090481

DeStefano, L., & Thompson, D. S. (1990). Adaptive behavior: The construct and its measurement. In C. R. Reynolds, & R. W. Kamphaus (Eds.), *Handbook of psychological and educational assessment of children: Personality, behavior, and context* (pp. 445 - 471). New York, NY: Guilford Press.

DeVries, L., Bundy, M. & Gore, J. (2013). Patterns of adaptive performance by individuals with autism spectrum disorders on the Behavior Assessment System for Children II (BASC-2). *International Journal on Disability and Human Development, 12*(3), 347-352. doi:10.1515/ijdhd-2012-0114

Dewey, M., & Everard, P. (1974). The near normal autistic adolescent. *Journal of Autism and Childhood Schizophrenia, 4*, 348-356. doi: 10.1007/BF02105378

Dikmen, S. S., Heaton, R. K., Grant, I., & Temkin, N. R. (1999). Test–retest reliability and practice effects of expanded Halstead–Reitan Neuropsychological Test Battery. *Journal of the International Neuropsychological Society, 5*(04), 346-356.

Dimitrovsky, L., Spector, H., Levy-Shiff, R., & Vakil, E. (1998). Interpretation of facial expressions of affect in children with learning disabilities with verbal or nonverbal deficits. *Journal of Learning Disabilities, 31*(3), 286-292. doi: 10.1177/002221949803100308

Ditterline, J., Banner, D., Oakland, T., & Becton, D. (2008). Adaptive behavior profiles of students with disabilities. *Journal of Applied School Psychology*, *24*(2), 191-208. doi: 10.1080/15377900802089973

Dodge, K. A., Laird, R., Lochman, J. E., & Zelli, A. (2002). Multidimensional latent-construct analysis of children's social information processing patterns: Correlations with aggressive behavior problems. *Psychological Assessment, 14,* 60–73. doi: 10.1037/1040-3590.14.1.60

Dombrowski, S. C., Kamphaus, R. W., & Reynolds, C. R. (2004). After the demise of the discrepancy: Proposed learning disabilities diagnostic criteria. *Professional Psychology: Research and Practice, 35,* 364–372. doi: 10.1037/0735-7028.35.4.364

Dool, C. B., Fuerst, K. B., & Rourke B. P. (1995). Sotos syndrome. In B. P. Rourke (Ed.), *Syndrome of nonverbal learning disabilities: Neurodevelopmental manifestations* (pp. 239-254). New York, NY: Guilford Press.

Dool, C. B., Stelmack, R., & Rourke, B. P. (1993). Event-related potentials in children with learning disabilities. *Journal of Clinical Child Psychology, 22,* 387–398. doi: 10.1207/s15374424jccp2203_10

Dowker, A. (2006). What can functional brain imaging studies tell us about typical and atypical cognitive development in children? *Journal of Physiology-Paris, 99*(4), 333-341. doi: 10.1016/j.jphysparis.2006.03.010

Drummond, C. R., Ahmad, S. A., & Rourke, B. P. (2005). Rules for the classification of younger children with nonverbal learning disabilities and basic phonological processing disabilities. *Archives of Clinical Neuropsychology, 20,* 171–182.

Dupont, H., Gardner, O. S., & Brody, D. S. (1974). *Toward affective development*. Circle Pines, Minn.: American Guidance Service.

D'Zurilla, T. J., Goldfried, M. R. (1971). Problem-solving and behavior modification. *Journal of Abnormal Psychology, 78,* 107-126. doi: 10.1037/h0031360

Ehlers, S., Nydén, A., Gillberg, C., Sandberg, A. D., Dahlgren, S. O., Hjelmquist, E., & Odén, A. (1997). Asperger syndrome, autism and attention disorders: A comparative study of the cognitive profiles of 120 children. *Journal of Child Psychology and Psychiatry, 38*(2), 207-217. doi: 10.1111/j.1469-7610.1997.tb01855.x

Eldevik, S., Hastings, R. P., Hughes, J. C., Jahr, E., Eikeseth, S., & Cross, S. (2009). Meta-analysis of early intensive behavioural intervention for children with autism. *Journal of Clinical Child & Adolescent Psychology, 38*(3), 439-450. doi: 10.1080/15374410902851739

Ewing-Cobbs, L., Fletcher, J. M., & Levin, H. S. (1995). Traumatic brain injury. In B. P. Rourke (Ed.), *Syndrome of nonverbal learning disabilities: Neurodevelopmental manifestations* (pp. 433-459). New York, NY: Guilford Press.

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behaviour Research Methods, 41*, 1149-1160.

Fein, D., Stevens, M., Dunn, M., Waterhouse, L., Allen, D., Rapin, I., & Feinstein, C. (1999). Subtypes of pervasive developmental disorder: Clinical characteristics. *Child Neurology, 5*, 1–23. doi: 10.1076/chin.5.1.1.7075

Feldman, R., Bamberger, E., & Kanat-Maymon, Y. (2013). Parent-specific reciprocity from infancy to adolescence shapes children's social competence and dialogical skills. *Attachment & Human Development, 15*(4), 407-423. doi: 10.1080/14616734.2013.782650

Fine, J. G., Musielak, K. A., & Semrud-Clikeman, M. (2014). Smaller splenium in children with nonverbal learning disability compared to controls, high-functioning autism and ADHD. *Child Neuropsychology, 20*(6), 641-661. doi: 10.1080/09297049.2013.854763

Fisher, N. J., Deluca, J. W., & Rourke, B. P. (1997). Wisconsin Card Sorting Test and Halstead Category Test performances of children and adolescents who exhibit the syndrome of nonverbal learning disabilities. *Child Neuropsychology, 3*(1), 61-70. doi: 10.1080/09297049708401368

Fisk, J. L., & Rourke, B. P. (1983). Neuropsychological subtyping of learning-disabled children: History, methods, implications. *Journal of Learning Disabilities, 16*(9), 529-531.

Fletcher, J. M., Francis, D. J., Morris, R. D., & Lyon, G. R. (2005). Evidence-based assessment of learning disabilities in children and adolescents. *Journal of Clinical Child and Adolescent Psychology, 34*(3), 506-522. doi: 10.1207/s15374424jccp3403_7

Fletcher, J. M., Lyon, G. R., Fuchs, L. S., & Barnes, M. A. (2007). *Learning disabilities: From identification to intervention*. New York, NY: The Guilford Press.

Fombonne, E., Wostear, G., Cooper, V., Harrington, R., & Rutter, M. (2001). The Maudsley long-term follow-up of child and adolescent depression. *The British Journal of Psychiatry, 179*(3), 210-217. doi: 10.1192/bjp.179.3.210

Forrest, B. J. (2004). The utility of math difficulties, internalized psychopathology, and visual-spatial deficits to identify children with the nonverbal learning disability syndrome: evidence for a visualspatial disability. *Child Neuropsychology, 10*(2), 129-146. doi: 10.1080/09297040490911131

Freeman, B. J., Del'Homme, M., Guthrie, D., & Zhang, F. (1999). Vineland Adaptive Behavior Scale scores as a function of age and initial IQ in 210 autistic children. *Journal of Autism and Developmental Disorders, 29*(5), 379–384. doi: 10.1023/A:1023078827457

Fuerst, D. R., Fisk, J. L., & Rourke, B. P. (1990). Psychosocial functioning of learning-disabled children: Relations between WISC Verbal IQ-Performance IQ discrepancies and personality subtypes. *Journal of Consulting and Clinical Psychology, 58*, 657-660. doi: 10.1037/0022-006X.58.5.657

Fydrich, T., Chambless, D.L., Perry, K.J., Buergener, F., & Beazley, M.B. (1998). Behavioral assessment of social performance: A rating system for social phobia. *Behaviour Research and Therapy, 36*, 995–1010. doi: 10.1016/S0005-7967(98)00069-2

Gaddes, W. H. & Edgell, D. (Eds.). (2010). *Learning disabilities and brain function: A neuropsychological approach* (3rd ed.). New York, NY: Springer Science & Business Media.

Gadeyne, E., Ghesquiere, P., & Onghena, P. (2004). Psychosocial functioning of young children with learning problems. *Journal of Child Psychology and Psychiatry, 45*(3), 510-521. doi: 10.1111/j.1469-7610.2004.00241.x

Gallistel, C. R. (1975). Motivation as central organizing process: The psychophysical approach to its functional and neurophysiological analysis. *Nebraska Symposium on Motivation, 22,* 182–225.

Galway, T. M., & Metsala, J. L. (2011). Social cognition and its relation to psychosocial adjustment in children with nonverbal learning disabilities. *Journal of Learning Disabilities, 44*(1), 33-49. doi: 10.1177/0022219410371680

Gerhardt, P. F., & Mayville, E. (2010). Assessment of social skills and social competence in learners with autism spectrum disorders. In D. W. Nangle, D. J. Hansen, C. A. Erdley & P. J. Norton (Eds.), *Practitioner's guide to empirically based measures of social skills* (pp. 193-205). New York: Springer. doi: 10.1007/978-1-4419-0609-0_13

Gillberg, C. (1991). Clinical and neurobiological aspects of Asperger syndrome in six family studies. In U. Frith (Ed.), *Autism and Asperger syndrome* (pp. 122-146). Cambridge: Cambridge University Press.

Goldberg, E., & Costa, L. D. (1981). Hemisphere differences in the acquisition and use of descriptive systems. *Brain and Language, 14*(1), 144–173. doi:10.1016/0093-934X(81)90072-9

Gotham, K., Risi, S., Dawson, G., Tager-Flusberg, H., Joseph, R., Carter, A., ... Lord, C. (2008). A replication of the Autism Diagnostic Observation Schedule (ADOS)

revised algorithms. *Journal of the American Academy of Child and Adolescent Psychiatry, 47*(6), 642-651. doi: 10.1097/CHI.0b013e31816bffb7

Gotham, K., Risi, S., Pickles, A., & Lord, C. (2007). The Autism Diagnostic Observation Schedule: Revised algorithms for improved diagnostic validity. *Journal of Autism and Developmental Disorders, 37,* 613-627. doi: 10.1007/s10803-006-0280-1

Gotham, K., Pickles, A., & Lord, C. (2009). Standardizing ADOS scores for a measure of severity in autism spectrum disorders. *Journal of autism and developmental disorders, 39*(5), 693-705. doi: 10.1007/s10803-008-0674-3

Gragg, M., Casey, J. E., Drummond, C. M., & Kayfitz, A. D. (2004). Intellectual and academic profiles of children with Asperger's Disorder and Nonverbal Learning Disabilities. Poster presented at the meeting of the Geneva International Symposium on Autism, Toronto, Canada.

Graziano, A. M. (2002). *Developmental disabilities: Introduction to a diverse field*. Boston: Allyn and Bacon.

Green, M. F. (1996). What are the functional consequences of neurocognitive deficits in schizophrenia? *American Journal of Psychiatry, 153*(3), 321–330.

Greene, R.W., & Biederman, J. (1999). Further validation of social impairment as a predictor of substance use disorders: Findings from a sample of siblings of boys with and without ADHD. *Journal of Clinical Child Psychology, 28*, 349–355. doi: 10.1207/S15374424jccp280307

Green, J., Gilchrist, A., Burton, D., & Cox, A. (2000). Social and psychiatric functioning in adolescents with Asperger syndrome compared with conduct disorder. *Journal*

*of Autism and Developmental Disorders, 30*(4), 279-293. doi: 10.1023/A:1005523232106

Green, S. B., & Salkind, N. J. (2005). *Using SPSS for Windows and Macintosh: Analyzing and understanding data* (4 ed.). Upper Saddle River, New Jersey: Pearson Education, Limited.

Greenham, S. L. (1999). Learning disabilities and psychosocial adjustment: A critical review. *Child Neuropsychology, 5*(3), 171-196.

Grelotti, D., Gauthier, I., & Schultz, R. (2002). Social interest and the development of cortical face specialization: What autism teaches us about face processing. *Developmental Psychobiology, 40*, 213–225. doi: 10.1002/dev.10028

Gresham, F. M., & Cavell, T. A. (1986). Assessing adolescent social skills. In R. G. Harrington (Ed.), *Testing adolescents: A reference guide for comprehensive psychological assessments* (pp. 93-123). Kansas City: Test Corporation of America.

Gresham, F. M., & Elliott, S. N. (1984). Assessment and classification of children's social skills: A review of methods and issues. *School Psychology Review, 13*, 292-301.

Gresham, F. M., & Elliott, S. N. (1987). The relationship between adaptive behavior and social skills issues in definition and assessment. *The Journal of Special Education, 21*(1), 167-181. doi: 10.1177/002246698702100115

Gresham, F. M., & Elliott, S. N. (1990). *Social Skills Rating System.* Circle Pines, MN: American Guidance Service, Inc.

Grodzinsky, G. M., Forbes, P. W., & Bernstein, J. H. (2010). A practice-based approach to group identification in nonverbal learning disorders. *Child Neuropsychology, 16*, 433-450. doi: 10.1080/09297041003631444

Grossman, H. J. (Ed.). (1983). *Classification in mental retardation.* Washington, DC: American Association on Mental Deficiency.

Guralnick, M. J. (1999). Family and child influences on the peer-related social competence of young children with developmental delays. *Mental Retardation and Developmental Disabilities Research Reviews, 5*, 21–29.

Halberstadt, A. G., Denham, S. A., & Dunsmore, J. C. (2001). Affective social competence. *Social development, 10*(1), 79-119. doi: 10.1111/1467-9507.00150

Harnadek, M. C., & Rourke, B. P. (1994). Principal identifying features of the syndrome of nonverbal learning disabilities in children. *Journal of Learning Disabilities, 27*(3), 144–154. doi:10.1177/002221949402700303

Harris, L. T., Todorov, A., & Fiske, S. T. (2005). Attributions on the brain: neuro-imaging dispositional inferences, beyond theory of mind. *Neuroimage, 28*(4), 763-769.

Harrison, A. G. (2005). Recommended best practices for the early identification and diagnosis of children with specific learning disabilities in Ontario. *Canadian Journal of School Psychology*, *20*(1-2), 21-43.

Harrison, P. L., & Boan, C. H. (2004). Assessment of adaptive behavior. In B. A. Bracken (Ed.), *The psychoeducational assessment of preschool children* (pp. 124-144). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Harrison, P. L., & Oakland, T. (2003). *Manual of the adaptive behaviour assessment system – second edition*. San Antonio, TX: Harcourt Assessment.

Hartman, C. A., Luteijn, E., Serra, M., & Minderaa, R. (2006). Refinement of the Children's Social Behaviour Questionnaire (CSBQ): An instrument that describes the diverse problems seen in milder forms of PDD. *Journal of Autism and Developmental Disorders, 36*(3), 325-342.

Hauck, M., Fein, D., Waterhouse, L., & Feinstein, C. (1995). Social initiations by autistic children to adults and other children. *Journal of Autism and Developmental Disorders, 25*, 579–595. doi: 10.1007/BF02178189f

Hebb, D.O. (1949). *The organization of behavior: A neuropsychological theory*. New York, NY: John Wiley & Sons.

Helt, M., Kelley, E., Kinsbourne, M., Pandey, J., Boorstein, H., Herbert, M., & Fein, D. (2008). Can children with autism recover? If so, how? *Neuropsychology Review, 18*(4), 339-366. doi: 10.1007/s11065-008-9075-9

Hobson, R. P., Chidambi, G., Lee, A., Meyer, J., Müller, U., Carpendale, J., ... Racine, T. (2006). Foundations for self-awareness: An exploration through autism. *Monographs of the Society for Research in Child Development, 71*(2), i-166.

Hosmer, D., & Lemeshow, S. (2000). *Applied Logistic Regression* (2nd ed.). New York: Wiley.

Humphrey, N., & Symes, W. (2011). Peer interaction patterns among adolescents with autistic spectrum disorders (ASDs) in mainstream school settings. *Autism, 15*(4), 397-419. doi: 10.1177/1362361310387804

Hupp, S. D. A., LeBlanc, M., Jewell, J. D., & Warnes, E. (2009). History and overview. In J. L. Matson (Ed.), *Social behavior and skills in children* (pp. 1 – 21). New York, NY: Springer.

IBM Corp. (2012). *IBM SPSS Statistics for Windows*, Version 21.0. Armonk, NY: IBM Corp.

Ikemoto, S. (2010). Brain reward circuitry beyond the mesolimbic dopamine system: A neurobiological theory. *Neuroscience & biobehavioral reviews, 35*(2), 129-150. doi: 10.1016/j.neubiorev.2010.02.001

Izuma, K., Matsumoto, K., Camerer, C. F., & Adolphs, R. (2011). Insensitivity to social reputation in autism. *Proceedings of the National Academy of Sciences, 108*(42), 17302-17307. doi: 10.1073/pnas.1107038108

Jewell, J. D., Grippi, A., Hupp, S. D., & Krohn, E. J. (2007). The effects of a rotating classroom schedule on classroom crisis events in a school for autism. *North American Journal of Psychology, 9*(1), 37-52.

Johnson, D. J., & Myklebust, H. R. (1967). *Learning disabilities: Educational principles and practices*. New York: Grune & Stratton.

Kalat, J.W. (2004). *Biological psychology* (8th ed.). Belmont, CA: Thomson Wadsworth.

Kamphaus, R. W. (2003). Adaptive behavior scales. In C. R. Reynolds, & R. W. Kamphaus (Eds.), *Handbook of psychological and educational assessment of children: Personality, behavior, and context* (Vol. 2, pp. 455 – 469). New York, NY: Guilford Press.

Kanne, S. M., & Mazurek, M. O. (2011). Asperger's Disorder. In J. S. Kreutzer, B. Caplan & J. DeLuca (Eds.), *Encyclopedia of clinical neuropsychology* (pp. 258-262). New York: Springer. doi: 10.1007/978-0-387-79948-3

Kanne, S. M., Randolph, J. K., & Farmer, J. E. (2008). Diagnostic and assessment findings: A bridge to academic planning for children with autism spectrum disorders. *Neuropsychology Review, 18*(4), 367-384.

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child, 2*, 217–250.

Kashluba, S., Hanks, R. A., Casey, J. E., & Millis, S. R. (2008). Neuropsychologic and functional outcome after complicated mild traumatic brain injury. *Archives of physical medicine and rehabilitation, 89*(5), 904-911. doi:10.1016/j.apmr.2007.12.029

Kaufmann, L., Wood, G., Rubinsten, O., & Henik, A. (2011). Meta-analyses of developmental fMRI studies investigating typical and atypical trajectories of number processing and calculation. *Developmental neuropsychology, 36*(6), 763-787. doi: 10.1080/87565641.2010.549884

Kikuchi, Y., Senju, A., Tojo, Y., Osanai, H., & Hasegawa, T. (2009). Faces do not capture special attention in children with autism spectrum disorder: A change blindness study. *Child Development, 80*(5), 1421-1433. doi: 10.1111/j.1467-8624.2009.01342.x

Kim, J., Szatmari, P., Bryson, S., Streiner, D. L., & Wilson, F. J. (2000). The prevalence of anxiety and mood problems among children with autism and Asperger syndrome. *Autism, 4*, 117–132. doi: 10.1177/1362361300004002002

Klin, A., Saulnier, C. A., Sparrow, S. S., Cicchetti, D. V., Volkmar, F. R., & Lord, C. (2007). Social and communication abilities and disabilities in higher functioning individuals with autism spectrum disorders: The Vineland and the ADOS. *Journal of autism and developmental disorders, 37*(4), 748-759. doi: 10.1007/s10803-006-0229-4

Klin, A., Saulnier, C., Tsatsanis, K., & Volkmar, F. R. (2005). Clinical evaluation in autism spectrum disorders: Psychological assessment within a transdisciplinary framework. In F. R. Volkmar, R. Paul, A. Klin, & D. Cohen (Eds.), *Handbook of autism and pervasive developmental disorders: Vol. 2. Assessment, interventions, and policy* (3rd ed., pp. 772–798). Hoboken, NJ: Wiley.

Klin, A., Sparrow, S. S., Marans, W. D., Carter, A., & Volkmar, F. R. (2000). Assessment issues in children and adolescents with Asperger syndrome. In A. Klin, F. R. Volkmar, & S. S. Sparrow (Eds.), *Asperger syndrome* (pp. 309–339). New York: Guilford.

Klin, A., Sparrow, S. S., Volkmar, F., Cicchetti, D. V., & Rourke, B. P. (1995). Asperger syndrome. In B. P. Rourke (Ed.), *Syndrome of nonverbal learning disabilities: Neurodevelopmental manifestations* (pp. 93–118). New York: Guilford Press.

Klin, A., Volkmar, F., Sparrow, S., Cicchetti, D., & Rourke, B. (1996). Validity and neuropsychological characterization of Asperger syndrome: Convergence with nonverbal learning disabilities syndrome. *Annual Progress in Child Psychiatry and Child Development, 36*, 241-259.

Klinger, L. G., Dawson, G., Barnes, K., & Crisler, M. (2014). Autism spectrum disorder. In E. J. Mash & R. A. Barkley (Eds.), *Child psychopathology* (3rd. Ed., pp. 531-572). New York, NY: Guildford Press.

Knights, R. M., & Moule, A. D. (1968). Normative data on the motor steadiness battery for children. *Perceptual and Motor Skills, 26*(2), 643-650.

Kohls, G., Chevallier, C., Troiani, V., & Schultz, R. T. (2012). Social 'wanting' dysfunction in autism: neurobiological underpinnings and treatment implications. *Journal of Neurodevelopmental Disorders, 4*(10), 1-20. doi: 10.1186/1866-1955-4-10

Kolb, B., & Whishaw, I. Q. (2009). *Fundamentals of human neuropsychology (6th ed.).* New York, NY, US: Worth Publishers.

Krantz, P. J., Land, S. E., & McClannahan, L. E. (1989). Conversational skills for autistic adolescents: An autistic peer as prompter. *Behavioural Interventions, 4*(3), 171-189. doi: 10.1002/bin.2360040303

Krantz, P. J., & McClannahan, L. E. (1993). Teaching children with autism to initiate to peers: Effects of a script-fading procedure. *Journal of Applied Behaviour Analysis, 26*(1), 121-132. doi: 10.1901/jaba.1993.26-121

Lachar, D. (1982). *Personality Inventory for Children (PIC) Revised Format Manual Supplement.* Western Psychological Services, Los Angeles, CA.

Lachar, D. (1990). Objective assessment of child and adolescent personality: The Personality Inventory for Children. In C. R. Reynolds, & R. W. Kamphaus (Eds.), *Handbook of psychological and educational assessment of children: Personality, behavior, and context* (pp. 298 - 323). New York, NY: Guilford Press.

Landa, R. (2000). Social language use in Asperger syndrome and high functioning autism. In A. Klin, F. R. Volkmar, & S. S. Sparrow (Eds.), *Asperger Syndrome* (pp. 125-155). New York, NY: Guildford Press.

Learning Disabilities Association of Ontario. (2015). *What are learning disabilities?* Retrieved from http://www.ldao.ca/introduction-to-ldsadhd/what-are-lds/

Le Couteur, A., Lord, C., & Rutter, M. (2003). *Autism Diagnostic Interview-Revised*. Los Angeles, CA: Western Psychological Services.

Lecavalier, L. (2006). Behavioural and emotional problems in young people with pervasive developmental disorders: Relative prevalence, effects of subject characteristics, and empirical classification. *Journal of Autism and Developmental Disorders, 36*(8), 1101-1114. doi: 10.1007/s10803-006-0147-5

Leary, M. R., & Allen, A. B. (2011). Belonging motivation: Establishing, maintaining, and repairing relational value. In D. Dunning (Ed.), *Social motivation* (pp. 37-55). New York, NY: Psychology Press.

Leary, M. R., & Cox, C. (2008). Belongingness motivation: A mainspring of social action. In J. Shah & W. Gardner (Eds.), *Handbook of motivation science* (pp. 27–40). New York, NY: Guilford.

Leekam, S., & Ramsden, C. H. (2006). Dyadic orienting and joint attention in preschool children with autism. *Journal of Autism and Developmental Disorders*, *36*(2), 185-197. doi: 10.1007/s10803-005-0054-1

Lemerise, E. A., & Arsenio, W. F. (2000). An integrated model of emotion processes and cognition in social information processing. *Child development, 71*(1), 107-118. doi: 10.1111/1467-8624.00124

Lewandowski, L. J., & Lovett, B. J. (2014). In E. J. Mash & R. A. Barkley (Eds.), *Child psychopathology* (3rd. Ed., pp. 625-669). New York, NY: Guildford Press.

Lezak, M. D., Howieson, D. B., Bigler, E. D., & Tranel, D. (2012). *Neuropsychological Assessment* (5 ed.). New York: Oxford University Press.

Lichtenstein, P., Carlström, E., Råstam, M., Gillberg, C., & Anckarsäter, H. (2010). The genetics of autism spectrum disorders and related neuropsychiatric disorders in childhood. *American Journal of Psychiatry, 167*(11), 1357-1363. doi: 10.1176/appi.ajp.2010.10020223

Liebal, K., Colombi, C., Rogers, S., Warneken, F., & Tomasello, M. (2008). Helping and cooperation in children with autism. *Journal of Autism and Developmental Disorders, 38*(2), 224-238. doi: 10.1007/s10803-007-0381-5

Lindgren, S. D., & Benton, A. L. (1980). Developmental patterns of visuospatial judgment. *Journal of Pediatric Psychology, 5*, 217–225. doi: 10.1093/jpepsy/5.2.217

Lipton, M., & Nowicki, S. (2009). The social emotional learning framework (SELF): A guide for understanding brain-based social emotional learning impairments. *The Journal of Developmental Processes, 4*(2), 99-115.

Liss, M., Harel, B., Fein, D., Allen, D., Dunn, M., Feinstein, C., Morris, R., Waterhouse, L., & Rapin, I. (2001). Predictors and correlates of adaptive functioning in children with developmental disorders. *Journal of Autism and Developmental Disorders, 31*(2), 219–230. doi: 10.1023/A:1010707417274

Little, S. S. (1993). Nonverbal learning disabilities and socioemotional functioning: A review of recent literature. *Journal of Learning Disabilities, 26*(10), 653-665. doi: 10.1177/002221949302601003

Lochman, J. E., & Wells, K. C. (2002). Contextual social– cognitive mediators and child outcome: A test of the theoretical model in the Coping Power program. *Development and Psychopathology, 14*, 945–967. doi: 10.1017/S0954579402004157

Lord, C., & Magill-Evans, J. (1995). Peer interactions of autistic children and adolescents. *Development and Psychopathology, 7*, 611–626. doi: 10.1017/S095457940000674X

Lord, C., Risi, S., Lambrecht, L., Cook Jr, E. H., Leventhal, B. L., DiLavore, P. C., . . . Rutter, M. (2000). The Autism Diagnostic Observation Schedule-Generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders, 30*(3), 205-223.

Lord C, Risi S, Pickles A. (2004). Trajectory of language development in autistic spectrum disorders. In M. L. Rice & S. F. Warren (Eds.), *Developmental language disorders: From phenotypes to etiologies* (pp. 7-29). Mahwah, NJ: Lawrence Erlbaum Associates.

Lord, C., Rutter, M., DiLavore, P., & Risi S. (2001). *Autism diagnostic observation schedule (ADOS)*. Torrance, CA: WPS.

Lord, C., Rutter, M., DiLavore, P. C., Risi, S., Gotham, K., & Bishop, S. (2012). *Autism Diagnostic Observation Schedule, second edition*. Torrance, CA: Western Psychological Services.

Loveland, K. A., Fletcher, J. M., & Bailey, V. (1990). Verbal and nonverbal communication of events in learning-disability subtypes. *Journal of Clinical and Experimental Neuropsychology, 12,* 433-447. doi: 10.1080/01688639008400991

Loukusa, S., Leinonen, E., Kuusikko, S., Jussila, K., Mattila, M. L., Ryder, N., ... & Moilanen, I. (2007). Use of context in pragmatic language comprehension by children with Asperger syndrome or high-functioning autism. *Journal of Autism and Developmental Disorders, 37*(6), 1049-1059. doi: 10.1007/s10803-006-0247-2

Lovett, B. J., & Gordon, M. (2005). Discrepancies as a basis for the assessment of learning disabilities and ADHD. *ADHD Report, 13,* 1-4. doi: 10.1521/adhd.2005.13.3.1

Luckasson, R., Borthwick-Duffy, S., Buntix, W. H. E., Coulter, D. L., Craig, E. M., Reeve, A., Schalock, R. L., Snell, M. E., Spitalnik, D. M., Spreat, S., Tassé, M. J. (2002). *Mental retardation: Definition, classification, and systems of supports* (l0th ed.). Washington DC: American Association on Mental Retardation.

MacNeil, B. M., Lopes, V. A., & Minnes, P. M. (2009). Anxiety in children and adolescents with autism spectrum disorders. *Research in Autism Spectrum Disorders, 3*(1), 1-21. doi: 10.1016/j.rasd.2008.06.001

Magiati, I., Moss, J., Charman, T., & Howlin, P. (2011). Patterns of change in children with autism spectrum disorders who received community based comprehensive

interventions in their pre-school years: A seven year follow-up study. *Research in Autism Spectrum Disorders, 5*(3), 1016-1027. doi: http://dx.doi.org/10.1016/j.rasd.2010.11.007

MaGill-Evans, J., Koning, C., Cameron-Sadava, A., & Manyk, K. (1996). *Manual for the child and adolescent social perception measure.* Unpublished manuscript.

Mahan, S., & Matson, J. L. (2011). Children and adolescents with autism spectrum disorders compared to typically developing controls on the Behavioural Assessment System for Children (BASC-2). *Research in Autism Spectrum Disorders, 5*(1), 119-125. doi: 10.1016/j.rasd.2010.02.007

Malec, J. F. (2011). Outcome, outcome measurement. In J. S. Kreutzer, B. Caplan & J. DeLuca (Eds.), *Encyclopedia of clinical neuropsychology* (pp. 1834-1836). New York: Springer. doi: 10.1007/978-0-387-79948-3

Mamen, M. (2002). Nonverbal learning disabilities and their clinical subtypes: *Assessment, diagnosis and management* (4th ed.). Ottawa, Ontario, Canada: Centrepointe Professional Services.

Mammarella, I. C., & Cornoldi, C. (2014). An analysis of the criteria used to diagnose children with Nonverbal Learning Disability (NLD). *Child Neuropsychology, 20*(3), 255-280. doi: 10.1080/09297049.2013.796920

Maniaci, M. (2009). Belonging, need for. In H. T. Reis & S. Sprecher (Eds.), *Encyclopedia of human relationships* (Vol. 1, pp. 165-168). Thousand Oaks, CA: Sage Publications. doi: 10.4135/9781412958479

Marshall, M. (2013). The role of the educational therapist: Academic interventions for reading and writing. In J. Broitman & J. M. Davis (Eds.), *Treating NVLD in Children* (pp. 147-172). New York, NY: Springer.

Matthews, C. G., & Kløve, K. (1964). *Instruction manual for the Adult Neuropsychology Test Battery*. Madison, WI: University of Wisconsin Medical School.

Mattson, A., Sheer, D., & Fletcher, J. (1992). Electrophysiological evidence of lateralized disturbances in children with learning disabilities. *Journal of Clinical and Experimental Neuropsychology*, *14*, 707–716. doi: 10.1080/01688639208402857

Max, J. E., Koele, S. L., Lindgren, S. D., Robin, D. A., Smith, W. L. Jr., Sato, Y., and Arndt, S. (1998). Adaptive functioning following traumatic brain injury and orthopedic injury: A controlled study. *Archives of Physical Medicine and Rehabilitation, 79*, 893–899.

Mayer, J. D., & Salovey, P. (1997). What is emotional intelligence? In P. Salovey & D. J. Sluyter (Eds.), *Emotional development and emotional intelligence: Educational implications* (pp. 3-34). New York: Harper Collins.

Mazzone, L., Postorino, V., De Peppo, L., Fatta, L., Lucarelli, V., Reale, L., ... & Vicari, S. (2013). Mood symptoms in children and adolescents with autism spectrum disorders. *Research in developmental disabilities, 34*(11), 3699-3708. doi:10.1016/j.ridd.2013.07.034

McCauley, R. (2010). Review of the Children's Communication Checklist-2. *Eighteenth mental measurements yearbook.* Retrieved from EbscoHost Mental Measurements Yearbook with Tests in Print database.

McClure, E. B. (2000). A meta-analytic review of sex differences in facial expression processing and their development in infants, children, and adolescents. *Psychological Bulletin, 126*(3), 424.

McGrath, L. M., & Peterson, R. L. (2008). Autism spectrum disorder. In B. F. Pennington (Ed.), *Diagnosing Learning Disorders* (2nd ed., pp. 108-151). New York, NY: Guilford Press.

McIntosh, D. E., Dunham, M. D., Dean, R. S., & Kundert, D. K. (1995). Neuropsychological characteristics of learning disabled/gifted children. *International Journal of Neuroscience, 83*(1-2), 123-130.

Mehzabin, P., & Stokes, M. A. (2011). Self-assessed sexuality in young adults with high-functioning autism. *Research in Autism Spectrum Disorders, 5*(1), 614-621.

Metsiou, K., Papadopoulos, K. & Agaliotis I. (2011). Adaptive behavior of primary school students with visual impairments: The impact of educational settings. *Research in Developmental Disabilities, 32* (6), 2340–2345. doi: 10.1016/j.ridd.2011.07.030

Meyer, J. A., & Minshew, N. J. (2002). An update on neurocognitive profiles in Asperger syndrome and high-functioning autism. *Focus on autism and other developmental disabilities, 17*(3), 152-160. doi: 10.1177/10883576020170030501

Miles, S. B., & Stipek, D. (2006). Contemporaneous and longitudinal associations between social behavior and literacy achievement in a sample of low-income elementary school children. *Child Development, 77,* 103–117. doi: 10.1111/j.1467-8624.2006.00859.x

Miller, G. M., & Chapman, J. P. (2001). Misunderstanding analysis of covariance. *Journal of Abnormal Psychology, 110,* 40–48. doi: 10.1037/0021-843X.110.1.40

Miller, M. D. (2010). Review of the Wechsler Individual Achievement Test-Third Edition. *Eighteenth mental measurements yearbook*. Retrieved from EbscoHost Mental Measurements Yearbook with Tests in Print database.

Modi, M. E., & Young, L. J. (2012). The oxytocin system in drug discovery for autism: animal models and novel therapeutic strategies. *Hormones and Behaviour, 61*(3), 340-350.

Munakata, Y., Casey, B. J., & Diamond, A. (2004). Developmental cognitive neuroscience: Progress and potential. *Trends in Cognitive Sciences, 8,* 122–128. doi:10.1016/j.tics.2004.01.005

Mundy, P., Sullivan, L., & Mastergeorge, A. M. (2009). A parallel and distributed-processing model of joint attention, social cognition and autism. *Autism Research, 2*(1), 2-21. doi: 10.1002/aur.61

Njiokiktjien, C., de Rijke, W., & Jonkman, E. (2001). Children with nonverbal learning disabilities (NLD): Coherence values in the resting state may reflect hypofunctional long distance connections in the right hemisphere. *Human Physiology, 27,* 523–528. doi: 10.1023/A:1012335223507

Norbury, C. F., & Bishop, D. V. M. (2005). Children's Communication Checklist-2: A validation study. *TRANEL (Travaux neuchâtelois de linguistique), 42*, 53-63.

Nussbaum, N. L., & Bunner, M. R. (2009). Halstead-Reitan neuropsychological test batteries for children. In C. R. Reynolds & E. Fletcher-Janzen (Eds.), *Handbook of clinical child neuropsychology* (3 ed., pp. 247-266). New York, NY: Springer.

Oakland, T. & Harrison, P. (2008). Adaptive behaviors and skills: An introduction. In: T. Oakland & P. L. Harrison (Eds.), *Adaptive behavior assessment system-II: Clinical use and interpretation* (pp. 3-18). New York, NY: Elsevier

Ozols, E. J., & Rourke, B. P. (1985). Dimensions of social sensitivity in two types of learning-disabled children. In B. P. Rourke (Ed.), *Neuropsychology of learning disabilities: Essentials of subtype analysis* (pp. 281-301). New York: Guilford Press.

Ozonoff, S., & Rogers, S. J. (2003). Autism spectrum disorders: A research review for practitioners. In S. Ozonoff, S. J. Rogers, & R. L. Hendren (Eds.), *Review of psychiatry* (pp. 3–33). Washington: American Psychiatric Publishing.

Parker, J., Rubin, K. H., Erath, S., Wojslawowicz, J. C., & Buskirk, A. A. (2006). Peer relationships and developmental psychopathology. In D. Cicchetti & D. Cohen (Eds.), *Developmental psychopathology: Risk, disorder, and adaptation* (Vol. 2, 2nd ed., pp. 419–493). New York: Wiley.

Pavlov, I. P. (1927). *Conditioned Reflexes*. London: Oxford Univ. Press

Pelletier, P. M., Ahmad, S. A., & Rourke, B. P. (2001). Classification rules for basic phonological processing disabilities and nonverbal learning disabilities: Formulation and external validity. *Child Neuropsychology*, *7*(2), 84-98.

Pennington, B. F. (1991). *Diagnosing learning disorders*. New York, NY: Guilford Press.

Pennington, B. F. (2008). *Diagnosing learning disorders: A neuropsychological framework*. New York, NY: Guilford Press.

Peppé, S., McCann, J., Gibbon, F., O'Hare, A., & Rutherford, M. (2007). Receptive and expressive prosodic ability in children with high-functioning autism. *Journal of Speech, Language, and Hearing Research, 50*(4), 1015-1028.

Peterson, D. B. (2005). International Classification of Functioning, Disability and Health: An introduction for rehabilitation psychologists. *Rehabilitation Psychology, 50*, 105-112.

Peterson, D. B. (2011). *Psychological aspects of functioning, disability, and health.* New York: Springer Pub.

Petti, V., Voelker, S., Shore, D., & Hayman-Abello, S. (2003). Perception of nonverbal emotion cues by children with nonverbal learning disabilities. *Journal of Developmental and Physical Disabilities, 15*(1), 23-36. doi: 10.1023/A:1021400203453

Philofsky, A., Fidler, D. J., & Hepburn, S. (2007). Pragmatic language profiles of school-age children with autism spectrum disorders and Williams syndrome. *American Journal of Speech-Language Pathology, 16*(4), 368-380.

Piaget, J. (1952). *The origins of intelligence in children*. New York: International Universities Press.

Priebe, S. (2007). Social outcomes in schizophrenia. *The British Journal of Psychiatry, 191*(50), s15-s20. doi: 10.1192/bjp.191.50.s15

Prigatano, G. P. (1991). Disturbances of self-awareness of deficit after traumatic brain injury. In G. P. Prigatano & D. L. Schacter (Eds.), *Awareness of deficit after brain injury: Clinical and theoretical issues* (pp. 111–126). New York: Springer.

Prigatano, G. P., Altman, I., & O'Brien, K. (1990). Behavioral limitations that traumatic brain injured patients tend to underestimate. *The Clinical Neuropsychologist*, 4, 1–14. doi: 10.1080/13854049008401509

Psychological Corporation. (1999). *Wechsler Abbreviated Scale of Intelligence*. San Antonio, TX: Harcourt Assessment, Inc.

R Development Core Team (2015). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing.

Regier, D. A., Narrow, W. E., Clarke, D. E., Kraemer, H. C., Kuramoto, S. J., Kuhl, E. A., & Kupfer, D. J. (2013). DSM-5 field trials in the United States and Canada, part II: Test-retest reliability of selected categorical diagnoses. *American Journal of Psychiatry, 170*, 59–70. doi: 10.1176/appi.ajp.2012.12070999

Reichow, B. (2012). Overview of meta-analyses on early intensive behavioural intervention for young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 42*(4), 512-520.

Renwick, S., & Emler, N. (1991). The relationship between social skills deficits and juvenile delinquency. *British Journal of Clinical Psychology, 30*, 61–71. doi: 10.1111/j.2044-8260.1991.tb00920.x

Reschly, D. J., Myers, T. G., & Hartel, C. R. (Eds.). (2002). The role of adaptive behavior assessment. In *Mental retardation: Determining eligibility for social security benefits* (pp. 141-207). Washington, DC: National Academy Press

Reynolds, C. R., & Kamphaus, R. W. (2004). *Behavior Assessment System for Children second edition manual*. Minneapolis, MN: NCS Pearson Inc.

Rice, C. (Speaker). (2009, December 19). *CDC press briefing on Autism surveillance summary* [audio podcast]. Retrieved from http://www.cdc.gov/media/transcripts/2009/t091218.htm

Ris, M. D., Ammerman, R. T., Waller, N., Walz, N., Oppenheimer, S., Brown, T. M., . . . Yeates, K. O. (2007). Taxonicity of nonverbal learning disabilities in spina bifida. *Journal of the International Neuropsychological Society, 13,* 50-58. doi: 10.10170S1355617707070087

Ris, M. D., & Nortz, M. (2008). Nonverbal learning disorder. In J. E. Morgan & J. H. Ricker (Eds.), *Textbook of clinical neuropsychology* (pp. 346-359). New York, NY: Taylor & Francis.

Ro, T., Russell, C., & Lavie, N. (2001). Changing Faces: A Detection Advantage in the Flicker Paradigm. *Psychological Science, 12*(1), 94-99.

Rose-Krasnor, L. (1997). The nature of social competence: A theoretical review. *Social Development,* 6, 111-135. doi: 10.1111/j.1467-9507.1997.tb00097.x

Rose-Krasnor, L. & Denham, S. (2009). Social-emotional competence in early childhood. In K. H. Rubin, W. M. Bukowski, & B. Laursen (Eds.), *Handbook of peer interactions, relationships, and groups* (pp. 162-179). New York, NY: Guilford Press.

Rourke, B. P. (1982). Central processing deficiencies in children: Toward a developmental neuropsychological model. *Journal of Clinical and Experimental Neuropsychology, 4*(1), 1-18. doi: 10.1080/01688638208401112

Rourke, B. (1987). Syndrome of nonverbal learning disabilities: The final common pathway of white-matter disease/dysfunction? *The Clinical Neuropsychologist, 1*(3), 209–234. doi: 10.1080/13854048708520056

Rourke, B. P. (1988). The syndrome of nonverbal learning disabilities: Developmental manifestations in neurological disease, disorder, and dysfunction. *The Clinical Neuropsychologist, 2*(4), 293-330.

Rourke, B. P. (1989). *Nonverbal learning disabilities: The syndrome and the model*. New York: Guilford Press.

Rourke, B. P. (1993a). Arithmetic disabilities, specific and otherwise: A neuropsychological perspective. *Journal of Learning disabilities, 26*(4), 214-226. doi: 10.1177/002221949302600402

Rourke, B. P. (1993b). *Nonverbal learning disabilities (NLD) scale*. Unpublished manuscript. University of Windsor and Yale University.

Rourke, B. P. (Ed.). (1995). *Syndrome of nonverbal learning disabilities: Neurodevelopmental manifestations.* New York, NY: Guilford Press.

Rourke, B. P. (2000). Neuropsychological and psychosocial subtyping: A review of investigations within the University of Windsor laboratory. *Canadian Psychology/Psychologie Canadienne, 41*(1), 34. doi: 10.1037/h0086856

Rourke, B. P., Ahmad, S. A., Collins, D. W., Hayman-Abello, B. A., Hayman-Abello, S. E., & Warriner, E. M. (2002). Child clinical/pediatric neuropsychology: Some recent advances. *Annual review of psychology, 53*(1), 309-339. doi: 10.1146/annurev.psych.53.100901.135204

Rourke, B. P., Dietrich, D. M., & Young, G. C. (1973). Significance of WISC verbal-performance discrepancies for younger children with learning disabilities. *Perceptual and Motor Skills, 36*(1), 275–282. doi:10.2466/pms.1973.36.1.275

Rourke, B. P., & Finlayson, M. A. (1978). Neuropsychological significance of variations in patterns of academic performance: Verbal and visual-spatial abilities. *Journal of Abnormal Child Psychology, 6*(1), 121–133. doi:10.1007/BF00915788 PMID:632453

Rourke, B. P., Fisk, J. L., & Strang, J. D. (1986). *Neuropsychological assessment of children: A treatment-oriented approach.* New York, NY: Guilford Press.

Rourke, B. P., & Fuerst, D. R. (1991). *Validation of psychosocial subtypes of children with learning disabilities.* New York, NY: Guilford Press.

Rourke, B. P., & Strang, J. D. (1978). Neuropsychological significance of variations in patterns of academic performance: Motor, psychomotor, and tactile-perceptual abilities. *Journal of Pediatric Psychology, 3*(2), 62–66. doi:10.1093/jpepsy/3.2.62

Rourke, B. P., & Telegdy, G. A. (1971). Lateralizing significance of WISC verbal-performance discrepancies for older children with learning disabilities. *Perceptual and Motor Skills, 33*(3), 875–883. doi:10.2466/pms.1971.33.3.875

Rourke, B. P., & Tsatsanis, K. D. (1996). Syndrome of nonverbal learning disabilities: Psycholinguistic assets and deficits. *Topics in Language Disorders, 16*(2), 30-44.

Rourke, B. P., & Tsatsanis, K. D. (2000). Nonverbal learning disabilities and Asperger syndrome. In A. Klin, F. R. Volkmar, & S. S. Sparrow (Eds.), *Asperger syndrome* (pp. 231-253). New York: Guilford Press

Rourke, B. P., Young, G. C., & Flewelling, R. W. (1971). The relationships between WISC verbal-performance discrepancies and selected verbal, auditory-perceptual, visual-perceptual, and problem-solving abilities in children with learning disabilities. *Journal of Clinical Psychology*, *27*(4), 475–479. doi:10.1002/1097-4679(197110)27:4<475::AID-JCLP2270270421>3.0.CO;2-R

Rubin, K. H., Bukowski, W., & Parker, J. (2006). Peer interactions, relationships, and groups. In N. Eisenberg (Ed), *Handbook of child psychology: Social, emotional, and personality development* (6th ed., pp. 571–645) New York: Wiley.

Rubin, K. H., & Rose-Krasnor, L. (1992). Interpersonal problem-solving. In V. B., VanHassett, & M. Hersen (Eds.). *Handbook of social and behavioral development* (pp. 1-18). Hillsdale, NJ: Erlbaum.

Rutgers, A. H., Bakermans-Kranenburg, M. J., Ijzendoorn, M. H., & Berckelaer-Onnes, I. A. (2004). Autism and attachment: a meta-analytic review. *Journal of Child Psychology and Psychiatry, 45*(6), 1123-1134.

Rutter, M., Le Couteur, A., Lord, C. (2003). *Autism diagnostic interview revised (ADI-R).* Torrance, CA: WPS.

Sabbagh, M. A. (2004). Understanding orbitofrontal contributions to theory-of-mind reasoning: Implications for autism. *Brain and Cognition, 55*(1), 209-219.

Salamone, J. D. (2006). Commentary: Will the last person who uses the term ‘reward’ please turn out the lights? Comments on processes related to reinforcement, learning, and effort. *Addiction Biology, 11*(1), 43-44. doi:10.1111/j.1360-0443.2006.00011.x

Sattler, J. M. (2001). *Assessment of children: Cognitive applications*(4 ed.). La Mesa, CA: Jerome M. Sattler.

Sattler, J. M. (2008). *Assessment of children: Cognitive foundations* (5 ed.). San Diego, CA: J. M. Sattler.

Schalock, R. L., Borthwick-Duffy, S. A., Bradley, V., Buntix, W. H. E., Coulter, M. D., Craig, E. M., Gomez, S. C, Lachapelle, Y., Luckasson, R., Reeve, A., Shogren, K. A., Snell, M. E., Spreat, S., Tassé, M. J., Thompson, J. R., Verdugo, M. A., Wehmeyer, M. L., a Yeager, M. H. (2010). *Intellectual disability: Definition, classification and systems of supports* (11th ed.). Washington, DC: American Association on Intellectual and Developmental Disabilities.

Schatz, J., & Hamdan-Allen, G. (1995). Effects of age and IQ on adaptive behavior domains for children with autism. *Journal of Autism and Developmental Disorders, 25*(1), 51–60.

Schear, J. M., & Sato, S. D. (1989). Effects of visual acuity and visual motor speed and dexterity on cognitive test performance. *Archives of Clinical Neuropsychology, 4*(1), 25-32.

Scheuermann, B., & Webber, J. (2002). *Autism: Teaching does make a difference*. Belmont, CA: Wadsworth.

Schopler, E., Reichler, R. J., DeVellis, R. F., & Daly, K. (1980). Toward objective classification of childhood autism: Childhood Autism Rating Scale (CARS). *Journal of Autism and Developmental Disorders, 10*(1), 91-103.

Schultz, W., 2006. Behavioral theories and the neurophysiology of reward. *Annual Review of Psychology,* 57, 87–115. doi: 10.1146/annurev.psych.56.091103.070229

Scourfield, J., Martin, N., Lewis, G., & McGuffin, P. (1999). Heritability of social cognitive skills in children and adolescents. *British Journal of Psychiatry, 175*, 559–564. doi: 10.1192/bjp.175.6.559

Semrud-Clikeman, M., (2007). *Social competence in children*. New York: Springer.

Semrud-Clikeman, M., & Hynd, G. (1990). Right hemispheric dysfunction in nonverbal learning disabilities: Social, academic, and adaptive functioning in adults and children. *Psychological Bulletin, 107,* 198–209. doi: 10.1037/0033-2909.107.2.196

Semrud-Clikeman, M., Walkowiak, J., Wilkinson, A., & Christopher, G. (2010). Neuropsychological differences among children with Asperger syndrome, nonverbal learning disabilities, attention deficit disorder, and controls. *Developmental Neuropsychology, 35*(5), 582-600. doi: 10.1080/87565641.2010.494747

Semrud-Clikeman, M., Walkowiak, J., Wilkinson, A., & Minne, E. P. (2010). Direct and indirect measures of social perception, behavior, and emotional functioning in children with Asperger's disorder, nonverbal learning disability, or ADHD. *Journal of Abnormal Child Psychology, 38*(4), 509-519. doi: 10.1007/s10802-009-9380-7

Senju, A., & Johnson, M. H. (2009). The eye contact effect: mechanisms and development. *Trends in Cognitive Sciences, 13*(3), 127-134. doi: http://dx.doi.org/10.1016/j.tics.2008.11.009

Sheshlow, A. W. (2001). Review of the Wide Range Assessment of Visual Motor Abilities. *Fourteenth mental measurements yearbook*. Retrieved from EbscoHost Mental Measurements Yearbook with Tests in Print database.

Shrout, P. E., & Yager, T. J. (1989). Reliability and validity of screening scales: Effect of reducing scale length. *Journal of Clinical Epidemiology, 42*(1), 69-78.

Siegel, L. S. (1992). An evaluation of the discrepancy definition of dyslexia. *Journal of Learning Disabilities, 25*, 618–629. doi: 10.1177/002221949202501001

Sigman, M., Dissanayake, C., Arbelle, S., & Ruskin, E. (1997). Cognition and emotion in children and adolescents with autism. In D. Cohen and F. R. Volkmar (Eds.), *Handbook of autism and pervasive developmental disorders* (2nd ed., pp. 248-265). New York, NY: John Wiley and Sons.

Sigman, M., & Ruskin, E. (1999). Continuity and change in the social competence of children with autism, Down syndrome, and developmental delays. *Monographs of the Society for Research in Child Development, 64* (1, Serial No. 256). doi: 10.1007/BF02178189

Sikora, D. M., Vora, P., Coury, D. L., & Rosenberg, D. (2012). Attention-deficit/hyperactivity disorder symptoms, adaptive functioning, and quality of life in children with autism spectrum disorder. *Pediatrics, 130*(Supplement 2), S91-S97. doi: 10.1542/peds.2012-0900G

Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., & Baird, G. (2008). Psychiatric disorders in children with autism spectrum disorders: Prevalence, comorbidity, and associated factors in a population-derived sample. *Journal of the American Academy of Child & Adolescent Psychiatry, 47*(8), 921-929. doi: 10.1097/CHI.0b013e318179964f

Smith, L. A., & Rourke, B. P. (1995). Callosal agenesis. In B. P. Rourke (Ed.), *Syndrome of nonverbal learning disabilities: Neurodevelopmental manifestations* (pp. 45-92). New York, NY: Guilford Press.

South, M., Ozonoff, S., & McMahon, W. M. (2005). Repetitive behaviour profiles in Asperger syndrome and high-functioning autism. *Journal of Autism and Developmental Disorders, 35*(2), 145-158. doi: 10.1007/s10803-004-1992-8

Sparrow, S. S., Balla, D. A., & Cicchetti, D. V. (1984). *Vineland Adaptive Behavior Scales (Expanded Form).* Circle Pines, MN: American Guidance Service.

Spitzberg, B.H. (2003). Methods of interpersonal skill assessment. In J.O. Greene and B.R. Burleson (Eds.), *Handbook of Communication and Social Interaction Skills* (pp. 93–134). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Spreen, O. (2011). Nonverbal learning disabilities: A critical review. *Child Neuropsychology, 17*(5), 418-443. doi: 10.1080/09297049.2010.546778

Steese-Seda, D., Brown, W. S., & Caetano, C. (1995). Development of visuomotor coordination in school aged children: The Bimanual Coordination Test. *Developmental Neuropsychology, 11,* 181–199. doi: 10.1080/87565649509540612

Stein, M. T., Klin, A., & Miller, K. (2004). When Asperger's syndrome and a nonverbal learning disability look alike. *Pediatrics, 114*(Supplement 6), 1458-1463.

Stein, S. (2007). Review of the Behavior Assessment System for Children [Second Edition]. In *the 17th mental measurements yearbook*. Retrieved from EBSCO Mental Measurements Yearbook database.

Stern, S. K., & Morris, M. K. (2013). Discrimination of ADHD and reading disability in adults using the D-KEFS. *Archives of clinical neuropsychology, 28*(2), 125-134. doi: 10.1093/arclin/acs111

Sternberg, R. J., & Grigorenko, E. L. (2002). Difference scores in the identification of children with learning disabilities: It's time to use a different method. *Journal of School Psychology, 40,* 65–83. doi: 10.1016/S0022-4405(01)00094-2

Stokes, M., Newton, N., & Kaur, A. (2007). Stalking, and social and romantic functioning among adolescents and adults with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 37*(10), 1969-1986. doi: 10.1007/s10803-006-0344-2

Stone, W. L., & Caro-Martinez, L. M. (1990). Naturalistic observations of spontaneous communication in autistic children. *Journal of Autism and Developmental Disorders, 20*,437– 453. doi: 10.1007/BF02216051

Strang, J. D., & Del Dotto, J. E. (1985). *Specific nonverbal disorders in children: Neuropsychological assessment and intervention*. Unpublished manuscript. (Available from authors: Regional Children's Centre, Windsor Western Hospital, 1453 Prince Road, Windsor, Ontario, Canada, N9C 8Z4).

Strang, J. D., & Rourke, B. P. (1983). Concept-formation/non-verbal reasoning abilities of children who exhibit specific academic problems with arithmetic. *Journal of Clinical Child Psychology, 12*(1), 33–39. doi:10.1080/15374418309533110

Strang, J. D., & Rourke, B. P. (1985). Adaptive behaviour of children who exhibit specific arithmetic disabilities and associated neuropsychological abilities and deficits. In B. P. Rourke (Ed.), *Neuropsychology of learning disabilities: Essentials of subtype analysis* (pp. 303-328). New York: Guilford Press.

Strauss, E., Sherman, E. M. S., & Spreen, O. (2006). *A compendium of neuropsychological tests: Administration, norms, and commentary.* New York: Oxford University Press.

Strom, D. A., Gray, J. W., Dean, R. S., & Fischer, W. E. (1987). The incremental validity of the Halstead-Reitan Neuropsychological Battery in predicting achievement for learning-disabled children. *Journal of Psychoeducational Assessment, 5*(2), 157-165. doi: 10.1177/073428298700500207

Stuebing, K. K., Fletcher, J. M., LeDoux, J. M., Lyon, G. R., Shaywitz, S. E., & Shaywitz, B. A. (2002). Validity of IQ-discrepancy classifications of reading disabilities: A meta-analysis. *American Educational Research Journal, 39,* 465–518. doi: 10.3102/00028312039002469

Stump, K. N., Ratliff, J. M., Wu, Y. P., & Hawley, P. H. (2009). Theories of social competence from the top-down to the bottom-up: A case for considering foundational Human Needs. In J. L. Matson (Ed.), *Social behavior and skills in children* (pp. 23 – 37). New York, NY: Springer.

Sutera, S., Pandey, J., Esser, E. L., Rosenthal, M. A., Wilson, L. B., Barton, M., ... & Fein, D. (2007). Predictors of optimal outcome in toddlers diagnosed with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 37*(1), 98-107. doi: 10.1007/s10803-006-0340-6

Swineford, L. B., Thurm, A., Baird, G., Wetherby, A. M., & Swedo, S. (2014). Social (pragmatic) communication disorder: A research review of this new DSM-5 diagnostic category. *Journal of neurodevelopmental disorders, 6*(1), 1-8. doi: 10.1186/1866-1955-6-41

Szatmari, P. (1998). Differential diagnosis of Asperger disorder. In E. Schopler, G. B. Mesibov & L. J. Kunce (Eds.), *Asperger syndrome or high-functioning autism?* (pp. 61-76). New York: Springer.

Szatmari, P., Bartolucci, G., Bremner, R., Bond, S., & Rich, S. (1989). A follow-up study of high-functioning autistic children. *Journal of Autism and Developmental Disorders, 19*(2), 213-225. doi: 10.1007/BF02211842

Szatmari, P., Bryson, S. E., Boyle, M. H., Streiner, D. L., & Duku, E. (2003). Predictors of outcome among high functioning children with autism and Asperger syndrome. *Journal of Child Psychology and Psychiatry, 44*(4), 520–528. doi: 10.1111/1469-7610.00141

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Boston, MA: Allyn & Bacon/Pearson Education.

Tager-Flusberg, H. B. (1981). On the nature of linguistic functioning in early infantile autism. *Journal of Autism and Developmental Disorders, 11,* 45-56. doi: 10.1007/BF01531340

Tager-Flusberg, H. B. (1999). A psychological approach to understanding the social and language impairments in autism. *International Review of Psychiatry, 11*(4), 325-334. doi: 10.1080/09540269974203

Tan, C. S. (2007). Test review Behavior Assessment System for Children (2nd ed.). *Assessment for Effective Intervention, 32*(2), 121-124. doi:10.1177/15345084070320020301

Taneja, C. (2001). Does the Nonverbal Learning Disabilities (NLD) scale distinguish between subtypes of Pervasive Developmental Disorder? (Master of Arts), University of Windsor, Windsor, ON.

Tannock, R. (2013). Rethinking ADHD and LD in DSM-5: Proposed changes in diagnostic criteria. *Journal of Learning Disabilities, 46*(1), 5-25. doi: 10.1177/0022219412464341

Tassé, M. J., Schalock, R. L., Balboni, G., Bersani Jr, H., Borthwick-Duffy, S. A., Spreat, S., ... & Zhang, D. (2012). The construct of adaptive behavior: Its conceptualization, measurement, and use in the field of intellectual disability. *American Journal on Intellectual and Developmental Disabilities, 117*(4), 291-303. doi: 10.1352/1944-7558-117.4.291

Thomeer, M. L., Lopata, C., Volker, M. A., Toomey, J. A., Lee, G. K., Smerbeck, A. M., ... Smith, R. A. (2012). Randomized clinical trial replication of a psychosocial treatment for children with high-functioning autism spectrum disorders. *Psychology in the Schools, 49*(10), 942-954. doi: 10.1002/pits.21647

Thorndike, E. L. (1911). *Animal intelligence: Experimental studies*. New York, NY: MacMillan Thorpe.

Tiffin, J. (1968). *Purdue Pegboard: Examiner manual*. Chicago: Science Research Associates.

Tobin, M. C., Drager, K. D., & Richardson, L. F. (2014). A systematic review of social participation for adults with autism spectrum disorders: Support, social functioning, and quality of life. *Research in Autism Spectrum Disorders, 8*(3), 214-229. doi: 10.1016/j.rasd.2013.12.002

Towne, R. L. (2010). Review of the Children's Communication Checklist-2. *Eighteenth mental measurements yearbook.* Retrieved from EbscoHost Mental Measurements Yearbook with Tests in Print database.

Trahan, D. E. (1998). Judgment of line orientation in patients with unilateral cerebrovascular lesions. *Assessment, 5*, 227–235.

Tsatsanis, K. D., Foley, C., & Donehower, C. (2004). Contemporary outcome research and programming guidelines for Asperger syndrome and high-functioning autism. *Topics in Language Disorders, 24*(4), 249-259.

Tsatsanis, D., & Rourke, B. P. (2003). Syndrome of nonverbal learning disabilities: Effects on learning. In A. H. Fine & R. A. Kotkin (Eds.), *Therapists guide to learning and attention disorders* (pp. 109-145). San Diego, CA: Academic Press.

Tsatsanis, D., & Rourke, B. P. (2008). Syndrome of nonverbal learning disabilities in adults. In L. E. Wolf, H. E. Schreiber & J. Wasserstein (Eds.), *Adult learning disorders: Contemporary issues* (pp. 159-190). New York, NY: Psychology Press.

Van der Valk, J. C., Van den Oord, E. J. C. G., Verhulst, F. C., & Boomsma, D. I. (2001). Using parental ratings to study the etiology of 3-year-old twins' problem

behaviours: Different views or rater bias? *Journal of Child Psychology and Psychiatry, 42*(7), 921-931. doi: 10.1111/1469-7610.00788

Van der Valk, J. C., Van den Oord, E. J. C. G., Verhulst, F. C., & Boomsma, D. I. (2003). Using shared and unique parental views to study the etiology of 7-year-old twins' internalizing and externalizing problems. *Behaviour Genetics, 33*(4), 409-420. doi: 10.1023/A:1025369525924

Van Der Vlugt, H. *Studies on the reliability of the NLD scale*. Unpublished manuscript.

Verhulst, F. C., Dekker, M. C., & Van der Ende, J. (1997). Parent, teacher and self-reports as predictors of signs of disturbance in adolescents: Whose information carries the most weight? *Acta Psychiatrica Scandinavica, 96*(1), 75-81. doi: 10.1111/j.1600-0447.1997.tb09909.x

Verté, S., Geurts, H. M., Roeyers, H., Rosseel, Y., Oosterlaan, J., & Sergeant, J. A. (2006). Can the Children's Communication Checklist differentiate autism spectrum subtypes?. *Autism, 10*(3), 266-287. doi: 10.1177/1362361306063299

Volden, J. (2004). Nonverbal Learning Disability: A tutorial for speech-language pathologists. *American Journal of Speech-Language Pathology, 13*(2), 128-141. doi: 10.1044/1058-0360(2004/014)

Volker, M. A., Lopata, C., Smerbeck, A. M., Knoll, V. A., Thomeer, M. L., Toomey, J. A., & Rodgers, J. D. (2010). BASC-2 PRS profiles for students with high-functioning autism spectrum disorders. *Journal of Autism and Developmental Disorders, 40*(2), 188-199. doi: 10.1007/s10803-009-0849-6

Volkmar, F. R. (2011). Pervasive developmental disorder NOS. In J. S. Kreutzer, B. Caplan & J. DeLuca (Eds.), *Encyclopedia of clinical neuropsychology* (pp. 1927-1928). New York: Springer. doi: 10.1007/978-0-387-79948-3

Volkmar, F. R., & Klin, A. (1998). Asperger syndrome and nonverbal learning disabilities. In E. Schopler, G. B. Mesibov, & L. J. Kunce (Eds.*), Asperger syndrome or high-functioning autism? Current issues in autism* (pp. 107–121). New York: Plenum.

Volkmar, F. R., Sparrow, S. S., Goudrequ, D., Cicchetti, D. V, Paul, R., & Cohen, D. J. (1987). Social deficits in autism: An operational approach using the Vineland Adaptive Behavior Scales. *Journal of the Academy of Child and Adolescent Psychiatry, 26*, 155-161. doi:10.1097/00004583-198703000-00005

Walitza, S., Melfsen, S., Jans, T., Zellmann, H., Wewetzer, C., & Warnke, A. (2011). Obsessive-compulsive disorder in children and adolescents. *Deutsches Ärzteblatt International, 108*(11), 173-179. doi: 10.3238/arztebl.2011.0173

Wallace, C. J., Nelson, C. J., Liberman, R. P., Aitchison, R. A., Lukoff, D., Elder, J. P., et al. (1980). A review and critique of social skills training with schizophrenic patients. *Schizophrenia Bulletin, 6*(1), 42–63.

Waterhouse, L., Fein, D., & Modahl, C. (1996). Neurofunctional mechanisms in autism. *Psychological Review, 103*(3), 457. doi: 10.1037/0033-295X.103.3.457

Wechsler, D. (1949). *The Wechsler Intelligence Scale for Children*. New York, NY: Psychological Corporation.

Wechsler, D. (1991). *Wechsler Intelligence Scale for Children* (3 ed.). San Antonio, TX: The Psychological Corporation.

Wechsler, D. (2003). *Wechsler Intelligence Scale for Children* (4 ed.). San Antonio, TX: The Psychological Corporation.

Wechsler, D. (2004). *WISC-IV Canadian manual*. Toronto, ON: Harcourt Assessment.

Wechsler, D. (2010). *Wechsler Individual Achievement Test* (3 ed.). San Antonio, TX: The Psychological Corporation.

Weissman, M. M., Orvaschel, H., & Padian, N. (1980). Children's symptom and social functioning self-report scales comparison of mothers' and children's reports. *Journal of Nervous and Mental Disease, 168,* 736–740.

Weitz, C., Dexter, M., & Moore, J. (1997). AAC and children with developmental disabilities. In S. Glennen & D. DeCoste (Eds.), *Handbook of augmentative and alternative communication* (pp. 395–431). San Diego, CA: Singular.

White, S. W., Oswald, D., Ollendick, T., & Scahill, L. (2009). Anxiety in children and adolescents with autism spectrum disorders. *Clinical Psychology Review, 29*(3), 216-229. doi: 10.1016/j.cpr.2009.01.003

Whitehouse, A. J., Barry, J. G., & Bishop, D. V. (2007). The broader language phenotype of autism: A comparison with specific language impairment. *Journal of Child Psychology and Psychiatry, 48*(8), 822-830. doi: 10.1111/j.1469-7610.2007.01765.x

Whitehouse, A. J., Durkin, K., Jacquet, E., & Ziatas, K. (2009). Friendship, loneliness and depression in adolescents with Asperger's Syndrome. *Journal of Adolescence, 32,* 309–322. doi: 10.1016/j.adolescence.2008.03.004

Whitehouse, A. J., Line, E. A., Watt, H. J., & Bishop, D. V. (2009). Qualitative aspects of developmental language impairment relate to language and literacy outcome in

adulthood. *International Journal of Language & Communication Disorders, 44*(4), 489-510. doi: 10.1080/13682820802708080

Widaman, K. F., Borthwick-Duffy, S. A., & Little, T. D. (1991). The structure and development of adaptive behaviors. In N. W. Bray (Ed.), *International review of research in mental retardation* (Vol. 17, pp. 1-54). San Diego, CA: Academic Press.

Widaman, K. F., & McGrew, K. S. (1996). The structure of adaptive behavior. In J. W. Jacobson & J. A. Mulick (Eds.), *Manual of diagnosis and professional practice in mental retardation* (pp. 97-110). Washington, DC, US: American Psychological Association.

Wilkinson, A. D. (2006). *Motor speed and tactile perception in children and adolescents with nonverbal learning disabilities* (Unpublished doctoral dissertation). Retrieved from https://utexas-ir.tdl.org/handle/2152/2985

Wing, L. (1981). Asperger's syndrome: A clinical account. *Psychological Medicine, 11,* 115-129. doi:10.1017/S0033291700053332.

Wirt, R., Lachar, D., Klinedinst, J., & Seat, P. (1977). *Personality inventory for children*. Los Angeles, CA: Western Psychological Corporation.

Woods, S. P., Weinborn, M., Ball, J., Tiller-Nevin, S., & Pickett, T. C. (2000). Periventricular leukomalacia (PVL): An identical twin case study illustration of white matter dysfunction and nonverbal learning disability (NLD). *Child Neuropsychology, 6*(4), 274-285. doi: 10.1076/chin.6.4.274.3138

World Health Organization. (2001). *International Classification of Functioning, Disability and Health: ICF*. Geneva, Switzerland: World Health Organization.

World Health Organization. (2002). *Towards a common language for functioning, disability and health: ICF*. Geneva: World Health Organization.

World Health Organization. (2004). *International classification of diseases and related health problems* (10th ed.). Geneva, Switzerland: Author.

World Health Organization. (2007). *International Classification of Functioning, Disability and Health: Children and youth version: ICF-CY*. Geneva, Switzerland: World Health Organization.

Yager, J. A., & Ehmann, T. S. (2006). Untangling social function and social cognition: a review of concepts and measurement. *Psychiatry, 69*(1), 47-68. doi: 10.1521/psyc.2006.69.1.47

Yalof, J. (2006). Case illustration of a boy with nonverbal learning disorder and Asperger's features: Neuropsychological and personality assessment. *Journal of personality assessment, 87*(1), 15-34. doi: 10.1207/s15327752jpa8701_02

Yeates, K. O., Bigler, E. D., Dennis, M., Gerhardt, C. A., Rubin, K. H., Stancin, T., ... & Vannatta, K. (2007). Social outcomes in childhood brain disorder: A heuristic integration of social neuroscience and developmental psychology. *Psychological bulletin, 133*(3), 535-556. doi: 10.1037/0033-2909.133.3.535

Yeates, K. O., & Selman, R. L. (1989). Social competence in the schools: Toward an integrative developmental model for intervention. *Developmental Review, 9*(1), 64-100. doi: 10.1016/0273-2297(89)90024-5

Zander, E., Sturm, H., & Bölte, S. (2015). The added value of the combined use of the Autism Diagnostic Interview–Revised and the Autism Diagnostic Observation

Schedule: Diagnostic validity in a clinical Swedish sample of toddlers and young preschoolers. *Autism,19*(2), 187-199. doi: 10.1177/1362361313516199

# Appendices

## Appendix A: Screening Questions for Participation

1. How old is your child?

2. What previous diagnoses does your child have (e.g., Asperger's disorder, pervasive developmental disorder not otherwise specified, autistic disorder, etc):

3. Does your child have any other diagnoses, such as depression, anxiety, attention-deficit/hyperactivity disorder, conduct disorder, a learning disorder, oppositional defiant disorder, mental retardation/intellectual disability or cerebral palsy (note: they are still eligible to participate in the study if they have anxiety, depression, or ADHD that is managed, or a learning disorder, but not any of the other conditions)?

4. Who made the diagnoses (e.g., primary care doctor, a psychologist, etc.) and when were they made?

5. Do you have a professional report (e.g., from a physician or psychologist) or other document that states the child has one or more diagnoses?

6. (If no previous diagnosis of Asperger's disorder, autism, autism spectrum disorder, pervasive developmental disorder not otherwise specified, intellectual disability, cerebral palsy) Does your child have a lot of difficulty with the following compared to peers?
   - Fine motor tasks (e.g., fastening buttons, tying shoes, using bread bag ties)
   - Motor coordination (e.g., running, balance, riding a bicycle)
   - Visual-motor abilities (e.g., catching a ball or drawing)
   - Nonverbal problem-solving skills (e.g., solving puzzles, or picture problems)
   - Understanding abstract concepts
   - Making inferences about a passage that has been read
   - Judgment in social situations with peers (e.g., making rude remarks and then not understanding why others are upset)
   - Adjusting to new situations, such as entering a room full of strangers
   - Arithmetic skills
   - Understanding mathematical concepts
   - Mathematical reasoning

7. Has your child ever had a head injury (i.e., hit his/her head and lost consciousness for more than half an hour)?

8. Does your child have any problems with hearing or vision (they are still eligible to participate if those problems are corrected, with glasses for example)?

## Appendix B: Letter of Information

**LETTER OF INFORMATION FOR CONSENT TO PARTICIPATE IN RESEARCH**

Title of Study: *The Social Functioning of Children with Nonverbal Learning Disorder or High Functioning Autism: Implications for Differential Diagnosis.*

You are asked to participate in a research study conducted by Selena Scott and Dr. Joseph Casey from the Department of Psychology at the University of Windsor. This study will comprise Selena Scott's Doctoral Dissertation.

If you have any questions or concerns about the research, please feel to contact please feel to contact Selena Scott at xxx-xxx-xxxx between 9:00 a.m. and 5:00 p.m. (or you can contact her by email at xxxx) or Dr. Joseph Casey at 519-253-3000 ext. 2220 between 9:00 a.m. and 5:00 p.m.

PURPOSE OF THE STUDY

The purpose of this study is to investigate and compare the social functioning of two clinical groups: individuals with the high functioning variant of an autism spectrum disorder and individuals with nonverbal learning disorder. It is often challenging to establish a differential diagnosis between nonverbal learning disorder and the variants of autism in which there is no evidence of mental retardation (i.e., high functioning autism spectrum disorder and Asperger's Disorder). This is critical given the need for different treatment approaches. Whereas impaired social functions have been studied extensively in autism spectrum disorder, relatively little research has focused on the social functioning of children with nonverbal learning disorder. As of yet, no study has systematically examined their social functioning with measures used to diagnose autism spectrum disorder, which would extend our understanding of the nature of their social dysfunction as well as the way in which it may differ from those diagnosed with the high functioning variant of autism spectrum disorder. The present study aims to identify reliable differences in aspects of social functioning between these two disorders based on behaviour inventories and direct observation of social behaviour using the Autism Diagnostic Observation Schedule-2.

PROCEDURES

If you volunteer to participate in this study, you will be asked to do a number of things.

You will be asked to bring your child to 332 Sunset Avenue on the University of Windsor campus for two appointments to participate in psychological testing and to receive feedback about the results of the psychological testing. Eligibility of participants for the study will be determined prior to or shortly after the first appointment. Individuals are eligible to participate if they are between 9 and 16 years of age, and they do not have a history of traumatic brain injury, mental retardation, significant mood disorders or conduct disorders, or a significant physical impairment related to vision, hearing, or movement (e.g., cerebral palsy). Individuals must be previously diagnosed with autism spectrum disorder or they must meet research criteria for nonverbal learning disorder.

Neuropsychological measures will be administered during the first appointment with the child. Guardians will be asked to fill out several questionnaires about their child's behaviour and developmental history prior to, or during the first appointment. Participants will be contacted for a second appointment within four weeks of the first appointment. If participants are not eligible for the study, but completed neuropsychological testing during the first appointment, they may still attend the second appointment to receive a summary of the child's results.

During the second appointment, the ADOS-2 will be administered and recorded on tape. Also, a summary of the child's performance on the psychological tests will be shared with the family of each child participant during the second appointment. If the child meets research criteria for nonverbal learning disorder, the family will be made aware of this in the summary. Additional questions about the summary will be answered by the principal graduate student investigator during the second appointment. Presentation of the results and discussion will last for thirty minutes. If you express discomfort or anxiety about the results or about the child meeting research criteria for nonverbal learning disorder, you will be directed to the local phone book for the contact information of local clinical psychologists who offer psychotherapy services.

Participants will be assigned to groups on the basis of the developmental history, neuropsychological test results, and previous diagnoses. The total time commitment required from you for this study will be approximately two and a half hours for guardians and six and a half hours for child participants spread over two appointments (approximately 4.5 hours for the first appointment and 1.5 hours for the second appointment).

POTENTIAL RISKS AND DISCOMFORTS

There is a low level of physical risk (such as possible injury), social risk (such as possible loss of status, privacy and/or reputation), and risk of a breach in data security. There are some psychological/emotional risks (feeling uncomfortable, embarrassed, anxious or upset) involved during or following psychological testing. Overall, the risks involved in participating in this study are no greater than those faced in day-to-day living. In the event of psychological or emotional discomfort, participants will be comforted. Subsequently, participants will be referred to the local phone book for the contact information of local clinical psychologists who offer psychotherapy services.

## POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

Children will receive psychological testing at no charge and a brief one page summary of the results, including a description of cognitive strengths and weaknesses, as well as information about whether they meet the research criteria for nonverbal learning disorder. Sharing this information with your child's school psychologist may help with program planning or accommodations for children. This study will also benefit the scholarly community since it is a seminal study in the area of differential diagnosis between nonverbal learning disorder and autism spectrum disorder on the basis of social functioning. As of yet, no study has systematically examined the social functioning of children with nonverbal learning disorder with measures used to diagnose autism spectrum disorders, which would extend our understanding of the nature of the former's social dysfunction as well as the way in which it may differ from those diagnosed with the high functioning variant of autism spectrum disorders.

## COMPENSATION FOR PARTICIPATION

Parking will be provided for participants, and a small token of appreciation will be provided to children for participating (e.g., a five dollar gift certificate from Tim Horton's or iTunes for each appointment a child attends for at least thirty minutes). If families choose to take a bus, they will be reimbursed for the cost of bus fare to a maximum of $5.

## CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be used to identify you will remain confidential and will be disclosed only with your permission. Participants' neuropsychological test data will be password protected and electronically stored on the computer in the faculty supervisor's laboratory space at 332 Sunset Avenue. Identifying information provided in the consent and assent forms will be stored in a locked filing cabinet in the faculty supervisor's lab. Consent/assent forms will be retained for five years following the completion of publications arising from the data and then disposed of in a secure manner (i.e., shredded or securely deleted, respectively). Healthcare data (i.e., hard copies of test record forms and video recordings of ADOS-2 administrations) will be retained securely in the faculty supervisor's office or other secure location for ten years after your child's 18$^{th}$ birthday, or ten years after the most recent clinical contact (whichever is longer). You have the right to review or edit the tapes. Consent forms with personally identifying information will be stored in a separate physical location from the video recordings and test record forms (both of which will show the code for each participant and no identifying information). All test record forms, videos of ADOS-2 administrations, and consent/assent forms will be stored within a locked drawer. The principal investigator, the faculty supervisor, and the research assistants will have direct access to the data; all have agreed to keep this personal information confidential. By law, confidentiality would be broken is if a participant indicates that child abuse has occurred, or if participants indicate that they are at risk of hurting themselves or others.

PARTICIPATION AND WITHDRAWAL

Participants (adults or children) can withdraw from participating in the study at any time without incurring any adverse consequences. You can withdraw your child's data from the study any time prior to the completion of data collection from all participants (i.e., approximately June, 2015). If child participants do not meet eligibility requirements, they will be withdrawn from the study and they will not participate in psychological testing. You will still receive reimbursement for public transportation costs and a $5 gift card if you attend the first appointment for more than thirty minutes. The researchers may withdraw participants from the study at any time should circumstances warrant such action.

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE PARTICIPANTS

The results of this study will be available to you and your child(ren) on a website. A summary of the overall findings of the study will be provided on the website, but no identifying information (e.g., names or initials) will be included with the data. Data from individual participants will not be presented separately from the group data.

Web address: _
http://web4.uwindsor.ca/units/researchEthicsBoard/studyresultforms.nsf/VisitorView?OpenForm&count=-1_
Date when results are available: _June, 2015_____

SUBSEQUENT USE OF DATA

These data may be used in subsequent studies, in publications and in presentations.

RIGHTS OF RESEARCH PARTICIPANTS

If you have questions regarding your rights as a research participant, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario, N9B 3P4; Telephone: 519-253-3000, ext. 3948; email: ethics@uwindsor.ca

SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

_____ _____

Signature of Investigator Date

## Appendix C: Consent and Assent forms


### CONSENT TO PARTICIPATE IN RESEARCH

Title of Study: *The Social Functioning of Children with Nonverbal Learning Disorder or High Functioning Autism: Implications for Differential Diagnosis.*

You are asked to participate, and to consent to have your child participate, in a research study conducted by Selena Scott and Dr. Joseph Casey from the Department of Psychology at the University of Windsor. This study will comprise Selena Scott's Doctoral Dissertation.

If you have any questions or concerns about the research, please feel to contact please feel to contact Selena Scott at xxx-xxx-xxxx between 9:00 a.m. and 5:00 p.m. (or you can contact her by email at xxxx) or Dr. Joseph Casey at 519-253-3000 ext. 2220 between 9:00 a.m. and 5:00 p.m.

PURPOSE OF THE STUDY

The purpose of this study is to investigate and compare the social functioning of two clinical groups: individuals with the high functioning variant of an autism spectrum disorder and individuals with nonverbal learning disorder. It is often challenging to establish a differential diagnosis between nonverbal learning disorder and the variants of autism in which there is no evidence of mental retardation (i.e., high functioning autism spectrum disorder and Asperger's Disorder). This is critical given the need for different treatment approaches. Whereas impaired social functions have been studied extensively in autism spectrum disorder, relatively little research has focused on the social functioning of children with nonverbal learning disorder. As of yet, no study has systematically examined their social functioning with measures used to diagnose autism spectrum disorder, which would extend our understanding of the nature of their social dysfunction as well as the way in which it may differ from those diagnosed with the high functioning variant of autism spectrum disorder. The present study aims to identify reliable differences in aspects of social functioning between these two disorders based on behaviour inventories and direct observation of social behaviour using the Autism Diagnostic Observation Schedule-2.

## PROCEDURES

If you volunteer to participate in this study, you will be asked to do a number of things.

You will be asked to bring your child to 332 Sunset Avenue on the University of Windsor campus for two appointments to participate in psychological testing and to receive feedback about the results of the psychological testing. Eligibility of participants for the study will be determined prior to or shortly after the first appointment. Individuals are eligible to participate if they are between 9 and 16 years of age, and they do not have a history of traumatic brain injury, mental retardation, significant mood disorders or conduct disorders, or a significant physical impairment related to vision, hearing, or movement (e.g., cerebral palsy). Individuals must be previously diagnosed with autism spectrum disorder or they must meet research criteria for nonverbal learning disorder.

Neuropsychological measures will be administered during the first appointment with the child. Guardians will be asked to fill out several questionnaires about their child's behaviour and developmental history prior to, or during, the first appointment. Participants will be contacted for a second appointment within four weeks of the first appointment. If participants are not eligible for the study, but completed neuropsychological testing during the first appointment, they may still attend the second appointment to receive a summary of the child's results.

During the second appointment, the ADOS-2 will be administered and recorded on tape. Also, a summary of the child's performance on the psychological tests will be shared with the family of each child participant during the second appointment. If the child meets research criteria for nonverbal learning disorder, the family will be made aware of this in the summary. Additional questions about the summary will be answered by the principal graduate student investigator during the second appointment. Presentation of the results and discussion will last for thirty minutes. If you express discomfort or anxiety about the results or about the child meeting research criteria for nonverbal learning disorder, you will be directed to the local phone book for the contact information of local clinical psychologists who offer psychotherapy services.

Participants will be assigned to groups on the basis of the developmental history, neuropsychological test results, and previous diagnoses. The total time commitment required from you for this study will be approximately two and a half hours for guardians and six and a half hours for child participants spread over two appointments (approximately 4.5 hours for the first appointment and 1.5 hours for the second appointment).

## POTENTIAL RISKS AND DISCOMFORTS

There is a low level of physical risk (such as possible injury), social risk (such as possible loss of status, privacy and/or reputation), and risk of a breach in data security. There are some psychological/emotional risks (feeling uncomfortable, embarrassed, anxious or upset) involved during or following psychological testing. Overall, the risks involved in

participating in this study are no greater than those faced in day-to-day living. In the event of psychological or emotional discomfort, participants will be comforted. Subsequently, participants will be referred to the local phone book for the contact information of local clinical psychologists who offer psychotherapy services.

## POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

Children will receive psychological testing at no charge and a brief one page summary of the results, including a description of cognitive strengths and weaknesses, as well as information about whether they meet the research criteria for nonverbal learning disorder. Sharing this information with your child's school psychologist may help with program planning or accommodations for children. This study will also benefit the scholarly community since it is a seminal study in the area of differential diagnosis between nonverbal learning disorder and autism spectrum disorder on the basis of social functioning. As of yet, no study has systematically examined the social functioning of children with nonverbal learning disorder with measures used to diagnose autism spectrum disorders, which would extend our understanding of the nature of the former's social dysfunction as well as the way in which it may differ from those diagnosed with the high functioning variant of autism spectrum disorders.

## COMPENSATION FOR PARTICIPATION

Parking will be provided for participants, and a small token of appreciation will be provided to children for participating (e.g., a five dollar gift certificate from Tim Horton's or iTunes for each appointment a child attends for at least thirty minutes). If families choose to take a bus, they will be reimbursed for the cost of bus fare to a maximum of $5.

## CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be used to identify you will remain confidential and will be disclosed only with your permission. Participants' neuropsychological test data will be password protected and electronically stored in an anonymized database on the computer in the faculty supervisor's laboratory space at 332 Sunset Avenue. Identifying information provided in the consent and assent forms will be stored in a locked filing cabinet in the faculty supervisor's lab. Consent/assent forms will be retained for five years following the completion of publications arising from the data and then disposed of in a secure manner (i.e., shredded or securely deleted, respectively). Healthcare data (i.e., hard copies of test record forms and video recordings of ADOS-2 administrations) will be retained securely in the faculty supervisor's office or other secure location for ten years after your child's 18$^{th}$ birthday, or ten years after the most recent clinical contact (whichever is longer). You have the right to review or edit the tapes. Consent forms with personally identifying information will be stored in a separate physical location from the video recordings and test record forms (both of which will show the code for each participant and no identifying information). All test record forms, videos of ADOS-2 administrations, and consent/assent forms will be stored within a locked drawer. The principal investigator,

the faculty supervisor, and the research assistants will have direct access to the data; all have agreed to keep this personal information confidential. By law, confidentiality would be broken is if a participant indicates that child abuse has occurred, or if participants indicate that they are at risk of hurting themselves or others.

PARTICIPATION AND WITHDRAWAL

Participants (adults or children) can withdraw from participating in the study at any time without incurring any adverse consequences. You can withdraw your child's data from the study any time prior to the completion of data collection from all participants (i.e., approximately June, 2015). If child participants do not meet eligibility requirements, they will be withdrawn from the study and they will not participate in psychological testing. You will still receive reimbursement for public transportation costs and a $5 gift card if you attend the first appointment for more than thirty minutes. The researchers may withdraw participants from the study at any time should circumstances warrant such action.

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE PARTICIPANTS

The results of this study will be available to you and your child(ren) on a website. A summary of the overall findings of the study will be provided on the website, but no identifying information (e.g., names or initials) will be included with the data. Data from individual participants will not be presented separately from the group data.

Web address:
http://web4.uwindsor.ca/units/researchEthicsBoard/studyresultforms.nsf/VisitorView?OpenForm&count=-1_
Date when results are available: _June, 2015_____

SUBSEQUENT USE OF DATA

These data may be used in subsequent studies, in publications and in presentations.

RIGHTS OF RESEARCH PARTICIPANTS

If you have questions regarding your rights as a research participant, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario, N9B 3P4; Telephone: 519-253-3000, ext. 3948; email: ethics@uwindsor.ca

SIGNATURE OF RESEARCH PARTICIPANT/LEGAL REPRESENTATIVE

I understand the information provided for the study **The Social Functioning of Children with Nonverbal Learning Disorder or High Functioning Autism: Implications for Differential Diagnosis** as described herein. My questions have been answered to my satisfaction, and I agree to participate, and to have my child participate, in this study. I have been given a copy of this form.

_____
Name of Parent/Guardian

_____ _____
Signature of Parent/Guardian Date

SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

_____ _____
Signature of Investigator Date

Second appointment:
The test results have been reviewed and I agree to continue participating in this study.

_____ _____
(Signature of Parent or Guardian) (Date)

**ASSENT TO PARTICIPATE IN RESEARCH**

Title of Study: **The Social Functioning of Children with Nonverbal Learning Disorder or High Functioning Autism: Implications for Differential Diagnosis *(Child/Adolescent assent).***

You are being asked to participate in a research study. This study is being done by Selena Scott as a research project for the University of Windsor.

If you have any questions about the study, you can ask your parents to contact Selena Scott at xxx-xxx-xxxx between 9:00 a.m. and 5:00 p.m. (or you can contact her by email at xxxx) or Dr. Joseph Casey at 519-253-3000 ext. 2220 between 9:00 a.m. and 5:00 p.m.

PURPOSE OF THE STUDY

Selena Scott is doing a study with children who have autism spectrum disorders (e.g., high functioning autism, or Asperger's Disorder) or nonverbal learning disorder. It is often difficult to tell the difference between these two disorders when making a diagnosis, but it is important to be able to tell the difference between them since each one requires a particular type of treatment. I am investigating some areas in which these two disorders may differ (i.e., some aspects of social interaction with other people). I am interested to see if children with nonverbal learning disorder interact with other people differently than children with autism spectrum disorders.

PROCEDURES

Eligibility:

- You will be asked some questions to see if you can participate in this study (you will be able to participate in the study if you have not been diagnosed with mental retardation, a serious brain injury that resulted from hitting your head, significant mood disorders or conduct disorders, or a significant physical problem related to vision, hearing or movement).
- You can participate if you have been diagnosed with an autism spectrum disorder or with nonverbal learning disorder
- If you have not been diagnosed with nonverbal learning disorder, but it is suspected that you might have it (based on some answers to a questionnaire), you can participate

Tasks and Activities:

- Your parents will answer some questions to measure how well you communicate with others, how well you interact with others, and the way your parents and teachers see your behaviour.

- You will also meet with Selena two separate times to do some activities, such as working with blocks, reading some words, doing some math calculations, spelling some words, drawing some pictures, working with your hands, and answering some questions that she will ask.
- During the second appointment, Selena will tell your parents about your performance on the tasks you did during the first appointment.
- Selena will record one of the activities that we do together with a camcorder.

## POTENTIAL RISKS AND DISCOMFORTS

The risks of participating in this study are likely no greater than those you face every day at school or at home. You may experience some frustration while completing some of the tasks with Selena, but any frustration you experience will likely be similar to what you experience while completing school work. You may face some emotional risks (e.g., anxiety, feeling uneasy, or feeling nervous) if you find out that you meet the criteria for nonverbal learning disorder. If that happens, you can talk to Selena about it and she will let you know where you can look in the local phone book for information about counselling services offered by psychologists in the area where you live.

## POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

As a result of participating in this study, you will receive psychological testing and a brief one page summary of the testing results, including a description of areas of thinking that are a strength for you and areas that are a weakness for you. You will also find out if you meet the research criteria for nonverbal learning disorder. Your parents can share this information with your school psychologist and this may help with arranging appropriate support for you at school. This study will also benefit society since it is investigating a research question that has not been investigated previously (i.e., Do children with autism spectrum disorders and children with nonverbal learning disorder interact with other people differently, and does this help us tell the difference between these two disorders when making a diagnosis?).

## COMPENSATION FOR PARTICIPATION

For each appointment that you attend for at least half an hour, you will receive a $5 gift certificate (you have a choice between a Tim Horton's or an iTunes gift certificate). Once you receive the certificate, it is yours to keep. If you take the bus to the appointments, you will be reimbursed for the cost of bus fare.

## CONFIDENTIALITY

Selena will not be telling your teachers or any other children/adolescents how you answer the questions she asks, and she will not show the tape of the recorded task to anyone not involved in the research study. The only exception is if you tell her that someone has been hurting or abusing you, or if you indicate that you may hurt yourself or others. If she thinks that you are being hurt or abused, or that you may hurt yourself or others, she will

need to tell your parents or someone else who can help you. Otherwise, she will keep everything that you tell her private. Selena will talk to your parents during the second appointment to give them a summary of your performance on tasks you did during the first appointment, but she will not tell them the exact answers you gave to particular questions. The information gathered from you during this study will be available with appropriate consent for ten years after your 18th birthday, or ten years after the most recent meeting with the researchers (whichever is longer).

There will not be negative consequences if you decide not to answer any of the questions. Even if you decide to answer the questions, you can stop answering them at any time, and you don't have to answer any question you do not want to answer. It's entirely up to you. Whether you decide to answer any questions or not, your family will still receive the gift certificate when you leave that day, provided that you have worked with Selena for at least half an hour.

PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without any consequences. If you withdraw before the end of the first appointment, Selena will not meet with your parents during the second appointment to give them a summary of how you performed during the first appointment, since she will not have enough information to do this. You can still complete the tasks that are part of the second appointment and stay in the study. You may also refuse to answer any questions you don't want to answer. Your parents/guardians or you can remove your data from the study at any time before June, 2015. The researchers may withdraw you and your parents/guardians from the study at any time if it is thought to be in your best interests.

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE PARTICIPANTS

A summary of the performance of all participants will be provided on a website, but no identifying information (i.e., names, initials, etc.) will be included with the data.

Web address:
http://web4.uwindsor.ca/units/researchEthicsBoard/studyresultforms.nsf/VisitorView?OpenForm&count=-1)

Date when results are available: It is anticipated that results will be available by September 1, 2015.

SUBSEQUENT USE OF DATA

This data will be used in subsequent studies.

RIGHTS OF RESEARCH PARTICIPANTS

You may withdraw your consent at any time and discontinue participation without any negative consequences. If you have questions about you rights as a research participant, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario, N9B 3P4; Telephone: 519-253-3000, ext. 3948; email: ethics@uwindsor.ca

SIGNATURE OF RESEARCH PARTICIPANT/LEGAL REPRESENTATIVE

I understand the information provided for the study **The Social Functioning of Children with Nonverbal Learning Disorder or High Functioning Autism: Implications for Differential Diagnosis** as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

_____
Name of Participant

_____ _____
Signature of Participant Date

SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

_____ _____
Signature of Investigator Date

Second appointment:

The test results have been reviewed and I agree to continue participating in this study.

_____ _____
(Signature of Research Participant) (Date)


# CONSENT FOR OBTAINING PERSONAL INFORMATION

Child's/Research Participant's Name:

Title of the Project:
The Social Functioning of Children with Nonverbal Learning Disorder or High Functioning Autism: Implications for Differential Diagnosis

I consent to having the researchers collect personal information from me about my child and his or her developmental history (including birth history, developmental milestones, medical history, behavioural and mental health history, and educational history). This information will be kept confidential and will not be shared with anyone else outside of the researchers completing this project. I understand that I can refuse to answer any question and still participate in the study. I understand these are voluntary procedures and that I am free to withdraw at any time. I also understand that my name or (my child's name) will not be revealed to anyone. By law, the only instance in which confidentiality would be broken is if a participant indicates that child abuse has occurred.

_____ _____
(Signature of Parent or Guardian) (Date)

And

_____ _____
(Signature of Research Participant) (Date)


CONSENT FOR VIDEO TAPING

Child's/Research Participant's Name:

Title of the Project:
The Social Functioning of Children with Nonverbal Learning Disorder or High Functioning Autism: Implications for Differential Diagnosis

I consent to the video-taping of the administration of the Autism Diagnostic Observation Schedule-2 to my child.

I understand these are voluntary procedures and that I am free to withdraw at any time by requesting that the viewing be discontinued. I also understand that my name or (my child's name) will not be revealed to anyone and that viewing will be kept confidential. Tapes are filed by number only and stored in a locked cabinet.

I understand that confidentiality will be respected and the viewing of materials will be for professional use only.

_____ _____
(Signature of Parent or Guardian) (Date)

And

_____ _____
(Signature of Research Participant) (Date)

Second appointment:
The test results have been reviewed and I agree to continue participating in this study.

_____ _____
(Signature of Parent or Guardian) (Date)

And

The test results have been reviewed and I agree to continue participating in this study.

_____ _____
(Signature of Research Participant) (Date)

## Appendix D: Clinical Interview and Child History Questions

***Child History Form***

***Please read the questions carefully and answer them as fully as possible. Use the last page for additional comments if necessary. If there are any questions that you do not understand or do not know how to complete, please bring them to my attention at the time of your interview.***

**GENERAL INFORMATION**

Child's Name _____ Birth Date _____ Age _____
*First Last mon/day/year*

Home Address
_____
*Street City Postal Code Phone Number*

Child's family physician
_____
*Full Name City*

Other physician(s)
_____
*Full Name Type of Physician City*

**FAMILY HISTORY**

Child is living with:

| | | |
|---|---|---|
| Both parents | Mother | Father |
| Mother and Stepfather | Father and Stepmother | Legal Guardian |

Other (please specify) _____

Is the child adopted? No Yes If yes, at what age was the child adopted?
_____

**BIRTH AND DEVELOPMENTAL HISTORY**

**Pregnancy** Length in weeks _____

Any illnesses or complications while pregnant? No Yes

If yes, please explain.

_____

Any medications taken by the mother during pregnancy? No Yes If yes, please list and explain.

Substances used during pregnancy (check all that apply and explain):

Cigarettes No Yes If yes, how many? _____ per day week

Alcohol No Yes If yes, what kind?

_____

How many drinks? _____ per day week month

Drugs No Yes If yes, please describe type(s) of drugs, frequency of use, and at what month of pregnancy use was stopped (if applicable).

Where there any indications of fetal distress? No Yes If yes, please list and explain.

**Labour and Delivery**

Was the birth of the child "normal"? Yes No If no, please explain.

Check all that apply to the birth: Labour induced Forceps used Breech presentation Cesarean

**Perinatal History**

Birth weight APGAR scores (if known)

Birth length Length of baby's hospital stay

Did the baby require any special medical attention right after birth? No Yes If yes, please explain.

Did the baby go home with you after birth? Yes No If no, please explain.

Please list any birth defects.

**Infancy and Early Childhood**

Please rate the child as an infant and toddler (birth to age 2 years) on the following behaviours: Circle "1" if the behaviour on the left was present the majority of the time. Circle "5" if the behaviour on the right was present the majority of the time. Levels in between are represented by "2," "3," and "4." If there are two behaviours listed (e.g., tantrums and headbanging), please check whether one or both present.

| | | | | | | |
|---|---|---|---|---|---|---|
| quiet and content | 1 | 2 | 3 | 4 | 5 | colicky and irritable |
| very easy to feed | 1 | 2 | 3 | 4 | 5 | daily feeding problems |
| slept well | 1 | 2 | 3 | 4 | 5 | frequent sleeping problems |
| usually relaxed | 1 | 2 | 3 | 4 | 5 | often restless |
| Underactive | 1 | 2 | 3 | 4 | 5 | overactive |
| cuddly, easy to hold | 1 | 2 | 3 | 4 | 5 | did not enjoy cuddling |
| easily calmed down | 1 | 2 | 3 | 4 | 5 | tantrums headbanging |
| cautious and careful | 1 | 2 | 3 | 4 | 5 | accident prone daredevil |
| Coordinated | 1 | 2 | 3 | 4 | 5 | uncoordinated |
| enjoyed eye contact | 1 | 2 | 3 | 4 | 5 | avoided eye contact |
| liked people | 1 | 2 | 3 | 4 | 5 | disliked contact with people |

**Milestones**

Estimate in months the age the child achieved the following milestones:

| | | | |
|---|---|---|---|
| *Gross Motor:* | crawled | walked alone | rode a bicycle without help |
| *Fine Motor:* | fed self with spoon | scribbled | tied shoes |

*Language:* used first words used sentences (2+ words) described activity
*Social/Adaptive* toilet trained / day toilet trained / night

Overall development was: slow normal fast

Did any events, health conditions, separation, etc. disturb early infant / mother bonding or the developing toddler / mother relationship? No Yes

If yes, please explain.

What is the child's first language? _____

Is this still the child's primary language? Yes No If no, what language is? _____

List other languages in which the child understands and speaks fluently.

Feel free to add any other comments regarding infancy or early childhood development?

**MEDICAL HISTORY**

Has any disorder ever been diagnosed? No Yes If yes, indicate the disorder, when diagnosed, and by whom.

Has the child been taken to the hospital with a serious emergency, been hospitalized, or had outpatient surgery since birth? No Yes If yes, please describe the condition/injury, treatment, and when it occurred.

Has the child had any serious illnesses or other medical condition diagnosed? No Yes If yes, please explain.

Does the child have any allergies? No Yes If yes, please list:

Has the child ever had a head injury? No Yes If yes, when? _____

Did he or she lose consciousness? No Yes

If yes, how long was the unconsciousness:
less than a few minutes
few minutes – 20 minutes
20 minutes – 36 hours
more than 36 hours (specify): _____

Describe the circumstances of the injury:

Date of last hearing test: _____ Results: _____

Date of last vision test: _____ Results: _____

My child is: colour blind not colour blind (as far as I know)

Current medications:

| Name | Dosage | Reason for medication | Started |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

The child's current general health is: Excellent Good Fair Poor

**BEHAVIOURAL AND MENTAL HEALTH HISTORY**

Please describe any behaviours that are particularly concerning to you or others.

Please list any unusual, traumatic, or possibly stressful events in the child's life that you think may have had an impact on his or her development and current functioning. Include incident, child's age at the time, and comments.

Has the child or family received any professional mental health treatment, such as individual or family counselling, group counselling, etc.? No Yes

If yes, please list all past and current treatments, including type of counseling, person counselled, name of counsellor, and length of treatment. List chronologically, starting with the earliest treatment.

| ***Mon/yr*** | ***Mon/yr ended*** | **Type of treatment received and family members involved** |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

| | | |
|---|---|---|
| | | |
| | | |

What are your child's favourite activities (e.g., video games, Lego, reading, computer chat, organized sports)?

**EDUCATIONAL HISTORY**

If the child attended daycare or preschool, was anything unusual noted about his/her behaviour or learning?

Current grade and school:

Has the child received any special help <u>at school</u> in the past (e.g., LD or special ed. class placement; resource withdrawal; speech/language therapy)? No Yes At present? No Yes If yes to either, please describe the type of help and when it was provided.

Has the child been identified by the school as having an exceptionality? No Yes If yes, indicate which?

| ***Behaviour*** | ***Communication*** | ***Intellectual*** | ***Physical*** | ***Multiple*** |
|---|---|---|---|---|
| Behaviour | Autism | Gifted | Physical | Multiple |
| | Deaf and Hard of Hearing | Mild Intellectual Disability | | |

Language Impairment Developmental
Speech Impairment Disability
Learning Disability

List all special help or treatment that the child has received and is receiving outside of school (e.g., tutoring, Kumon, speech therapy). List chronologically, starting with the earliest treatment.

| ***Mon/yr started*** | ***Mon/yr ended*** | Type of treatment |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Please bring with you to your appointment copies (not originals) of reports or documents of any developmental, educational, or psychological testing.

**Individual completing this form:**

| *Print Name* | *Relationship to child* | *Today's date (mon/day/yr)* |
|---|---|---|
| | | |

| *Your address (if different than child's)* | *Your phone number* |
|---|---|
| | |

## Appendix E: Neuropsychological and Screening Measures

Neuropsychological measures are organized by cognitive domain. Neuropsychological tests tend to measure multiple abilities that span more than one cognitive domain and classification within a particular domain can be somewhat arbitrary (Lezak, Howieson, Bigler, & Tranel, 2012). Here, measures are categorized based on one of the domains tapped by the test, but they could potentially be classified under other domains as well. They are organized in the following order: general intellectual functioning, aspects of academic achievement, attention, aspects of executive functioning, memory for visual information, visual-spatial skills, motor functioning, and sensory functioning. The NLD Scale, a screening measure for NLD, is described last.

### General Intellectual Abilities

**Wechsler intelligence scales.** The WISC-IV (Wechsler, 2003) and the WISC-III (Wechsler, 1991) measure general intellectual functioning. Each measure has four Indexes that can be calculated, and the WISC-III also has Verbal Scale and Performance Scale composites that can be calculated (Sattler, 2001). The WISC-IV includes the Processing Speed, Working Memory, Perceptual Reasoning, and Verbal Comprehension Indexes, while the WISC-III includes Processing Speed, Perceptual Organization, Freedom from Distractibility, and Verbal Comprehension Indexes. The core subtests and supplemental subtests of the WISC-IV (Wechsler, 2003) tap several cognitive processes, including working memory, attention, speed of information processing, verbal knowledge and reasoning, and visual-perceptual skills. To provide an estimate of the participants' intellectual status and to determine the presence of a discrepancy between verbal and visual perceptual composites, the core subtests (i.e., Similarities, Vocabulary,

Comprehension, Block Design, Picture Concepts, Matrix Reasoning, Digit Span, Letter-Number Sequencing, Coding, and Symbol Search) as well as the Information and Arithmetic subtests of the WISC-IV (Wechsler, 2003) were administered. Internal consistency reliability for the core subtests of the WISC-IV (except for Coding and Symbol Search) as well as Information and Arithmetic ranges from .80 to .88 (Wechsler, 2004). Test-retest reliability for the core subtests as well as Information and Arithmetic ranges from .73 to .91 (Wechsler, 2004).

The validity of the WISC-IV has also been adequately demonstrated through the use of several different procedures. Exploratory factor analysis across the age range for which the WISC-IV is normed identified four factors that coincide with the four Indexes, with loadings of the core subtests as well as the supplemental subtests following the predicted pattern and secondary loadings on other factors not exceeding .20 (Wechsler, 2004). Confirmatory factor analysis also supported the four factor solution as the best fit (Wechsler, 2004). Additionally, the WISC-IV has been found to be correlated with other measures of general intellectual ability, including the WAIS-III, WASI, WISC-III, and the WPPSI-III, indicating that it measures constructs similar to those assessed by those instruments and providing support for its construct validity (Wechsler, 2004).

Additionally, selected subtests from the Perceptual Organization Index from the WISC-III (Wechsler, 1991) that have been shown to be useful in establishing the diagnosis of NLD (i.e., Object Assembly and Picture Arrangement) were administered in this study (Cederlund & Gillberg, 2004). Notably, Object Assembly taps the ability to solve visual-perceptual problems, speed of information processing, the ability to synthesize information, and fine-motor coordination (Sattler, 2008). Picture Arrangement

taps several abilities, including interpretation of social situations, planning, attention to detail, and cause and effect relationships (Sattler, 2008). For Object Assembly, internal consistency reliability was reported to be .69 and test-retest reliability was reported to be .66 (Sattler, 2001). For Picture Arrangement, internal consistency reliability was reported to be .76 and test-retest reliability was reported to be .64 (Sattler, 2001). Although the test-retest reliability of both subtests is marginal (Dikmen, Heaton, Grant, & Temkin, 1999), scores on these subtests have been found by Pelletier et al. (2001) to be useful in identifying NLD given that they are among the lowest subtest scaled scores obtained on a Wechsler intelligence test in approximately 75% of children with NLD. In terms of validity, Picture Arrangement and Object assembly were found to have correlations of .49 and .60, respectively, with the Performance Scale of the WISC-III, and .52 and .58, respectively, with the Full Scale IQ of the WISC-III. Sattler (2001) interpreted these findings, as well as findings pertaining to the correlations of other subscales to the Full Scale IQ, as support that the WISC-III measures general intellectual abilities. Factor analyses identified four factors of the WISC-III, with Picture Arrangement and Object Assembly loading .38 and .66, respectively, onto the Perceptual Organization Index and no more than .34 on any other Index (Sattler, 2001).

Descriptions of the subtests of the WISC-IV and the WISC-III are organized by Index and are summarized from Sattler's (2001, 2008) subtest descriptions. Only subtests included in the present study are described. The subtests of Working Memory Index of the WISC-IV include Digit Span and Letter-Number Sequencing. The former requires children to repeat strings of digits of increasing length. The latter requires children to repeat strings of letters and numbers of increasing length. Arithmetic is a supplemental

subtest that requires children to mentally calculate the answers to problems involving numerical operations and mathematical reasoning within a specified time limit.

The Processing Speed Index contains two core subtests: Coding and Symbol Search. Coding requires children to transcribe symbols from a key at the top of the page as quickly as possible. Symbol Search requires children to scan a group of symbols for one of the target symbols, and indicate whether a target symbol is present for each item. Children are instructed to work as fast as possible.

The subtests of the Verbal Comprehension Index include Vocabulary, Similarities, Comprehension, and Information. Vocabulary is a core subtest that requires children to orally define words presented to them. Similarities is also a core subtest and requires children to identify a way in which two objects or concepts are alike. Comprehension is a core subtest and requires children to explain how to solve a common practical or social problem. Information is a supplemental subtest that requires children to recall facts they have learned to answer general knowledge questions across a variety of areas, such as geography, history, science, human anatomy, and physiology.

There are three core subtests of the Perceptual Reasoning Index: Block Design, Picture Concepts, and Matrix Reasoning. Block Design requires children to assemble blocks with two red, two white, and two half red and half white sides to match a model design. Picture Concepts requires children to choose one picture from each of two or three rows based on a common underlying theme. Matrix Reasoning requires children to choose the picture that best completes an abstract pattern from five options.

Picture Arrangement and Object Assembly are two core subtests belonging to the Perceptual Organization Index and Performance Scale of the WISC-III. Picture

Arrangement requires children to place cards in their proper order so that they relate a logical sequence of events. Object Assembly requires children to assemble scrambled puzzle pieces as fast as possible either with or without knowing the object that is being assembled.

**Academic Achievement**

**WIAT-III.** The Wechsler Individual Achievement Test Third Edition (WIAT-III; Wechsler, 2010) is a comprehensive individually administered battery for assessing achievement in a variety of curriculum areas. Fourteen subtests are included in this measure. This measure allows identification of academic strengths and weaknesses, information which can be used to inform decisions regarding eligibility for special education services and identification and diagnosis of learning disabilities (Miller, 2010), including NLD (Casey, 2012).

To aid in identification of NLD and to provide information about academic functioning in the areas of reading, spelling, and mathematics, the Word Reading, Spelling, and Numerical Operations subtests of the WIAT-III were administered. Word Reading requires a child, depending on his or her age, to read words, identify letters of the alphabet, identify letter sounds, or find rhymes for words (Wechsler, 2010). Spelling is a measure of the ability to spell orally presented words correctly. Numerical Operations is a test of a child's ability to complete written math problems correctly, including addition, subtraction, multiplication, and division. The average age-based split-half reliability for the Word Reading, Spelling, and Numerical Operations subtests are .97, .95, and .93, respectively. In terms of validity, the WIAT-III has been correlated with other measures that purport to measure similar constructs, including the WIAT-II and the

Wechsler Fundamentals—Academic Skills. Specifically in terms of subtests from the WIAT-II and the WIAT-III, the Numerical Operations subtest had a correlation of .87; the Word Reading subtest had a correlation of .72; and the Spelling subtest had a correlation of .80 (Wechsler, 2010), providing support for the construct validity of the WIAT-III. Similarly, the WIAT-III has some common subtests with the Wechsler Fundamentals—Academic Skills: Canadian. The Numerical Operations, Word Reading, and Spelling subtests are common to both instruments, and have correlations of .75, .80, and .88, respectively, providing further support for the construct validity of the WIAT-III (Wechsler, 2010).

**Attention**.

**Trail Making Test.** Trail Making Test Part A from the Halstead-Reitan Neuropsychological Test Battery for Children (C-HRNB) measures visual attention, sequencing ability, working memory, symbol recognition, processing speed, and visual scanning (Nussbaum & Bunner, 2009). The Trail Making Test Part B assesses cognitive flexibility and divided attention in addition to the abilities measured by Part A (Nussbaum & Bunner, 2009). Measuring attention as part of a comprehensive neuropsychological assessment has been reported to be useful in establishing the diagnosis of NLD (Casey, 2012). Test-retest reliability in a sample of adolescents was .41 for Part A and .65 for Part B (Barr, 2003). In terms of validity, the C-HRNB has been shown to account for additional variability over intelligence tests in predicting achievement scores (Strom et al., 1987), and the Trail Making Test in particular was shown to significantly predict reading, spelling and mathematics scores on a standardized achievement measure (Strom et al., 1987). Strom et al. (1987) concluded that the C-

HRNB adds to the prediction of scores on tests of achievement over and above scores from intelligence tests, and that the C-HRNB is useful in the assessment of learning disorders (Strom et al., 1987).

Part A of the Trail Making Test requires children to connect circles numbered from 1 to 15 in sequential order with a continuous line. Children are instructed to complete this task as quickly as possible. The number of errors made and time taken to complete the entire sequence are the raw scores (Nussbaum & Bunner, 2009). Part B of the Trail Making Test requires children to connect a series of numbers (1 to 8) and letters (A to G) enclosed in circles, alternating between the two types of stimuli until the last circle is reached. The task is to be performed as quickly as possible (Nussbaum & Bunner, 2009). The scores derived from Part B include the total number of seconds taken to complete the task and the number of errors committed.

**Executive Functioning**

**Category Test.** Measuring executive functions, especially solving novel problems and nonverbal concept formation, as part of a comprehensive neuropsychological assessment has been reported to be useful in establishing the diagnosis of NLD (Casey, 2012). The Category Test assesses concept formation, problem-solving abilities, abstract thinking, and overall brain functioning (Nussbaum & Bunner, 2009). Internal consistency reliability has been reported to be .86 (Boll, 1993). Validity has been assessed in several ways, including identifying the underlying constructs of the test through factor analysis, and correlating the Category Test with other neuropsychological measures of executive functioning. For the Category Test, which has six subtests for children between the ages of 9 and 14 and seven subtests for children who are 15 or older, it was found that a two

factor solution was the best fit for the data. These two factors correlated moderately (*r* = .55). Additionally, the Category Test was found to correlate moderately with the Wisconsin Card Sorting Test, another measure of executive functioning, with 30% of the variance being shared between the two measures (Baron, 2004). The latter was reported to measure the tendency to respond perseveratively as well as the ability to identify relevant details and attributes, while the former measures learning of rules and higher order concepts (Baron, 2004).

The Category Test includes 168 items. The items are presented visually, and the child must choose a number (1, 2, 3, or 4) that corresponds with the item. Following each response, the child is informed if the response was correct or not. The score obtained on this test is the total number of errors.

**Memory for Visual Information**

**TPT.** The Tactual Performance Test (TPT) is a complex tactile-perceptual and motor task that also taps problem-solving, as well as spatial and memory functioning (Nussbaum & Bunner, 2009). Measuring memory for visual information as part of a comprehensive neuropsychological assessment has been reported to be useful in establishing the diagnosis of NLD (Casey, 2012). Furthermore, children with learning disabilities have been found to have significant difficulty with the Memory and Localization aspects of the task (McIntosh, Dunham, Dean, & Kundert, 1995). Insufficient information is available regarding the test-retest reliability of the TPT with children. Brown, Rourke, and Cicchetti (1989) found that test-reliability over a period of approximately 2.5 years was unacceptably low (less than .5 for all measured variables) in a pediatric population, but this is an unusually long period between assessments. Some

evidence for validity was provided by Steese-Seda, Brown, and Caetano (1995), who investigated the relationship between performance on the TPT and performance on a bimanual visuomotor coordination task, and found a positive relationship between scores on these two measures, suggesting that these two tasks tap similar dimensions of neuropsychological functioning.

The TPT requires the child to place six differently shaped blocks into their corresponding slots on a board one at a time while blindfolded. The task is first completed with the dominant hand, then with the nondominant hand, and finally with both hands simultaneously. After the board has been concealed, the child is asked to remove the blindfold and draw the location of the shapes on the board from memory. The scores derived from this test are the total time to complete the task with the dominant hand, the total time taken to complete the task with the nondominant hand, the total time taken to complete the task with both hands, the number of blocks recalled, and the number of blocks placed in the correct location when drawn.

**Visual-Spatial Functioning**

**JOLO Form V.** The Judgment of Line Orientation (JOLO; Benton et al., 1983) task taps spatial judgment, spatial perception, and orientation (Braaten, 2007; Strauss et al., 2006). Measuring visual-spatial perception as part of a comprehensive neuropsychological assessment has been reported to be useful in establishing the diagnosis of NLD (Casey, 2012). In terms of the psychometric properties of the JOLO, the standard versions (i.e., Form H and Form V) have been found to have acceptable split-half reliability ($r$ = .84) in children (Benton et al., 1994). Similarly, Lindgren and Benton (1980) investigated the corrected split-half reliability in 8 age bands that had a

one year increment for children between the ages of 7 and 14 years, and found that the reliability coefficients ranged from .61 to .87, with a general trend towards higher reliability in the older age bands. Test-retest reliability with a retest interval of one year was low overall for the group of 94 children ($r$ = .64) due to variability of performance and developmental changes for the younger children who were included. However, older children who were included and advanced from Grade 4 to Grade 5 during the test-retest interval had a correlation of .78 between testing sessions, which is acceptable. With regard to construct validity, Trahan (1998) found that JOLO scores tend to correlate more strongly with visual-spatial subtests of the WAIS-R (i.e., $r$ = .68 for Block Design and $r$ = .69 for Object Assembly) than with the verbal subtests of the WAIS-R (i.e., $r$ = .45 for Information and $r$ = .28 for Vocabulary).

The Judgment of Line Orientation (Benton et al., 1983) task requires a child to judge the location and orientation of lines. Each item displays two lines in a different orientation. The child must find the lines that match the test stimuli on a card that contains several lines drawn in various orientations. There are 30 items; the score is determined by the total number of correct items. Both lines must be correctly identified in order to receive credit for the item.

**WRAVMA.** The Visual-Spatial (Matching) and Visual-Motor (Drawing) subtests of the Wide Range Assessment of Visual Motor Abilities (WRAVMA; Sheshlow, 2001) were administered. The former assesses visual-spatial processing; the latter assesses visual-spatial processing as well as visual-motor integration (Bunker, 2001), which is the degree to which visual perception and fine motor movements are well coordinated (Braaten, 2007). These subtests have been found to be associated with school

performance (Bunker, 2001). In terms of reliability, test-retest reliability was reported to be .83 and .89 for the Visual-Spatial (Matching) and Visual-Motor (Drawing) subtests, respectively (Sheshlow, 2001). Internal-consistency reliability was reported to be .84 and .81 for the Visual-Spatial (Matching) and Visual-Motor (Drawing) subtests, respectively (Sheshlow, 2001). In terms of validity, the Visual-Motor (Drawing) subtest has a correlation of .76 with the Beery-Buktenica Developmental Test of Visual-Motor Integration, a test that measures similar abilities (Sheshlow, 2001). The Visual-Spatial (Matching) subtest has a moderate correlation of .54 with the Motor-Free Visual Perception Test (Sheshlow, 2001).

The Visual-Spatial (Matching) subtest requires children to choose one figure that matches the target from an array of four figures. The four options may differ in orientation, rotation, size, and perspective. Since the child is not required to manipulate objects (but merely to point to the chosen response), fine motor skills are not critically involved in this subtest. Feedback about the correctness of the response is provided to the child after each response. Scoring criteria are provided for the examiner on the test form.

The Visual-Motor (Drawing) subtest requires the child to copy progressively complex designs that are developmentally normed. Children receive a score of one if all scoring criteria are met and a score of zero if any of the scoring criteria are not met. The sum of the two subtests described, in addition to the score from the Fine Motor (Pegboard) subtest which was not administered in the context of the present study, can be used to determine a composite score for the WRAVMA. It takes approximately 15 to 30 minutes to administer the three subtests.

## Motor Functioning

**Grooved Pegboard Test.** Motor functioning was assessed with the Grooved Pegboard Test (Matthews & Kløve, 1964). This test assesses fine motor dexterity and coordination (Lezak et al., 2012). Measuring fine motor dexterity as part of a comprehensive neuropsychological assessment has been reported to be useful in establishing the diagnosis of NLD (Casey, 2012). The Grooved Pegboard has demonstrated adequate test-retest reliability ($r$ = .80 for dominant hand and $r$ = .81 for the non-dominant hand in children between the ages of 9 and 14 years; Knights & Moule, 1968). In terms of validity, the Grooved Pegboard has been found to correlate modestly with the Finger Tapping Test, a measure of fine motor speed (Schear & Sato, 1989). It has also been found to correlate moderately to strongly with measures of attention, processing speed, and nonverbal reasoning (Strauss et al., 2006).

The Grooved Pegboard Test uses a board with holes that have a round and a square component in different orientations arranged in a 5 x 5 square matrix. The pegs are all the same shapes and designed to fit into the holes; the pegs must be rotated in one's fingers to the correct orientation before they will fit properly into the holes. The examinee picks up and places the pegs into the holes across the rows one at a time using the only the dominant hand first and then only the nondominant hand. When using the right hand, pegs are placed into the holes in the board from left to right, and vice versa when the left hand is used. The examinee continues to place pegs in the holes until all holes have been filled. Time to completion is the score of interest that is compared to normative data (Lezak et al., 2012); qualitative information can be gleaned from the number of times an examinee drops the pegs with each hand.

### Sensory Functioning

**FTNW.** The Fingertip Number Writing Test of the Kløve-Matthews Sensory-Perceptual Examination measures complex sensory functioning and concentrated attention (Nussbaum & Bunner, 2009). Measuring sensory functioning as part of a comprehensive neuropsychological assessment has been reported to be useful in establishing the diagnosis of NLD (Casey, 2012). Reliability and validity data for pediatric populations are not available for this measure in the published literature (Wilkinson, 2006).

The Fingertip Number Writing Test requires children to identify numbers traced on their fingers one at a time, in a standard order while their eyes are closed. The task is done with each hand separately. Children are first oriented to the task by the examiner, who traces the numbers (i.e., 3, 4, 5 and 6) that will be written on their fingers during the test on their palms. The score for this test is determined by the number of errors made.

### Screening Measure

**NLD Scale.** During the recruitment phase, the NLD Scale, a screening measure for NLDs that was designed by Rourke (1993b), was used qualitatively to identify potential participants because normative data from typically developing children and children with NLD were not available for this measure (Taneja, 2001). The original scale was adapted to change the wording of some items in order to be consistent with phrases and terms commonly used today without changing the major focus and meaning of each item (see Appendix G for the adapted version of the scale). This behavioural questionnaire assesses behaviour related to the neuropsychological, academic, and social-emotional and adaptive characteristics of NLD (Taneja, 2001).

Several investigations have been undertaken that determine the reliability of the NLD screening instrument. Internal consistency was found to be 0.66 by Taneja (2001) in a sample of 49 males between the ages of 8 to 38 years diagnosed with NLD, HFA, or Asperger's disorder. This screening test is designed to measure more than one construct. Internal-consistency statistics are useful in providing information about reliability when the items in a scale measure one construct. However, since this screening measure assesses more than one construct, internal consistency estimates may underestimate the scale's reliability (Shrout & Yager, 1989). Test-retest reliability has been examined by three studies conducted by Van Der Vlugt (unpublished) and has been found to range from .82 to .92. Van der Vlugt (unpublished) found interrater reliability between parents and teachers completing the measure to be .67.

Validity of the scale was investigated by Taneja (2001). This author found support for the construct validity of the measure based on the significantly higher scores obtained by the participants who were deemed to have very probable NLD comorbid with ASD compared to those participants who were deemed to have a low probability of exhibiting NLD comorbid with ASD based on the characteristics of their neuropsychological profiles.

The NLD Scale is a forty item questionnaire that is designed for individuals aged 7 and older and is to be completed by a parent or caregiver. The forty items are divided into three sections—neuropsychological functioning (items 1 to 23 inclusive), academic achievement (items 24 to 30), and social-emotional and adaptive functioning (items 31 to 40; Taneja, 2001). Responses are made using a three point scale (i.e., no or never, somewhat or occasionally, and frequently).

## Appendix F: Group Comparison Measures

The group comparison measures are arranged alphabetically by test name. For each test, the constructs measured, available information pertaining to the reliability and validity, and a description of the tasks or activities involved are presented.

### Autism Diagnostic Observation Schedule Second Edition

The second edition of the Autism Diagnostic Observation Schedule (ADOS-2; Lord et al., 2012) has become the standard instrument for assessing autism spectrum disorders across age, developmental level, and language skills (Kanne, Randolph, & Farmer, 2008). The ADOS-2 is a semi-structured, standardised assessment of communication, social interaction, and play (Lord et al., 2012). The ADOS-2 is comprised of five modules. Only one module is used to assess a child (or adult) at a particular point in time, with each requiring approximately 30 to 60 minutes to administer. Deciding which module is appropriate to use is based on the client's level of expressive language (Lord et al., 2012) and to a lesser extent the developmental level of the person (e.g., if it is appropriate to ask them to play with toys). For example, the Toddler Module and Module One are appropriate for children who do not consistently and spontaneously use phrase speech. Module Two is for children of any age who are able to speak in phrases (i.e., spontaneous, non-echoed, and meaningful three-word phrases that sometimes include a verb), but do not do so fluently. Module Three is for children and adolescents who speak fluently and for whom it is developmentally appropriate to play with toys; this module also includes some interview questions. Finally, Module Four is for adolescents and adults who speak fluently and for whom it is more age-appropriate to assess using interview questions as opposed to playing with toys

(e.g., generally children who are 16 or older may be assessed with this module). Module Four includes socio-emotional questions as well as questions about daily living that are appropriate for examinees with a minimum level of independence with respect to relationships and goals (Lord et al., 2012).

The ratings made by examiners give rise to two domain scores (i.e., Restricted and Repetitive Behaviour and Social Affect) for the Toddler Module, as well for as Modules One through Three (inclusive). If a child's score exceeds the threshold cut-off score for the combined total of the Restricted and Repetitive Behaviour and Social Affect domains, then this is considered strong evidence to support the diagnosis of autism spectrum disorder (keeping in mind that other criteria must also be met in order to establish that diagnosis; Lord et al., 2012).

In terms of the psychometric properties of the instrument, interrater reliability and test-retest reliability have been found to be acceptable to excellent for the Modules. That is, Lord et al. (2012) reported that interrater reliability for the Overall Total of the ADOS-2 (i.e., the combined sum of the Restricted and Repetitive Behaviour composite and the Social Affect composite) was .97 for Module One, .96 for Module Two, and .94 for Module Three (Module Four was not calculated). Interrater reliability for the Social Affect composite was .97 for Module One, .98 for Module Two, and .92 for Module Three. For the Restricted Repetitive Behaviour composite, interrater reliability was .79 for Module One, .80 for Module Two, and .91 for Module Three. Test-retest reliability for the Overall Total of the ADOS-2 was .87 for Module 1, .83 for Module Two, and .87 for Module Three (Module Four was not calculated). Test-retest reliability for the Social Affect composite was .92 for Module One, .84 for Module Two, and .81 for Module

Three. Test-retest reliability for the Restricted and Repetitive Behaviour composite was .68 for Module One, .73 for Module Two, and .82 for Module Three.

The validity of the ADOS-2 has also been adequately demonstrated through the use of several different procedures. Prior to the release of the ADOS-2, the diagnostic algorithms for Modules One, Two and Three were recalculated (Gotham, Risi, Pickles, & Lord, 2007). The ADOS-2 diagnostic algorithms are based on these recalculations and restructured composite scores for Modules One through Three (the diagnostic algorithm for Module Four was not revised from that used in the previous version of the instrument). Exploratory factor analysis for the five distinct algorithm groups (i.e., two groups for Module One, two groups for Module Two, and one group for Module Three) was completed to establish the domain composites for the ADOS-2. For all five groups, a two factor solution (i.e., Restricted and Repetitive Behaviours and Social Affect) fit well and the two factors were found to correlate with each other. Confirmatory factor analysis also supported the two factor solution as the best fit.

The ADOS-2 diagnostic algorithms, in comparison to the algorithms used as part of the previous version of the instrument, demonstrated essentially equal sensitivity and improved specificity in most of the five groups (with mild decreases in specificity for some groups; Lord et al., 2012). The algorithms were used to compare children diagnosed with autistic disorder with children who were non-spectrum, and children who were on the autism spectrum, but did not meet full criteria for autistic disorder according to the DSM-IV-TR (American Psychiatric Association, 2000) with children who were non-spectrum. The Module Three algorithm was found to have a sensitivity of .91 and a specificity of .84 for identifying individuals with autistic disorder versus those who were

not on the autism spectrum. When it came to differentiating individuals who were on the autism spectrum but did not meet the full criteria for autistic disorder from individuals who were not on the autism spectrum, sensitivity was found to be .72 and specificity was found to be .76. The Module Four algorithms, which require scores to exceed the threshold of the Communication, Social Interaction, and Communication + Social Interaction combined), were not able to be improved upon in terms of their sensitivity and specificity. Sensitivity was found to be .90 and specificity was found to be .93 for differentiating autistic disorder and individuals on the spectrum who did not meet full criteria for autistic disorder from individuals who were non-spectrum using the original algorithms. Further evidence of validity is provided in the ADOS-2 manual (Lord et al., 2012). Of note, Lord et al. (2000) point out that the sound psychometric properties of the ADOS-2 are contingent upon having a properly trained and adequately reliable examiner administering the instrument.

Module Three was administered in the present study. This module contains fourteen activities and the examiner is required to make 29 ratings. All ratings are made after the assessment has occurred, and are made using a score of 0 (i.e., behaviour shows no evidence of abnormality associated with autism), 1 (i.e., behaviour shows some evidence of abnormality related to autism), or 2 (i.e., behaviour shows strong evidence of abnormality related to autism). For some items, obtaining a score of 3 is possible; this denotes severe behavioural abnormalities that are so disruptive that they interfere with observation during the assessment. Some items also permit a score of 7 (the meaning of this code varies based on the specific item that is being rated and this is outlined in the protocol) or a score of 8 (which generally means that an item is not applicable). Scores of

3 are converted to scores of 2 and score of 7 or 8 are transformed to 0 before being entered into the diagnostic algorithm.

**Behavior Assessment System for Children Second Edition**

The Behavior Assessment System for Children Second Edition (BASC-2; Reynolds & Kamphaus, 2004) is a measure of social adjustment, adaptive behavior, and self-perception of individuals aged two to 25 (Tan, 2007). It includes five components (i.e., Teacher Rating Scale, Parent Rating Scale, Self-Report of Personality, Structured Developmental History, and the Student Observation System to directly classify behaviour observed in the classroom) that can be used independently or in any combination with each other (Reynolds & Kamphaus, 2004). For the purposes of this study, only the Parent Rating Scale was administered.

The Parent Rating Scale (PRS) focuses on behaviours in community and home settings. It also has rating forms for three age groups (i.e., ages two to five, six to eleven, and 12 to 21). The PRS includes items that tap the domains of Externalizing Problems, Internalizing Problems, and Adaptive Skills. Composite scores can be derived for each of these domains based on scores obtained on Primary scales; the Behavioural Symptoms Index can also be derived. The PRS provides information about the performance of activities involved in daily living.

Reynolds and Kamphaus (2004) described three embedded validity scales of the PRS in the BASC-2 manual. The F-index assesses if the parent often uses extremes of the rating scale by tending to rate items assessing adaptive behaviours as “never” occurring and items assessing maladaptive behaviours as “almost always” occurring. An elevated score on this index can mean that severe maladaptive behaviour is present or that the

parent employed an overly negative response style when rating the child. An elevation in the Caution range was found to occur in less than five percent of the normative sample, whereas an elevation in the Extreme Caution range was found to occur in less than one percent of the normative sample (Reynolds & Kamphaus, 2004). The Response Pattern Index assesses whether the rater did not appropriately attend to the content of the items of the BASC-2 by identifying predictable or unusual patterns of responding (e.g., responding in the same way to many consecutive items, responding to consecutive items using an alternating pattern). The score on this index is the result of adding the number of times an item is rated differently than the previous item. If the index score is in the Low range (i.e., the tally is very low), then many items were completed with the same response. Such a pattern was observed in 0.5 percent of the normative sample. If the index score is in the High Caution range (i.e., the tally is very high), then this indicates that very few consecutive items were completed with the same response, and may indicate a cyclical or alternating pattern of responding. Scores in the High Caution range also occurred in 0.5 percent of the normative sample. The Consistency Index also assesses if raters appropriately attended to the content of BASC-2 items by evaluating if items that are similar in content were completed in a similar fashion. This index consists of pairs of items that are highly correlated. Scores in the Caution or Extreme Caution range may indicate that the rater did not appropriately attend to the content of the items, the rater's perspective shifted during the course of completing the PRS of the BASC-2, the rater misunderstood a number of items, different raters completed different sections of the PRS response form, or a rater inadvertently rated the behaviour of another child when responding to some of the items on the PRS (Reynolds & Kamphaus, 2004).

Test-retest reliabilities for the composite scales of the child form and the adolescent form of the PRS were obtained twice from the same parent over a retest interval that ranged from nine to 70 days. Composite scores of the child form of the PRS were found to range between .78 and .92; composite scores of the adolescent form of the PRS were found to range between .83 to .90 in the nonclinical normative data (Reynolds & Kamphaus, 2004).

There is evidence in support of the construct and criterion-related validity of the BASC-2. Construct validity is supported by the clinical scale and composite score profiles obtained by children and adolescents on the Teacher Rating Scale, Parent Rating Scale, and Self-Report of Personality; these profiles generally indicate patterns of strengths and weaknesses that would be expected within clinical groups (Stein, 2007). Intercorrelations among the BASC-2 and measures that purport to measure similar constructs (e.g., the Achenbach System of Empirically Based Assessment) generally reveal expected relationships, particularly with respect to the scales that tap externalizing problems; the majority of scales tapping similar constructs correlate moderately to highly, except for scales that tap anxiety (Stein, 2007). Such evidence supports the criterion-related validity of the BASC-2 (Stein, 2007).

The PRS BASC-2 rating form for children between the ages of six and eleven years consists of 160 items, while the rating form for adolescents between the ages of 12 and 21 consists of 150 items. Each item is rated on a forced-choice, four-point scale (i.e., “never”, “sometimes”, “often”, and “almost always”) that identifies the frequency of certain behaviours (e.g., “refuses to join group activities”) in the home and community setting.

**The Children's Communication Checklist Second Edition**

The Children's Communication Checklist Second Edition (CCC-2; Bishop, 2006) is a behaviour rating inventory designed to detect the presence of communication disorders, problems with language pragmatics, and social deficits in children between the ages of 9 and 16 years of age (Norbury & Bishop, 2005). Furthermore, it is useful as a screening tool for ASD and specific language impairment (Norbury & Bishop, 2005). The CCC-2 assesses strengths and weaknesses in structural and pragmatic aspects of language. The checklist consists of 70 items (seven items on each of ten subscales) that are rated on a scale of zero to three, with a higher rating corresponding to a higher frequency of specific communication behaviours. Of the seven items on each subscale, five items describe impairments and two items describe positive functioning (Bishop, 2006). The CCC-2 can be completed in approximately ten to fifteen minutes by an adult who knows the child being evaluated well (i.e., for at least three months prior to the evaluation; Norbury & Bishop, 2005). The CCC-2 includes ten subscales that give rise to the General Communication Composite score. The subscales are as follows: Speech, Syntax, Semantics, Coherence, Inappropriate Initiation, Stereotyped Language, Use of Context, Non-verbal Communication, Social Relations, and Interests (i.e., the presence or absence of stereotyped interests). The first four subscales assess structural language skills and the Inappropriate Initiation, Non-verbal Communication, Social Relations, and Interests subscales assess pragmatic aspects of communication. The Social-Interaction Difference Index (SIDI) is calculated by subtracting the sum of the scaled scores of the four subscales that assess structural language skills from the sum of the scaled scores of the four subscales that assess pragmatics. In this way, the SIDI provides useful

information about functioning in one area of communication relative to another and is helpful in differentiating between children who exhibit a specific language impairment (who typically have lower structural language skills in comparison to pragmatics) or ASD (who typically have lower scores on the pragmatic scales relative to structural language skills). Specifically with respect to ASD, normative data from typically developing children and children with ASD indicated that 27% of the ASD sample obtained a score of -11 or less on the SIDI while such a score was obtained by 0% of the typically developing children who were not on the autism spectrum and 5% of the specific language impairment sample (Bishop, 2006).

The CCC-2 has demonstrated adequate reliability. Test-retest reliability was established based on a subset of 98 children from the standardization sample who were demographically representative of that sample. These children were divided relatively evenly between three age groups (i.e., four to six years old, seven to nine years old and 10 to 16 years old). Informants filled out the CCC-2 for the selected 98 children between one and 28 days after first completing the questionnaire. Pearson product-moment correlations for the Global Communication Composite (GCC) at time one and time two were found to range between .86 and .96, indicating adequate test-retest reliability of the measure (McCauley, 2010). Internal consistency reliability was examined for each of the ten subscales, as well as the composite scores. Split-half reliability for the subscales was found to range between .69 and .85, indicating adequate internal consistency reliability for the subscales. For the GCC composite, internal consistency was found to range between .94 and .96, indicating an excellent level of reliability for that composite (Towne, 2010).

There is adequate evidence to support the construct validity of the CCC-2. When control participants from the standardization sample (who were matched on sex, age, level of parental education, and race/ethnicity) were compared to members of the clinical groups (i.e., specific language impairment, ASD, and pragmatic language impairment) on which the CCC-2 was standardized, it was found that participants who were from the clinical populations consistently obtained significantly lower scores, indicating greater dysfunction than control participants, on the ten subscales and the GCC composite of the CCC-2. This provides support that the CCC-2 is useful in differentiating between children who have unimpaired communication skills and those who have clinically significant communication difficulties (McCauley, 2010; Towne, 2010).

**Children's Social Behaviour Questionnaire Revised**

The revised version of the Children's Social Behaviour Questionnaire (CSBQR; Hartman et al., 2006) has been found to be useful in describing the severity and pattern of social skill deficits in clinical groups such as pervasive developmental disorders in children and adolescents between the ages of four to 18 inclusive. It includes 49 items that comprise six subscales: Behaviour or Emotions Not Optimally Tuned to the Social Situation; Reduced Contact and Social Interest; Orientation Problems in Time, Place, or Activity; Difficulties in Understanding Social Information; Stereotyped Behaviour; and Fear of and Resistance to Changes (Hartman et al., 2006). The questionnaire is designed to be completed by a child's caregiver who is asked to rate how well a description of a particular behaviour corresponds with the child's behaviour over the past two months using scale of 0 (i.e., "does not apply"), 1 (i.e., "sometimes or somewhat applies", or 2

(i.e., "clearly or often applies"). Higher scores indicate greater dysfunction (Hartman et al., 2006).

The revised version of the CSBQR has demonstrated adequate reliability and validity. For the CSBQR overall, internal consistency based on Cronbach's alpha was .94. Cronbach's alpha for the subscales ranged between .76 to .90. Interrater reliability was found to have an intraclass correlation of .86 for the total scale; the correlations for the subscales ranged from .75 to .89. Finally, the test-retest reliability for the overall scale was found to be excellent (.90). The test retest reliability for the subscales ranged from .80 to .89, which is within acceptable limits (Hartman et al., 2006).

In terms of validity, the CSBQR has been found to be useful in differentiating among several child clinical populations. The PDD-NOS group obtained significantly higher ratings on the CSBQR total score and all subscale scores than the group of typically developing children (and all effect sizes were large) and the children diagnosed with internalizing disorders. Additionally, the HFA group obtained significantly higher ratings on the CSBQR total score than the PDD-NOS group. The children diagnosed with PDD-NOS obtained significantly different scores on the CSBQR total score from children diagnosed with attention-deficit/hyperactivity disorder (ADHD); those children diagnosed with both ADHD and PDD-NOS were found to have significantly higher scores on the CSBQR total score than children diagnosed with only PDD-NOS or only ADHD. The group of children diagnosed with mental retardation and pervasive developmental disorder obtained significantly higher ratings on the CSBQR total score than the group of children diagnosed only with mental retardation (Hartman et al., 2006).

## Appendix G: NLD Scale

NLD Scale
(Adapted from the scale created by Byron Rourke, 1993b)
Participant's I.D.:_____ Date:_____
Examiner:_____

Instructions: Please answer each question based on your child's typical behaviour. Please do not provide responses that reflect whether and to what extend your child is capable of the behaviour. In other words, these questions deal with what the child does on a regular basis, rather than what the child is capable of doing (but does not typically do) in everyday life.

Three-point scale: All of the questions are to be answered on a three-point scale, as follows:

No, not at all, never
Somewhat; every once in a while
Yes, very much, frequently.

| Your Child: | No | Somewhat | Yes, Very Much |
|---|---|---|---|
| Neuropsychological Functioning: | | | |
| 1. is appropriately responsive to noises | | | |
| 2. follows spoken commands | | | |
| 3. is attentive to spoken directions | | | |
| 4. easily remembers verbal information | | | |
| 5. engages in simple, repetitive motor movements | | | |
| 6. explores objects through touch | | | |
| 7. visually explores new environments | | | |
| 8. is attentive to visual information | | | |
| 9. remembers what (s)he sees | | | |
| 10. has an age-appropriate level of skill in performing fine motor activities | | | |
| 11. is interested in new environments and actively explores them | | | |
| 12. is eager to engage in new activities | | | |
| 13. seeks out and enjoys problem-solving activities | | | |
| 14. has age-appropriate understanding of abstract concepts | | | |
| 15. spontaneously repeats verbatim what has been said to him/her in the past as if (s)he were reciting a script | | | |
| 16. remembers what is said to him/her | | | |
| 17. exhibits age-appropriate pronunciation of words | | | |

| | | | |
|---|---|---|---|
| 18. speaks out of turn; interrupts when others are trying to speak | | | |
| 19. has an age-appropriate level of awareness of the day of the week, the time of day, and other dimensions of time | | | |
| 20. speak more frequently and at greater length than others his/her age | | | |
| 21. prefers to spend time talking or reading rather than engaging in physical (including sporting) activities | | | |
| 22. prefer to interact with younger children or adults rather than same-age peers | | | |
| 23. shies away from new, unfamiliar, or complicated social events | | | |
| Academic Achievement | | | |
| 24. has neat, age-appropriate handwriting | | | |
| 25. reads single words at or above age-expectation | | | |
| 26. spells words at or above age-expectation | | | |
| 27. easily recalls (recites) school-related material | | | |
| 28. understands reading material at or above age-expectation | | | |
| 29. completes age-appropriate arithmetic calculations | | | |
| 30. has an age-appropriate understanding of scientific concepts | | | |
| Social-Emotional and Adaptive Functioning | | | |
| 31. seeks out new friends and new experiences | | | |
| 32. behaves appropriately with same-age children | | | |
| 33. prefers the company of family members over other individuals | | | |
| 34. behaves appropriately with adults | | | |
| 35. reacts with appropriate emotion in social situations | | | |
| 36. engages in an age-appropriate level of physical activity | | | |
| 37. has age-appropriate fine (e.g., handwriting) and gross (e.g., running or sports-related) motor skills | | | |
| 38. tends to play with younger children | | | |
| 39. displays age-appropriate responsiveness to the emotions of others | | | |
| 40. is socially “popular” with age-mates | | | |

## Vita Auctoris

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