SPECIFYING THE BOUNDARIES OF PERVERSIVE DEVELOPMENTAL DISORDER-NOT OTHERWISE SPECIFIED: COMPARISONS TO AUTISM AND OTHER DEVELOPMENTAL DISABILITIES ON PARENT-REPORTED AUTISM SYMPTOMS AND ADAPTIVE AND BEHAVIOR PROBLEMS

DISSERTATION

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ABSTRACT

Pervasive Developmental Disorder, Not Otherwise Specified (PDD-NOS) is the most frequently diagnosed pervasive developmental disorder (PDD), yet it is the least well characterized. Current diagnostic criteria for PDD-NOS are vague and difficult to use reliably, as specific numbers and types of symptoms are not provided. The few studies that have investigated PDD-NOS as a diagnostic category provide little support for its reliability or validity. The objective of the current study was to clarify PDD-NOS as a diagnostic category by specifying its boundaries with Autistic Disorder (AD) and similar disorders on parent-reported adaptive and behavior problems as well as PDD symptoms. The sample consisted of 162 children with PDD-NOS, AD, or other developmental disabilities (DDs). Participants were between the ages of 24 and 146 months (mean=65.2; SD=30.5). Individuals with PDD-NOS were matched to those with AD and DD on age, gender, ethnicity, and non-verbal IQ (NVIQ). The three groups were compared on select subscales of the Pervasive Developmental Disorder Behavior Inventory (PDDBI), the Child Behavior Checklist (CBCL), and the Scales of Independent Behavior-Revised (SIB-R). To measure the impact of age on PDD symptoms, behavior problems, and adaptive behavior, matched groups were separated by age into preschool (2-5 years), and school age (6-12 years) groups. Cluster analysis of PDD symptoms was performed to determine how classification based on multivariate heuristics would
compare to clinical diagnoses. Discriminant function analysis was used to determine which PDD symptoms would most effectively predict diagnostic group membership. MANOVAs indicated that no significant differences existed between PDD-NOS and AD groups on measures of PDD symptoms or adaptive behavior. The only differences to emerge between PDD-NOS and AD groups were significantly higher rates of anxiety and affective symptoms in the PDD-NOS group. The DD group had significantly fewer PDD symptoms and less-impaired adaptive behavior as compared to the PDD groups. Significant diagnosis-by-age interactions were not found. The cluster analysis revealed that a three-cluster solution best fit the data. The clusters were labeled “Subthreshold PDD Symptoms,” “Language Impaired, Ritualistic,” and “Typical Autism.” The clusters did not differentiate diagnostic groups. The discriminant function analysis revealed that a set of three PDD symptoms differentiated the DD group from the PDD groups with a 67% correct classification rate, and that a set of two symptoms differentiated PDD-NOS, AD, and DD groups with a 52% correct classification rate. Overall, these results suggest that previously-reported differences in symptomatology between PDD-NOS and AD might be better accounted for by differences in NVIQ. Level of functioning was a salient contributor to the heterogeneity observed in PDDs. Results of this study support proposals by other researchers to incorporate level of functioning into PDD classification systems.
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CHAPTER 1

INTRODUCTION

One of the most important developments in the field of autism over the past 20 years has been the acknowledgement of the wide variation in the clinical expression of autistic disorder (AD) (Szatmari, Merette, Bryson, Thivierge, Roy, Cayer, & Maziade, 2002). It is now widely recognized that children with AD present with varying severity and number of symptoms. To account for this range of presentation, classification systems have broadened to include pervasive developmental disorder (PDD) subtypes. The most frequently-diagnosed subtype is pervasive developmental disorder, not otherwise specified (PDD-NOS), yet it is the least well characterized PDD (Fombonne, 2005). Currently, only the number and distribution of behavioral descriptors are used to discriminate PDD-NOS from AD. Empirical research on the boundaries between these disorders is inconclusive. The current study will examine the validity of the distinction between AD and PDD-NOS.

PDDs are a group of disorders characterized by impairment in social interaction that may or may not occur with deficits in communication and the presence of restricted or repetitive behavior. The DSM-IV-TR (American Psychiatric Association, 2000) diagnostic criteria are separated into these three domains and include: (1) Social
Impairment: (a) impairment in the use of nonverbal behaviors, (b) failure to develop peer relationships, (c) lack of spontaneous seeking to share enjoyment, interests, or achievements, (d) lack of social or emotional reciprocity; (2) Communication Impairment: (a) delay or total lack of spoken language, (b) impairment in the ability to initiate or sustain a conversation, (c) stereotyped or repetitive language, (d) lack of make-believe or imitative play; (3) Restricted or Repetitive Behavior: (a) preoccupation with one or more stereotyped and restricted patterns of interest, (b) inflexible adherence to specific, nonfunctional routines or rituals, (c) stereotyped and repetitive motor mannerisms, (d) persistent preoccupation with parts of an object. For a diagnosis of AD, six total symptoms must be exhibited, with at least two symptoms from the social domain and at least one each in the other domains. Asperger’s Disorder requires the same impairments in socialization and the presence of restricted or repetitive behavior as AD, but does not require the presence of communication deficits. PDD-NOS is used when there is a severe impairment in social interaction and either communication impairments or restricted or repetitive behaviors. It is given when the diagnostic criteria for AD or Asperger’s Disorder are not met.

These disorders are hypothesized to cover a spectrum of disability, with severe AD at one end and near normality at the other (Towbin, 2005; Wing, 2005). PDD-NOS is thought to represent the moderate to mild end of the autism spectrum, however, the boundaries between disorders along this continuum are unclear. Some researchers posit that AD is at the most severe end of the continuum, followed by Asperger’s Disorder and PDD-NOS at the mild end (Prior, Eisenmajer, Leekan, Wing, Gould, et al., 1998). Others believe that PDD-NOS should represent the moderate range of impairment and
Asperger’s Disorder should fall at the mild end of the spectrum (Kurita, 1997). Empirical studies of the PDD spectrum have not provided consistent evidence for either view.

Towbin (2005) listed three other interpretations of the PDD-NOS diagnosis. These interpretations include: 1) PDD-NOS is not a clinical entity but rather a label to use when diagnostic conditions are unfavorable, such as when diagnostic information is absent or unreliable; 2) PDD-NOS is the diagnosis representing individuals who present with symptoms of AD but miss the age of onset criterion; 3) PDD-NOS is a heterogeneous group of as yet uncharacterized disorders that are similar to the autism spectrum in that they are characterized by early onset of symptoms and impairment in social reciprocity.

History of Diagnostic Criteria

Over the past several years, several changes have been made in the diagnosis and classification of PDDs. The diagnostic category of PDDs originated in the DSM-III (APA, 1980). The term PDD was used to refer to disorders characterized by a triad of impairments in social interaction, verbal and nonverbal communication, and repetitive or stereotyped behaviors. PDDs included in DSM-III were infantile autism (onset before 30 months), childhood onset PDD (onset after 30 months but before 12 years), residual autism (individuals with a history of infantile autism but no longer met criteria), and atypical autism (individuals who presented with autistic features but did not meet full criteria). Criteria for infantile autism included (1) social impairment, (2) language impairment, (3) resistance to change or attachments to objects, and (4) absence of symptoms of schizophrenia.
The revised version, DSM-III-R (APA, 1987), retained the diagnostic category of autism but collapsed the other subtypes of PDD into a single category of PDD-NOS. The criteria for autism were the same as in DSM-III but age of onset and absence of schizophrenic symptoms were excluded. Additionally, for each domain of impairment, a list of symptoms was provided. A minimum number of symptoms were required for the diagnoses of AD and PDD-NOS.

The DSM-IV (APA, 1994) retained the diagnoses of AD and PDD-NOS. The age of onset criterion for AD was changed to before three years. PDD-NOS was diagnosed when criteria for AD were not met and the individual demonstrated impairment in any one of the three behavioral domains. DSM-IV also introduced several PDD subtypes, such as Asperger’s Disorder, Childhood Disintegrative Disorder, and Rett’s Disorder. Asperger’s Disorder is characterized by the same symptoms as AD, but does not require communication impairments. Because of its similarity to AD and PDD-NOS, it has been grouped with these disorders on the autism spectrum.

Rett’s Disorder and Childhood Disintegrative Disorder are not included in the autism spectrum, due to specific characteristics that differentiate them from the other PDDs. Rett’s Disorder differs from other PDDs in its characteristic sex ratio and pattern of deficits. Whereas AD, Asperger’s Disorder, and PDD-NOS typically show a male to female sex ratio of 4:1, Rett’s Disorder is diagnosed almost exclusively in females. It is characterized by head growth deceleration, the loss of previously acquired fine and gross motor skills, and severe intellectual disability (ID) (APA, 2000). Additionally, unlike other PDDs, the genes that cause Rett’s Disorder have been identified (Amir, Van den Veyver, Wan, Tran, Francke, & Zoghbi, 1999). Childhood Disintegrative Disorder can be
distinguished from other PDDs based on its distinctive pattern of developmental regression after a period of at least two years of typical development (APA, 2000).

The DSM-IV-TR (APA, 2000) does not provide guidelines for which symptoms or how many symptoms should be endorsed for a diagnosis of PDD-NOS. It is described only as a diagnosis to be given when an individual demonstrates social impairment associated with deficits in verbal or nonverbal communication or the presence of restricted or repetitive behaviors. It is currently a subthreshold diagnosis that is used when the individual does not meet the diagnostic criteria for AD. It is diagnosed when the case is a less severe form of AD (fewer AD symptoms are present), the patterns of symptoms fail to meet those of the diagnostic criteria for AD (i.e. fewer than two social symptoms, etc.), the age of onset criteria is not met, or the case is characterized by uncommon or idiosyncratic AD symptoms. Individuals with PDD-NOS may demonstrate restricted interests, adherence to nonfunctional routines, limited imaginary play, and stereotyped behavior. Unlike those with AD or Asperger’s Disorder, these symptoms may be mild or absent. Compared to individuals with AD, communication impairments may or may not be present in individuals with PDD-NOS.

The current version of the International Classification of Diseases (ICD-10; World Health Organization, 1992) includes three categories corresponding to PDD-NOS in the DSM-IV-TR: atypical autism, other PDD, and PDD-unspecified. All of these categories describe AD that is atypical either in age of onset or in symptomatology.

Problems with Current Diagnostic System

Current definitions of PDD-NOS are ambiguous. Symptoms of the disorder are not specified, and neither is the number of symptoms required for the diagnosis. The only
qualifiers included in the DSM-IV-TR are “severe and pervasive impairment” in social interaction and “impairment” in communication. Whereas with other disorders, “impairment” is defined by the symptoms set forth in the diagnostic criteria, this is not the case for PDD-NOS. Because these statements are not defined by a set of specified criteria, it is up to clinicians to use their best judgment as to what qualifies as impairment, and whether or not it is severe or pervasive. This increases the heterogeneity within the diagnostic classification, as the definition of social and communication impairment will invariably differ between clinicians.

Diagnostic agreement between clinicians was investigated as part of the DSM-IV field trials (Volkmar, Klin, Siegel, Szatmari, Lord, et al., 1994). Clinicians rated 131 cases and had access to all clinical information. Agreement between clinicians when distinguishing between AD and non-PDD resulted in a kappa coefficient of .95. When distinguishing between AD and other PDDs, including PDD-NOS, the kappa value decreased to .65. This finding suggests that reliable differentiation between AD and PDD-NOS is difficult using DSM-IV criteria.

Because PDD-NOS is currently defined by what it is not rather than by its own diagnostic criteria, the reliability and validity with which it is diagnosed are compromised. Mahoney, Szatmari, MacLean, Bryson, Bartolucci et al. (1998) evaluated the ability of clinicians to reliability differentiate 143 individuals with AD (n = 93), PDD-NOS (n = 22), Asperger’s Disorder (n = 11), or a non-spectrum disorder (n = 17). Agreement in diagnosis was measured between three clinicians, all of whom had access to clinical notes, and the results of the “gold standard” assessment battery for PDDs: the Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter, & LeCouteur, 1994),
Autism Diagnostic Observation Schedule-Generic (ADOS-G; Lord, Rutter, DiLavore, & Risi, 1999) and results of cognitive testing. Diagnostic agreement was very good for non-spectrum disorders (kappa = .67), good for Asperger’s Disorder (k = .56), and AD (k = .55), but was much lower for PDD-NOS (k = .18). Clinicians reported that the difficulty in diagnosing PDD-NOS was deciding if the criteria for a particular domain were met, if the number or type of symptoms were inconsistent with the child’s developmental level, and how to classify children who previously met criteria for AD but at the time of assessment did not. The authors concluded that the DSM-IV criteria for PDD-NOS are insufficiently reliable for diagnostic or research purposes.

Because the diagnostic criteria for PDD-NOS are ambiguous and difficult to translate into clear definitions for clinical practice, some have questioned whether it is useful to differentiate PDD-NOS from AD (Szatmari, 1992; Towbin, 2005). One argument is that PDD-NOS should be eliminated from PDD classification schemes, as the vagueness of the criteria communicates very little information regarding the individual’s deficits, prognosis, or course. Because of this, the diagnosis itself becomes meaningless and not useful in clinical practice (Towbin, 2005). Another argument is that PDD-NOS should be encapsulated by AD because it is so similar that it does not warrant a separate diagnostic category. This view emphasizes the fact that the boundaries separating PDD-NOS and “high-functioning autism” are uncertain. Both disorders are contained by the autism spectrum and whereas they may differ in severity, it is unknown whether they are qualitatively distinct. This view is supported by the current diagnostic criteria for AD, Asperger’s Disorder, and PDD-NOS, as the symptoms used to define them are all the same. The only thing that distinguishes these three disorders is the
number and type of symptoms endorsed, which leads to questions regarding the validity of categorizing them as three distinct disorders.

The spectrum model of PDDs creates a unique challenge for categorical classification schemes such as those that are currently used in the DSM and ICD. Specifically, categorical systems require the delineation of meaningful categories using variables that are characterized as continuous. Imposing categorical boundaries on a continuous variable results in the loss of important information and creates arbitrary boundaries where none exist. An example of this distinction, provided by Cantwell and Rutter (1994) is the categorization of ID. An individual with an IQ of 68 is labeled “Mild ID,” but an individual with an IQ of 72 is classified as “Borderline Intellectual Functioning.” Despite being classified on opposite sides of the cutoff for ID, clinically meaningful differences likely do not exist between such individuals. In fact, the difference between these individuals (4 points on an IQ test) may be less than the differences between individuals within the same diagnostic category, which span a range of 10-15 points on an IQ test. Although categorical systems contribute to efficient communication and conceptual clarity of psychiatric disorders, they are inherently flawed due to the imposition of false dichotomies on continuous variables.

Categorical classification schemes are also limited in their treatment of subthreshold cases. Because categorical schemes require a specific set or a certain number of symptoms, there will always be individuals who miss the specified cutoff score. It is exactly this issue that gave rise to the development of the PDD-NOS category. As demonstrated in the aforementioned studies of the reliability and validity of the PDD-NOS criteria, the categorical approach of grouping all individuals who do not meet
criteria for other PDDs into one category can result in a less useful classification system. This issue is complicated, however, as the inclusion of subthreshold cases also represents a strength of our current system (Lord & Risi, 1998). Individuals with subthreshold PDD symptoms represent a large portion of the individuals with PDDs (Fombonne, 2005). Classification of these individuals is necessary in order to provide service and stimulate research. It is impossible to identify a cutoff that will result in perfect classification of all cases.

An additional limitation of the current diagnostic system for PDDs is that the diagnostic criteria are assumed to apply to individuals of all ages. Because PDDs are developmental disorders, there is a need for diagnostic criteria to apply to individuals across the age span. Several DSM-IV symptoms (poor peer relationships, limited conversational skills, and stereotyped language) may not be applicable to children with PDDs in infancy or young childhood (Stone, Lee, Ashford, Brissie, Hepburn, Coonrod, et al., 1999). Repetitive play, perseveration, preoccupations, and resistance to change may be similarly irrelevant to this age group, as children under three rarely display these behaviors (Dahlgren & Gillberg, 1989). Additionally, lack of varied, spontaneous make-believe play or social imitative play is difficult to operationalize for a young adult with PDD. Improvements to the current diagnostic system will likely include operationalized definitions of diagnostic criteria for individuals of different ages.

**Stability of Diagnosis**

In addition to the unclear diagnostic criteria for PDD-NOS, changes in the clinical manifestation of PDDs over time represent another challenge to the reliable diagnosis of PDD subtypes. Factors such as language and cognitive skill development contribute to
changes in the presentation of defining symptoms and can complicate reliable classification of subtypes (Lord & Corsello, 2005). Additionally, current diagnostic criteria are most appropriate for elementary school-age children with AD and mild to moderate ID (Lord & Corsello, 2005). Consequently, these criteria become less valid when applied to children at various ages and developmental levels. For example, the category of “resistance to change” behaviors are rarely seen in children under the age of three (Lord, Risi, DiLavore, Shulman, Thurm, & Pickles, 2006). Similarly, the symptom “impairment in the ability to initiate or sustain a conversation” is not appropriate for individuals with severe language or cognitive impairments.

Although diagnostic stability has been demonstrated for AD, diagnoses of PDD-NOS and Asperger’s Disorder are considerably less stable throughout childhood (Lord, 1995; Lord et al., 2006). Eaves and Ho (2004) examined the diagnostic stability of children from age 2 \(\frac{1}{2}\) to 4 \(\frac{1}{2}\) years. Of the 39 children diagnosed with AD at age 2 \(\frac{1}{2}\), 31 (79%) met criteria for AD two years later, two met criteria for PDD-NOS and one no longer received a PDD diagnosis. Of the nine children initially diagnosed with PDD-NOS, five were diagnosed with AD two years later, two retained the diagnosis of PDD-NOS, and two were not diagnosed with a PDD.

Lord et al. (2006) reported that of 46 children diagnosed with PDD-NOS at age two, at age nine 27 (59%) met criteria for AD, five (11%) no longer received a PDD diagnosis, and 14 (30%) continued to receive diagnoses of PDD-NOS. The majority of the changes in diagnoses occurred between the ages of two and five years. These researchers cited the unclear definition of PDD-NOS and the lack of delineation between
PDD-NOS, AD, and language disorders with autistic features as contributing to the lack of diagnostic stability of this disorder.

Finally, Kleinman, Ventola, Pandey, Verbalis, Barton, Hodgson, et al. (2008) found that of 15 children diagnosed with PDD-NOS around age two, only five (33%) retained the diagnosis approximately two years later. Eight children moved from a diagnosis of PDD-NOS to a non-PDD or no diagnosis, and two children received an AD diagnosis. The authors cited over-diagnosis at age two as a potential cause of the trend for children with PDD-NOS to move off the spectrum.

Studies examining developmental changes in the clinical presentation of children with PDDs have mainly focused on individuals with AD. Cross-sectional and longitudinal studies of preschoolers find that the type and number of PDD symptoms change with age in all three behavioral domains (Adrian, Lenior, Martineau, Perrot, Hameury, et al., 1993; Cox, Klein, Charman, Baird, Baron-Cohen, et al., 1999; Lord, 1995). The number of social and communication symptoms increase between the ages of two and five years, and repetitive behaviors generally do not appear prior to the age of three years. In the elementary school years, children with AD have been reported to show improvement in the communication domain, greater impairments in social interaction, and constant rates of repetitive behavior (Starr, Szatmari, Bryson, & Zwaigenbaum, 2003).

Two studies have examined developmental changes in symptoms in children with PDD-NOS. Lord et al. (2006) reported on 172 children who were diagnosed with AD (n=84), PDD-NOS (n=46), or non-spectrum diagnoses (n=42) at two years of age, and were reassessed with the ADI-R and ADOS at nine years of age. Similar age trends were
reported for children in the AD and PDD-NOS groups. On the ADI-R social domain, both groups showed an increase in scores with age. Scores on the nonverbal communication and repetitive behavior domains remained stable with age. On the ADOS social and communication domains, scores remained stable for both groups. On the ADOS repetitive behaviors domain, both groups showed a trend of decreasing scores with age.

Chawarska, Klin, Paul, and Volkmar (2007) investigated the stability of PDD symptoms between two and three years of age. Twenty-seven children between the ages of 14-25 months who were diagnosed with AD or PDD-NOS were reassessed at age three. Symptom stability was measured according to scores on the ADOS-G Module 1, which was administered at both time points. While significant improvement was found for both groups in the social and communication domain scores, children with PDD-NOS showed greater acquisition of social and language skills. Improvements in overall level of language and communication directed at others were found for both diagnostic groups. Play and stereotypic behaviors did not change over time. Limitations in the diagnostic stability of PDD-NOS may be due to greater changes in the syndrome expression of PDD-NOS as compared to AD.

Further studies examining the differences between PDD-NOS and AD with respect to symptom change are necessary. If different patterns of symptom trajectory are identified, this may provide evidence for the distinction between these disorders.

**Differential Diagnosis of PDD-NOS**

Clarification of PDD-NOS as a diagnostic category is difficult due not only to its similarity to other PDDs, but also due to its position on the edge of the boundary between
PDDs and similar disorders. In addition to other PDDs, differential diagnoses for PDD-NOS include other developmental disorders (DD), as well as disorders with a childhood onset that cause an impairment in one or more of the three PDD symptom domains. The disorders that are most similar to PDD-NOS will be described in the following paragraphs.

*Other Developmental Disorders*

*Language Disorders.* Developmental language disorders, such as Pragmatic Language Impairment (PLI), or Specific Language Impairment (SLI) can be confused with PDD-NOS due to similar impairments in communication skills. Both of these disorders are characterized by deficits in pragmatic language, or the use, content, and understanding of language. In addition, SLI is characterized by impairment in language acquisition (Tager-Flusberg, 2006). Deficits in the pragmatic aspects of communication have been consistently reported as a common communication deficit in individuals with PDD-NOS (Tager-Flusberg, Paul, & Lord, 2005). Bishop and Norbury (2002) found that children with PLI or SLI may be distinguished from those with PDD-NOS based on their pattern and trajectory of other PDD symptoms. These researchers found that the majority of PDD symptoms endorsed by children with PLI between the ages of 4-5 were those related to the communication domain (e.g., failing to ask for information, using stereotyped or idiosyncratic words). Symptoms endorsed by children with SLI at age 4-5 years had resolved between 3 and 4 years later.

It is understandable that language disorders might often be confused for PDD-NOS, as communication is by nature a social endeavor. Communication impairments can lead to social dysfunction, which increases the likelihood that such deficits will be
mistaken for a PDD (Snowling, Bishop, Stothard, Chipchase, & Kaplan, 2006). As reported by Bishop and Norbury (2002), however, the pattern and course of these symptoms can be distinguished from PDDs. PLI and SLI are terms best reserved for children whose primary impairment is in the acquisition of language or in the use of pragmatic language. Unfortunately, these are not diagnostic labels provided by the DSM-IV. Currently, the DSM-IV offers only five diagnostic classifications for communication disorders: Expressive Language Disorder, Mixed Receptive/Expressive Language Disorder, Phonological Disorder, Stuttering, and Communication Disorder, NOS. Reconciliation between psychiatric classification systems and the descriptions of language impairments used by communication specialists would allow for more reliable classification of children with communication disorders.

*Intellectual Disability (ID).* Similar to children with PDDs, children with ID often display language delays, social impairment, and stereotyped behavior in addition to their cognitive impairment (Einfeld & Tonge, 1996). It has been reported that in nearly 30% of individuals with ID also have a PDD (Bryson, Bradley, Thompson, & Wainwright, 2008). Other studies have reported that the incidence of PDDs is higher in individuals with more severe ID, suggesting that the severity of cognitive delay increases the risk for a comorbid PDD (de Bildt, Systema, Kraijer, & Minderaa, 2004). This association is true in the opposite direction as well. Individuals with PDDs who also have moderate ID map most closely onto current diagnostic criteria and are thought to represent “prototypical” autism. Assessment instruments for PDDs have the greatest accuracy in detecting this group of individuals (Lord & Corsello, 2005).
The mechanisms by which PDDs and ID are related are unclear. One hypothesis is that in some cases, these disorders may have shared a genetic etiology. Genetic disorders that are characterized in part by ID have also been demonstrated to occur at higher rates in individuals with PDDs as compared to the general population. The strongest associations exist for Fragile X and tuberous sclerosis (Bailey, Bolton, Butler, Le Couteur, Murphy, Scott, et al., 1993; Smalley, 1998). Additionally, studies that have demonstrated high concordance rates of autism between monozygotic and dizygotic twins have also demonstrated that PDD symptoms are more frequent if the proband also has ID (see Skuse, 2007, for a review). This trend suggests that the risk of displaying the full autism phenotype is increased if ID is present as well.

The dual diagnosis of ID and PDD is complicated by the substantial amount of behavioral overlap that can occur between these disorders. Low cognitive levels can account for less developed social and communicative behavior, as well as higher rates of repetitive behavior (DiLavore, Lord, & Rutter, 1995; Bodfish, Symons, Parker, & Lewis, 2000). Decisions as to when to diagnose PDD-NOS in addition to ID are generally made by considering an individual’s social and language impairment relative to their overall level of functioning (Towbin, 2005). This is often evaluated by comparing IQ scores to social or communication subscale scores of adaptive behavior instruments. Although specific impairment is usually defined as a 1.5 to 2 standard deviation discrepancy (as in the case of learning disorders), a universal definition of impairment in the case of PDDs does not exist (APA, 2000). With respect to restricted and repetitive behavior, studies suggest that sensory and motor mannerisms are more common in individuals with ID, whereas restricted interests and resistance to change might be more specific to PDDs.
Overall, the distinction between PDD and ID can be very challenging.

**Conditions with Childhood Onset**

**Attention Deficit Hyperactivity Disorder (ADHD).** ADHD symptoms in children with PDDs have been consistently reported (Gadow, Devincent, Pomeroy, & Azizian, 2004, 2005; Lecavalier, 2006; Luteijn, Serra, Jackson, Steenhuis, Althaus, Volkmar, et al. 2000). With respect to PDD-NOS, de Bruin, Ferdinand, Meester, de Nijs, and Verheij (2007) found that ADHD was co-morbid with PDD-NOS in nearly 45% of the sample. This is striking when considered in comparison with the general population rate of 2-11% for ADHD.

Similarities between children with ADHD and PDD-NOS include high rates of attention and social problems. In addition, Luteijn et al. (2000) found that 5-12 year-old children with PDD-NOS and those with ADHD had similar rates of ADHD symptoms as measured by the Child Behavior Checklist (CBCL; Achenbach & Edelbrock, 1991). Groups showed some overlap in terms of social problems, but the PDD-NOS group could be distinguished based on higher scores on the CBCL subscales measuring social problems and social withdrawal, as well as higher scores on caregiver-completed PDD rating scales.

Despite the recognition that attention and hyperactivity problems occur at high rates in children with PDD-NOS, the DSM-IV prohibits the diagnosis of both conditions, as it is assumed that these symptoms are secondary to the diagnosis of a PDD. Given that attention and hyperactivity problems are the most commonly-reported behavior problem
by parents and teachers of children with PDDs (Lecavalier, 2006), and the impairment imparted by such behavioral disturbance, it may be useful to consider revising this rule.

**Anxiety Disorders.** Studies examining rates of anxiety symptoms in children with PDDs have established that they are relatively common, with rates varying between 14-84% of PDD samples demonstrating significant anxiety symptoms (Muris, Steerneman, Merklebach, Holdrinet, & Meesters, 1998; Kim et al., 2000; Gadow et al., 2004, 2005; Lecavalier, 2006; deBruin et al., 2007; Sukhodolsky, Scahill, Gadow, Arnold, Aman, McDougle, et al., 2008). With respect to PDD-NOS specifically, de Bruin et al. (2007) found that of a sample of 94 children between the ages of 6-12 years, 55.3% met criteria for at least one anxiety disorder according to ratings on the Diagnostic Interview Schedule for Children (DISC-IV; Schaffer, Fisher, & Lucas, 1998). The most common comorbid anxiety disorder was simple phobia (38.3%), followed by social phobia (11%), Separation Anxiety Disorder (8.5%), Social Anxiety Disorder (6.4%), Obsessive-Compulsive Disorder (6.4%), and Generalized Anxiety Disorder (5.3%).

Although children with anxiety disorders can exhibit impairments in social functioning, these impairments are of a different nature as compared to the social impairments of PDDs. The social behavior of children with anxiety disorders related to socialization (social phobia, separation anxiety, social anxiety) is characterized by extreme shyness or worries about what others will think of them, as compared to the avoidance and aloofness often seen in children with PDDs (Gilliot, Furniss, & Walter, 2001). Additionally, children with anxiety disorders usually have a normal developmental history with respect to language development and imaginative play, and do not exhibit restricted and repetitive behaviors.
Because PDDs and Obsessive-Compulsive Disorder both share the symptom of repetitive behaviors, these two disorders can be somewhat challenging to distinguish. In the case of Obsessive-Compulsive Disorder, however, restricted and repetitive behavior or stereotyped behavior may be evident, but will generally occur without social or communication deficits. Additionally, in children with PDDs, engaging in the repetitive behavior is usually enjoyable, whereas in children with Obsessive-Compulsive Disorder, it is a source of significant anxiety.

*Mood Disorders.* Symptoms of depression have been reported in individuals with PDDs (Gadow et al., 2004, 2005; Ghaziuddin & Greden, 1998; Ghaziuddin, Alessi & Greden, 1995; Kim et al. 2000). However, relatively little research attention has been given towards rates of depression in children with PDD-NOS. de Bruin et al. (2007) reported that 19.1% of their sample met criteria for a mood disorder. Major depression occurred most frequently (10.6%), followed by Mania (3.2%), Hypomania (3.2%), and Dysthymic Disorder (2.1%). Similar to anxiety disorders, PDD-NOS can be distinguished from mood disorders based on developmental history, a primary impairment in social reciprocity, and the presence of communication deficits or restricted and repetitive behaviors.

*Schizophrenia.* In the study by de Bruin et al. (2007), none of the children with PDD-NOS met criteria for schizophrenia. However, 5.4% of the sample presented with hallucinations and 3.2% presented with delusions. The DSM-IV precludes schizophrenia and PDD-NOS to be diagnosed as comorbid conditions. If an individual with PDD-NOS meets criteria for schizophrenia, it trumps the PDD diagnosis and only the diagnosis of schizophrenia is given (APA, 2000).
A useful classification system for PDDs will not only clarify its boundaries with AD, but will also distinguish it from closely-related disorders. Studies of differences between PDD subtypes should include a comparison group composed of individuals with disorders that share some characteristics of PDDs, such as those listed above.

*Proposed Refinements to the Current Definitions of PDDs*

Two methods have been used to refine the current definitions of PDDs. Some groups have used clinical/conceptual methods, which rely on clinical observations of patterns in symptomology to classify subtypes. Others have used empirical/statistical methods to refine the classification of PDDs. Multivariate statistics, such as factor analysis and cluster analysis, have been employed to identify latent dimensions that account for the heterogeneity in PDDs and to derive homogenous subgroups of individuals with PDDs based on multiple descriptive variables.

Two research groups have used clinical methods to propose revisions to the diagnostic criteria for PDDs included in the DSM-IV and ICD-10 (Buitelaar, Van der Gaag, Klin, & Volkmann 1999; Walker, Thompson, Zwaigenbaum, Goldberg, Bryson, Mahoney et al., 2004). Buitelaar et al. (1999) used data from the DSM-IV field trials for AD to develop a diagnostic algorithm for PDD-NOS. DSM-IV and ICD-10 diagnostic criteria for AD were compared between subjects diagnosed with AD (n = 205), PDD-NOS (n = 80), or DD (n = 174). Participants included children and adults. All participants had an IQ greater than 50 and the AD group had a significantly lower IQ than the PDD-NOS group.

The most effective diagnostic algorithm was derived from a set of seven items that most effectively discriminated PDD-NOS from AD and other DDs. The seven
criteria included four items from the social impairment domain: (1) *marked impairment in the use of multiple non-verbal behaviors to regulate social interaction*, (2) *failure to develop peer relationships appropriate to developmental level*, (3) *lack of spontaneous seeking to share enjoyment*, and (4) *lack of social or emotional reciprocity*; two items from the communication impairment domain: (1) *impairment in the ability to initiate or sustain a conversation*, (2) *stereotyped and repetitive use of language or idiosyncratic language*; and one item from the restricted/repetitive behaviors domain (*stereotyped and repetitive motor mannerisms*). The scoring rule of at least three endorsed criteria with at least one item from the social impairment domain correctly classified 77% of the sample, with a sensitivity of .71 and a specificity of .79. When the age of onset criterion was included, specificity increased but sensitivity decreased such that too few cases of PDD-NOS were identified.

Four of the identified criteria for PDD-NOS were significantly associated with cognitive functioning (*failure to use non-verbal behavior, failure to develop peer relationships, lack of shared enjoyment, stereotyped motor mannerisms*). These criteria were more frequently endorsed by lower functioning individuals. Because this diagnostic algorithm was developed in subjects with an IQ above 50, it may not generalize to individuals with PDDs who have greater degrees of ID.

The authors concluded that while these classification rules for PDD-NOS provide a starting point for further work in this area, the sensitivity and specificity of this diagnostic algorithm is not yet ideal. It was noted that the algorithm for PDD-NOS may be improved by examining the diagnostic utility of symptoms that are not currently included in PDD classification systems of DSM-IV and ICD-10. Examples of such
symptoms include those in the domains of affective responses, anxiety, thought disorders, and imagination.

Walker et al. (2004) also made suggestions for revising the DSM criteria for PDDs. This group used a sample of children with PDD-NOS (n=21), AD (n=216), and Asperger’s Disorder (n=33) who were participating in a genetic study of PDDs. Diagnoses were made based on the following algorithms: AD was diagnosed according to DSM-IV criteria; Asperger’s Disorder was diagnosed based on DSM-IV criteria, with the lack of deficits in functioning and language defined as an IQ greater than 70 and phrase speech by 36 months; PDD-NOS was diagnosed when the symptom or age of onset criteria for AD was not met. If a child met criteria for AD and Asperger’s Disorder, a diagnosis of the latter was given. Diagnostic groups were compared on level of functioning (adaptive behavior, IQ, and age of language acquisition) and PDD symptoms.

Based on the results of these comparisons, Walker et al. suggested three changes to the DSM-IV that would contribute to better characterization of children with PDD-NOS. They suggested that the term ‘atypical autism’ be used to describe children who present with social impairments and language delays but few or no repetitive behaviors. Approximately 50% of the PDD-NOS sample in this study met this description. The second change was to use the diagnosis of Asperger’s Disorder to describe individuals with social impairments, symptoms of restricted and repetitive behaviors and the absence of current language impairment. This description characterized approximately 25% of the PDD-NOS sample. A diagnosis of PDD-NOS could then be reserved for children for whom the diagnostic criteria were not applicable due to young age or severe developmental or cognitive delays, or for children with a late age of onset. In this
diagnostic scheme, PDD-NOS would be used only if there was not sufficient clinical information to make a more specific diagnosis.

The recommendations by Walker et al. (2004) must be interpreted in light of the limitations of the study. The generalizability of their results is unclear, as the sample of children with PDD-NOS was quite small, and it was composed of children recruited for a genetic study of families with one or more children with a PDD. Additionally, Walker et al. classified groups according to a diagnostic algorithm that was unique to their study. It is unclear how well the results would replicate in a sample of children who were diagnosed according to standard criteria.

Tanguay, Robertson, and Derrick (1998) offered an alternative to the DSM classification system that aimed to classify the milder forms of PDDs better. Their sample included 63 individuals (n=32 AD, n=14 Asperger’s Disorder, n=17 PDD-NOS) between the ages of 3-16 years. Subjects were rated on a DSM-IV rating scale and were administered the ADI-R. A factor analysis was performed using 28 items from the ADI-R assessing social communication deficits. Correlations between the factors identified in the factor analysis and the DSM-IV symptoms endorsed, as well as the patterns of symptoms endorsed for each PDD subtype were examined in order to evaluate the current classification system.

Results of the factor analysis indicated that the social communication deficits assessed by the ADI-R are composed of three factors: affective reciprocity, joint attention, and theory of mind. These three factors were highly correlated with symptom endorsements in the DSM-IV domain of social interaction. The authors concluded that
the social interaction domain of the DSM-IV was a good representation of social communication skills that are impaired in PDDs.

The communication domain of the DSM-IV demonstrated weaker correlations with the social communication factors identified. It was noted that the DSM-IV communication items assess semantic and syntactic deficits in addition to social communication deficits. It was suggested that items assessing semantic/syntactic skills be removed from the PDD communication domain and that a lack of these skills be indicated as a comorbid developmental language disorder.

Not surprisingly, the restricted/repetitive behavior domain of the DSM-IV was not strongly correlated with the social communication factors. Additionally, most children with PDD-NOS did not have impairments in this domain. The authors suggested that this domain is not useful in the classification of PDD-NOS.

Based on these results, in a subsequent paper, Tanguay (2004) proposed that PDDs should be conceptualized as disorders of social communication. This conclusion must be interpreted in light of the methodological limitations of this study, however. Because Tanguay et al. (1998) only used ADI-R items from the social communication domain, it is expected that the highest correlations would be with the social and communication domains of the DSM-IV. Additionally, as acknowledged in his 2004 paper, the 1998 study had a small sample size, which is problematic when using factor analysis, as it can lead to inaccurate recovery of factors (MacCallum, Widaman, Zhang & Hong, 1999).

Several studies have attempted to identify PDD subtypes using cluster analysis (Eaves, Ho, and Eaves, 1994; Sevin, Matson, Coe, Love, Mateese, & Benavidez, 1995;
Prior et al., 1998; Fein, Stevens, Dunn, Waterhouse, Allen, Rapin, & Feinstein, 1999; Stevens, Fein, Dunn, Allen, Waterhouse, Feinstein, & Rapin, 2000; Bitsika, Sharpley, & Orapeleng, 2008). However, the usefulness of these studies in refining the current classification system has been limited by their use of DSM-III or DSM-III-R criteria to diagnose participants and the exclusion of children with PDD-NOS.

Shen, Lee, Holden, and Shatkay (2007) used hierarchical and k-means clustering methods to analyze 64 items from the ADI-R. The sample included 358 individuals (n=125 AD, n=27 Asperger’s Disorder, n=16 PDD-NOS, n=40 PDD, n=2 ADHD). The authors did not specify the difference between PDD and PDD-NOS. Four clusters were identified that ranged in terms of overall symptom severity and language acquisition. Children with AD comprised the largest number of subjects in clusters 1, 3, and 4, which were characterized by severe to moderately severe PDD symptoms, and communication deficits ranging from no verbal speech to delayed verbal development. Children with PDD-NOS and Asperger’s Disorder were classified into cluster 2, which was characterized by the least severe PDD symptoms and normal language acquisition. Shen et al. concluded that these results indicate that PDDs subtypes should be conceptualized not as discrete categories but a spectrum of impairment that ranges from nearly normal (PDD-NOS and Asperger’s Disorder) to highly impaired (AD). These results must be interpreted with caution, however, as the children with unspecified PDD and ADHD likely represented outliers in the data, which has been shown to negatively affect cluster recovery (Milligan & Cooper, 1987). Additionally, the sample size of individuals with PDD-NOS was quite small.
Verte, Geurts, Roeyers, Rosseel, Oosterlaan, and Sergeant (2006) performed a cluster analysis of ADI-R subscale scores. The sample included 57 children diagnosed with AD, 47 with Asperger’s Disorder, and 31 with PDD-NOS. The age range of the sample was 6-13 years and all children had an IQ above 80. A three cluster solution was selected. Cluster one was composed mostly of children with AD, cluster two was composed of children with AD or Asperger’s Disorder, and cluster three contained the majority of the children with PDD-NOS. The AD cluster was characterized by the highest scores on the ADI-R subscales measuring social impairment and repetitive behaviors, but it had similar scores on the communication subscales as the AD/Asperger’s Disorder cluster. The PDD-NOS cluster had the lowest scores on subscales measuring all three symptom domains.

Verte et al. suggested that these results indicate that the distinction between AD and Asperger’s Disorder is not useful, and that PDD-NOS represents children with the mildest PDD symptoms. The authors argued that categorical distinctions between subtypes are only useful for distinguishing between high-functioning and low-functioning subgroups based on PDD symptom severity. The restriction of range of IQ in this study makes it difficult to know how these results would compare to a study including children with PDDs who also have ID. This is a significant limitation, as this represents the majority of the PDD population. An additional limitation is that the ADI-R was used to diagnose the participants in this study. Because differences in symptom severity defined the diagnostic groups, it is not surprising that these differences emerged in the cluster analysis.
To summarize, cluster analytic studies suggest that the diagnostic category of PDD-NOS is represented by fewer PDD symptoms as compared to AD. However, methodological limitations, such as small sample sizes, the inclusion of outliers, and circularity of methods, prevent clear interpretation and generalizability of results.

Beglinger and Smith (2001) proposed a classification model for PDDs based on a review of the literature regarding PDD subtyping systems. The literature review suggested several consistent findings: (a) subtyping studies indicated that developmental level accounts for the largest proportion of variance in PDD symptomology, (b) most cluster analytic studies support three or four subtypes, and (c) most studies support a dimensional rather than categorical conceptualization of PDDs. Based on these conclusions, Beglinger and Smith proposed a model that was composed of three dimensions: developmental level, social features, and restricted/repetitive behavior. Individuals could be classified according to four subtypes based on impairment with respect to these three dimensions. The subtypes were stratified according to IQ scores (less than 50, 50-60, 60-70, and above 70) and from most to least severe PDD symptomology.

At present, such dimensional models of PDDs are conceptual in nature. It is not clear how these models will be reconciled with the categorical system currently in place. In order for this to happen, cutoff scores within the proposed dimensions will need to be identified. It should be emphasized that, whereas these models might improve upon categorical systems in that they do not presume that discrete subgroups exist, they are still subject to the problems inherent in imposing boundaries on a continuous variable.
A substantial amount of controversy continues to surround the classification of PDDs. Continued work in this area will benefit from well-designed studies comparing PDD subtypes on core symptoms as well as associated behaviors. A possible next step for a dimensional model might be the identification of additional salient dimensions that will contribute to the characterization of individuals on the autism spectrum.

Investigations of the Role of IQ in Uncovering PDD Subtypes

A review of the literature on the validity of the distinction between AD, PDD-NOS, and Asperger’s Disorder highlighted the role of IQ in distinguishing subtypes (Witwer & Lecavalier, 2008). These authors reviewed 22 studies that compared subtypes on clinical and demographic characteristics, neuropsychological profiles, comorbidity, and prognosis. Interpretable patterns of differences across subtypes were not found, as cognitive functioning was not consistently controlled across studies. It was concluded that the differences between subtypes might be better explained by IQ, as opposed to true differences between groups.

Only one study has examined the possibility that PDDs can be subtyped based on IQ. Munson, Dawson, Sterling, Beauchaine, Zhou, Kohler, et al. (2008) used latent class analysis and taxometric methods to classify 456 children with PDDs based on Mullen IQ scores. Evidence was found for four groups that were characterized by overall level of functioning and the magnitude of discrepancy between verbal and nonverbal IQ scores. Group One had the lowest overall level of functioning, with lower nonverbal IQs than verbal IQs. Group Two had low verbal IQs but significantly higher nonverbal IQ scores. Group Three had mild to moderate impairments in overall cognitive functioning with no verbal/nonverbal discrepancy, and Group Four had low average cognitive functioning.
with no discrepancy in verbal/nonverbal scores. Scores on the Vineland Adaptive Behavior Scales, ADOS, and ADI-R showed the greatest impairment in Group one, with impairment decreasing across Groups two to four. Authors of this study concluded that these results provide evidence that distinct subtypes of autism can be identified based on IQ profiles.

The study by Munson et al. (2008) underscores the importance of considering the role of cognitive functioning when examining PDD subtypes. If variability in IQ is the most salient predictor of the clinical picture of PDDs, then this metric should be included in the nosology of PDDs. Further work is necessary to uncover the role of IQ in discriminating current PDD subtypes. The extent to which level of functioning is associated with different symptom domains and whether these associations are specific to individuals with PDDs is a necessary area of focus.

**PDD Subtype Differences**

**Core PDD Symptoms**

*Impairment in Social Interactions.* Several studies have compared the symptom profile of children with PDDs using the ADI-R and the ADOS-G (Chakrabarti & Fombonne, 2005; deBruin, Verheij, & Ferdinand, 2006; Lord, Risi, Lambrecht, Cook, Leventhal, DiLavore, et al. 2000; Robertson, Tanguay, L’Ecuyer, Sims, & Waltrip, 1999; Walker et al., 2004). Results from these studies uniformly show that children with PDD-NOS show significantly fewer severe social impairment than children with AD. Children with PDD-NOS have also been found to show less severe social symptoms than children with AD on other measures of core PDD symptoms, such as the Autism Behavior Checklist (ABC; Krug, Arick, & Almond, 1980), Early Childhood Inventory – Fourth
Edition (ECI-4; Gadow & Sprafkin, 1997, 2000), and the Child Symptom Inventory – Fourth Edition (CSI-4; Gadow & Sprafkin, 2002) (Gadow et al., 2004; Gadow et al., 2005; Walker et al., 2004).

The results are less clear when comparing PDD-NOS to Asperger’s Disorder. Of four studies that compared PDD-NOS and Asperger’s Disorder on ADI-R and ADOS scores, three found that children with PDD-NOS had less severe social impairment (deBruin et al., 2006; Robertson et al., 1999; Walker et al., 2004) and one found that these groups showed equal levels of social impairment (Chakrabarti & Fombonne, 2005). A comparison of ABC scores indicated that children with PDD-NOS showed significantly fewer social symptoms than children with Asperger’s Disorder (Walker et al., 2004).

The examination of subtype differences in social impairment is relevant to the theoretical notion of the autism spectrum. Social communication (Tanguay et al., 1998) and social reciprocity (Wing & Gould, 1979) have been proposed as severity metrics for the autism spectrum. However, the metric of social impairment has typically been strongly associated with IQ, suggesting that differences between subtypes may be an artifact of IQ rather than true differences in social ability (Borden & Ollendick, 1994; Tanguay et al., 1998). Of the aforementioned studies, only one matched groups on IQ (Lord et al., 2000). Because of this methodological flaw, it cannot be concluded if differences in social impairment are due to IQ or represent true differences between groups.

Communication Impairments. A similar pattern between PDD subtypes emerges for communication symptoms. Studies using the ADI-R and ADOS consistently show
that children with PDD-NOS have less severe communication symptoms than children with AD and Asperger’s Disorder, although these differences do not reach statistical significance (Chakrabarti & Fombonne, 2005; deBruin et al., 2006; Lord et al., 2000; Lord et al., 2006; Walker et al., 2004). As stated previously, these results may be due to the use of diagnostic measures in the examination of subtype differences. Defining groups based on the number of symptoms and then comparing them based on the same measures is a circular process.

Two studies examined differences in communication symptoms using measures that are not used diagnostically. Less severe communication symptoms in children with PDD-NOS compared to AD and Asperger’s Disorder were reported in a study using the ABC (Walker et al., 2000). However, in this study, PDD-NOS group had significantly higher IQ scores as compared to the AD group, which may have influenced the differences in communication symptoms between groups. Conflicting results were reported by Gadow et al. (2004, 2005), who found that children with PDD-NOS had greater communication deficits impairments than children with Asperger’s Disorder on the CSI-4 and ECI-4.

Only one study has controlled for IQ and used a non-diagnostic measure in an examination of subtype differences on communication impairment. Verte et al. (2006) examined the profiles of children with high-functioning AD (n = 57), PDD-NOS (n = 31), or Asperger’s Disorder (n = 47) on the Children’s Communication Checklist (CCC; Bishop, 1998). All children had an IQ above 80. The CCC is a measure of pragmatic language that assesses language impairments associated with PDDs. In general, the
scores for children with PDD-NOS fell between those for children with AD and Asperger’s Disorder, but significant differences between subtypes did not emerge.

Restricted and Repetitive Behaviors. Studies using the ADI-R and ADOS to compare repetitive behaviors between subtypes generally report that children with AD or Asperger’s Disorder have a greater number of repetitive behaviors than children with PDD-NOS. Chakrabarti and Fombonne (2005) found that children with Asperger’s Disorder had the greatest number of repetitive behavior symptoms on the ADI-R, followed by children with AD, whereas children with PDD-NOS had the fewest symptoms. These differences were not statistically significant. De Bruin et al (2006) found that children with AD had the greatest number of symptoms, and those with Asperger’s Disorder or PDD-NOS had equally severe symptoms. A significant difference was only found between AD and PDD-NOS groups. Walker et al. (2000) found that children with AD and Asperger’s Disorder had significantly more repetitive behavior symptoms than children with PDD-NOS. Lord et al. (2000) found that when groups were matched on IQ, there was not a significant difference in repetitive behaviors (mannerisms, sensory behaviors, and repetitive interests and behaviors) between children with PDD-NOS or AD on the ADOS-G. When IQ is controlled, it appears that subtype differences in repetitive behaviors disappear. An unresolved issue is whether subtype differences in restricted and repetitive behavior exist when these symptoms are measured using a tool that is not used diagnostically.

In summary, results of subtype differences in core PDD symptoms indicate that children with PDD-NOS have fewer social, communication, and restricted/repetitive behavior symptoms than those with AD. However, these results are difficult to interpret.
due to the use of a diagnostic measure as the dependent variable, differences in IQ between subtypes, and the use of only high-functioning groups. Studies that examine subtype differences in PDD symptoms using groups matched on level of functioning and a measure that is not used diagnostically are missing from the current literature.

Psychiatric and Behavior Problems

Studies of children and adolescents with PDDs indicate that several psychiatric symptoms and disorders occur at greater rate in individuals with PDDs as compared to the typical population (Gadow et al., 2004; Gadow et al., 2005). These include obsessive-compulsive disorders (McDougle, Kresch, Goodman, Naylor, Volkmar, et al., 1995), mood disorders (Lainhart & Folstein, 1994), anxiety and fears (Weisbrot, Gadow, DeVincent, & Pomeroy, 2005) and ADHD symptoms such as inattention, impulsivity, and hyperactivity (Gillberg & Billstedt, 2000). Additionally, children with PDDs often exhibit problem behaviors such as overactivity, conduct problems (including defiance, stubbornness, arguing, tantrums, aggression, and property destruction), and self-injurious behavior (Lecavalier, 2006).

Four studies have examined differences in psychiatric symptoms between PDD subtypes. Gadow et al. (2004) used the ECI-4 to compare DSM-IV symptoms in a sample of 3-5 year old children with AD (n=67), Asperger’s Disorder (n=24), or PDD-NOS (n=91). Relatively few differences in psychiatric symptoms emerged between groups. Children with PDD-NOS had significantly fewer compulsions and vocal and motor tics than the AD group.

A subsequent study by this group examined the rate of psychiatric symptoms in 6-12 year old children with AD (n = 103), Asperger’s Disorder (n = 80), or PDD-NOS (n
Compared to children with AD, children with PDD-NOS had more symptoms of oppositional defiant disorder, obsessions, major depressive disorders, and dysthymia.

Weisbrot et al. (2005) examined symptoms of anxiety and psychosis in children with AD, Asperger’s Disorder, or PDD-NOS. The sample was divided by age into children between the ages of 3-5 years and those between the ages of 6-12 years. In the younger group, significant differences in symptoms of anxiety or psychosis were not found between PDD subtypes. In the older group, children with PDD-NOS were rated significantly higher than children with AD on symptoms of GAD and obsessions. Children with PDD-NOS also demonstrated significantly higher scores on delusions and significantly lower scores on grossly disorganized behavior than children with AD.

None of the studies that have examined subtype differences in psychiatric disorders have controlled for level of functioning. The results of the studies on subtype differences in psychiatric symptoms should be interpreted with caution, as these differences may be due to level of functioning. Studies of subtype differences on behavior problems are lacking in the current literature.

The effect of level of functioning on psychiatric and behavioral problems has been demonstrated in other studies, which found that as level of functioning decreased, anxiety and depression symptoms decreased and hyperactivity, self-injury/stereotypies, self-isolated/ritualistic behavior, and conduct problems increased (Brereton, Tonge, & Einfeld, 2006; Lecavalier, 2006). Sukhodolsky et al. (2007) found that higher levels of anxiety were associated with higher IQ and the presence of functional language use.
Cognitive and Adaptive Functioning

Approximately 40% of children with PDDs function in the range of ID (Bryson & Smith, 1998). Rates of ID differ between PDD subtypes. In an epidemiological study of PDDs, Chakrabarti and Fombonne (2001) found that 69% of their AD group functioned in the range of ID, compared to only 8% of the PDD-NOS group. This study suggested that individuals with PDD-NOS were typically higher functioning than those with AD.

Only one study has compared adaptive functioning between subtypes. Walker et al. (2004) found that compared to children with AD, children with PDD-NOS had higher scores on the communication, daily living skills and socialization subscales of the Vineland Adaptive Behavior Scales (Sparrow, Balla, & Cicchetti, 1984). Children with PDD-NOS also had significantly earlier acquisition of language skills. These results are difficult to interpret, as adaptive behavior and IQ are correlated, and children in the PDD-NOS group had significantly higher IQ scores as compared to the AD group in this study.

The importance of including adaptive behavior in the diagnostic assessment of PDDs was recently demonstrated by Tomanik, Pearson, Loveland, Lane, and Shaw (2007). These authors examined the utility of using adaptive behavior scores in addition to the ADI-R and ADOS-G when diagnosing AD (n=65 AD, n=52 non-PDD). Adaptive behavior scores for children who were classified as False Negatives (the autism cutoff is met on the ADI-R but not for the ADOS) were lower than the scores for the True Negatives (autism cutoff is not met for the ADI-R or ADOS). Discriminant analyses were performed using the ADOS alone or the ADOS in combination with the Communication, Socialization, and Daily Living Skills domains of adaptive behavior. Results indicated that adding the adaptive behavior scores to the ADOS improved diagnostic accuracy by
9%. The authors suggested that the use of an adaptive behavior scale may improve diagnostic classification by converting False Negatives to True Positives based on their lower adaptive behavior scores.

A summary of the reviewed studies of subtype differences are presented in Table 1. The current literature regarding differences between subtypes on the core PDD symptoms, psychiatric and behavioral problems, and adaptive functioning is difficult to interpret due to differences in the treatment of IQ. Eight out of the ten studies reviewed did not control for IQ across subtypes. It is possible that the reported differences are due to level of functioning. Overall, conclusions regarding the validity of the distinction between AD and PDD-NOS are limited by differences between groups in levels of functioning and the use of the dependent measure to make the diagnosis.
<table>
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<th>Study</th>
<th>Sample Size</th>
<th>Age Range</th>
<th>Mean IQ</th>
<th>IQ Controlled?</th>
<th>IQ Differences</th>
<th>Measures</th>
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<td></td>
<td>non-PDD: 99 (15.6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>80 Asperger’s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>191 Other DSM-IV psychiatric dx</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lord et al. (2000)</td>
<td>98 AD</td>
<td>1.5-40 years</td>
<td>*AD: 94.1 (28.2)</td>
<td>Yes, matched on VIQ</td>
<td>None</td>
<td>ADOS-G</td>
</tr>
<tr>
<td></td>
<td>69 PDD-NOS</td>
<td></td>
<td>PDD-NOS: 105.2 (21.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>66 Other DD</td>
<td></td>
<td>Non-PDD: 103.8 (27.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lord et al. (2006)</td>
<td>84 AD</td>
<td>2-9 years</td>
<td>*AD: 63.3 (16.9)</td>
<td>No</td>
<td>Not Compared</td>
<td>ADI-R</td>
</tr>
<tr>
<td></td>
<td>46 PDD-NOS</td>
<td></td>
<td>PDD-NOS: 74.0 (22.3)</td>
<td></td>
<td></td>
<td>ADOS</td>
</tr>
<tr>
<td></td>
<td>42 Other DD</td>
<td></td>
<td>Non-PDD: 72.7 (26.5)</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Table 1. Summary of Reviewed Studies of Subtype Differences in PDD Symptoms, Psychiatric and Behavior Problems, and Adaptive Behavior

Continued
<table>
<thead>
<tr>
<th>Reference</th>
<th>Sample</th>
<th>Age Range</th>
<th>NVIQ</th>
<th>IQ &gt; 80</th>
<th>Comparison</th>
<th>ADI-R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robertson et al. (1999)</td>
<td>22 AD</td>
<td>3-16 years</td>
<td>88% &gt; 70</td>
<td>No</td>
<td>Not Compared</td>
<td>ADOS</td>
</tr>
<tr>
<td></td>
<td>12 PDD-NOS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>17 Asperger’s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verte et al. (2006)</td>
<td>57 AD</td>
<td>6-13 years</td>
<td>AD: 98.9 (17.6)</td>
<td>Yes, IQ&gt;80</td>
<td>PDD&lt;non-PDD</td>
<td>CCC</td>
</tr>
<tr>
<td></td>
<td>31 PDD-NOS</td>
<td></td>
<td>PDD-NOS: 98.0 (14.7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>47 Asperger’s</td>
<td></td>
<td>Asperger’s: 105.7 (16.3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>47 “Normal Controls”</td>
<td></td>
<td>Non-PDD: 112.1 (9.7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walker et al. (2004)</td>
<td>216 AD</td>
<td>AD: 99.0 mo</td>
<td>67.0 (30.5)</td>
<td>No</td>
<td>AD&lt;PDD-NOS</td>
<td>ADI-R</td>
</tr>
<tr>
<td></td>
<td>21 PDD-NOS</td>
<td>PDD-NOS: 86.3</td>
<td>PDD-NOS:82.4 (33.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>33 Asperger’s</td>
<td>Asperger’s: 117.2</td>
<td>Asperger’s: 89.5 (23.1)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ABC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>VABS</td>
</tr>
<tr>
<td>Weisbrot et al. (2005)</td>
<td>170 AD</td>
<td>3-12 years</td>
<td>3-5 years: PDD: 79 (22.7)</td>
<td>Non-PDD&gt;PDD</td>
<td>ECI-4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>209 PDD-NOS</td>
<td></td>
<td>non-PDD: 92 (14.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>104 Asperger’s</td>
<td></td>
<td>6-12 years: PDD: 87 (25.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>326 Other DSM-IV psychiatric dx</td>
<td></td>
<td>non-PDD: 98 (15.8)</td>
<td></td>
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</tr>
</tbody>
</table>

*mean NVIQ scores reported for a subset of the total sample
Importance of a Reliable and Valid Taxonomy

A reliable and valid classification system of PDDs is necessary for several reasons. In order for a classification system to be useful for research, it must be reliable (Cantwell, 1996). Researchers require a reliable classification system in order to ensure that studies are carried out on consistently defined groups of individuals. As previously discussed, the current taxonomy of PDDs has led to considerable confusion among clinicians regarding the discrimination of PDD subtypes. In the absence of reliable and valid diagnostic criteria, researchers are forced to create their own methods for diagnosing PDD subtypes. This results in inconsistency between research groups and prevents replication efforts and the generalization of results. In order for studies of PDD subtypes to inform future research, they need to be interpretable, which requires the use of a common diagnostic language.

Specifically, the identification of more homogenous subgroups may aid researchers in facilitating the discovery of the underlying causes of PDDs. Researchers investigating the etiology of psychiatric disorders seek to establish the relationship between the genotype (underlying cause) and the phenotype (clinical presentation) of the disorder. Genetic research indicates that PDDs demonstrate significant genetic heterogeneity, with several genes interacting to form the phenotype (Happé, Ronald, & Plomin, 2006). Several researchers have argued that a more homogenous etiology might be discovered if the phenotypic variability of PDDs is reduced (Abrahams & Geshwind, 2008). Clinically well-characterized subtypes will aid in the detection of genetic and biological markers that correspond to distinct PDD phenotypes (Geschwind, 2009). Identification of biomarkers implicated in PDDs will allow for earlier identification of
those at risk for PDD to facilitate early therapeutic intervention. Additionally, distinct etiologic subtypes can be defined which will be more informative for research than the current, subjective, DSM diagnoses. Without a reliable definition of the disorder, studies of the etiology, course, and response to treatment are impossible.

Despite the growing body of research on the biological and genetic markers of PDDs, the heterogeneity within this group of disorders poses a significant challenge for this research. Even the most promising biological and genetic markers only account for a small percentage of PDD cases (Geschwind, 2009). Behavioral descriptions will continue to be a necessary and primary method of the classification of PDDs.

From a clinical standpoint, a reliable and valid classification system enhances communication between clinicians and researchers and improves the diagnostic process. To the extent that the behavioral indicators included in a classification system are specific, reliable, and valid indicators of a disorder, they facilitate more consistent use of diagnostic labels on the part of researchers and clinicians. This improves the translation of research evidence into clinical practice. Additionally, classification schemes have implications for legal mandates for services. Entitlement to educational and treatment services as well as reimbursement for such services is dependent upon diagnostic labels (Volkmar, 1998).

Establishing Diagnostic Validity

According to Robins and Guze (1970), the first step in determining the diagnostic validity of a psychiatric disorder is to describe its clinical picture. This includes identifying behavioral features of the disorder, as well as other associated variables, such as race, sex, age of onset, and etiological factors. Clinical and associated features are
integrated to form a reliable definition of the disorder. Differences between disorders with respect to these variables provide initial support for their validity. As discussed earlier, the current clinical description of PDD-NOS is insufficient and does not reliably distinguish it from closely related disorders.

Further validation of psychiatric disorders is achieved by conducting laboratory studies, which include the administration of reliable psychological measures as well as measures of biological, chemical, physiological, and anatomical features. Robins and Guze (1970) noted that the value of conducting studies on these external variables is reduced if a clinical picture of the disorder has not been previously defined. Laboratory studies of PDD-NOS have included neuropsychological and neuroimaging studies (see Volkmar, Lord, Bailey, Schultz, & Klin, 2004). These studies have not found differences between AD and PDD-NOS on measures of neuropsychological attributes, such as joint attention, executive function, gaze fixation, or theory of mind (Dawson, Munson, Estes, Osterling, McPartland, Toth et al. 2002; Dawson, Carver, Meltzoff, Panagiotides, McPartland, & Webb, 2002; van der Geest, Kemner, Verbaten, & van Engeland, 2002, also see Witwer & Lecavalier, 2008). Similarly, neuroimaging studies indicate that differences are found when groups are classified based on IQ rather than by PDD subtype (Gillberg, 1992; Reiss, Abrams, Singer, Ross, & Denckla, 1996; Sparks, Friedman, Shaw, Aylward, Echelard, Artru et al., 2002).

A reliable definition of a disorder, including clinical and associated features, as well as laboratory studies, is the basis for the third phase in the process, which is to distinguish the behavioral profile of the disorder from different but perhaps closely-related disorders. In the case of PDDs, closely-related disorders include those listed
earlier as differential diagnoses. Studies that aim to describe PDD-NOS better and to
differentiate it from AD and related disorders satisfy these first three phases of the

The fourth and fifth phases are to conduct follow-up and family studies in order to
determine the outcome of the disorder and the extent to which it runs in families. Genetic
research to date indicates that PDD-NOS and AD have similar patterns of inheritance.
Family studies indicate that siblings of individuals diagnosed with AD are equally likely
to receive a diagnosis of PDD-NOS as they are to receive an AD diagnosis (Bailey,
LeCouteur, Gottesman, Bolton, Simonoff, Yuzda, & Rutter, 1995). However, progress
with respect to the identification of specific genes that are implicated in PDDs has been
hampered by the lack of reliably differentiated subtypes. More reliable definitions of
PDD subtypes will facilitate genetic studies of PDDs, as homogeneous subgroups are
more biologically informative than the current labels of PDD-NOS, PDDs, or autism
spectrum disorders (Geshwind, 2009).

Objectives of the Current Study

The current study is a clinical description of PDD-NOS. The aim was to clarify
PDD-NOS as a diagnostic category by specifying its boundaries with other PDDs and
similar disorders. It used a well-characterized sample to examine subtype differences in
terms of parent-reported PDD symptoms, as well as adaptive and problem behaviors.
Developmental changes in the clinical presentation of children diagnosed with PDD-
NOS, AD, and DD were also considered, as symptoms were compared for groups in two
age levels: preschool (2-5 years), and school age (6-12 years). A clearer understanding of
the behaviors that characterize PDD-NOS across developmental levels will contribute to
the diagnostic validity of the disorder. The association between level of functioning and the clinical and associated features of PDDs was also assessed. Correlational analyses were performed on NVIQ scores, and measures of PDD symptoms, and adaptive and problem behaviors.

The extent to which diagnostic groups could be reliably differentiated using empirical methods was investigated through cluster analysis and discriminant function analysis. Cluster analysis of PDD symptoms was performed to determine how classification based on multivariate heuristics would compare to clinical diagnosis. Discriminant function analysis was used to determine if specific PDD symptoms would effectively predict group membership.

The current study improved upon previous studies of PDD-NOS by matching groups on chronological age and level of functioning, and assessing PDD symptoms using a measure that was independent from diagnosis. Additionally, the contrast group was composed of children with developmental disorders that are similar to PDDs. Including this group is important in the clarification of the boundaries of PDD-NOS, as PDD-NOS occupies the position at the edge of the autism spectrum. It borders AD as well as similar non-PDD disorders. Desirable comparison groups in studies of the autism spectrum are those whose behavioral profiles most closely resemble those of PDDs (Lord & Corsello, 2005).

It was expected that in the domain of PDD symptoms, children with AD or PDD-NOS will show a greater number of PDD symptoms than children with non-spectrum developmental disabilities (DD). Children with PDD-NOS were expected to show similar rates of PDD symptoms as children with AD. The differences between PDD-NOS and
AD groups in the social domain were expected to increase due to greater impairments in the AD group with age. Differences between groups on communication and restricted and repetitive behaviors were expected to remain constant with age.

Analyses of psychiatric and behavioral problems were expected to show higher rates of symptoms in children with AD and PDD-NOS compared to the DD group, and similar results between children with PDD-NOS and AD. This finding was expected to remain constant with age.

Analyses of adaptive behavior were expected to show that children with AD or PDD-NOS would show greater deficits in adaptive behavior compared to children with DD. After controlling for IQ, no differences were expected to emerge between PDD-NOS and AD groups. These results were not expected to change with age.
CHAPTER 2

METHOD

Participants

Data were collected on a total of 452 subjects. Of these, 159 (35%) were excluded due to missing data, including the absence of an IQ assessment, or incomplete measures of PDD symptoms, psychiatric/behavior problems, or adaptive behavior. Children diagnosed with Asperger’s Disorder were also excluded, as there were too few of them to include in the subtype comparisons (n=34). Of the remaining 259 subjects, 162 (63%) were used in the final analysis after matching groups. Participants were children between the ages of 24 and 146 months (mean=65.2, SD=30.5) who were consecutive referrals for possible PDDs at the Developmental Assessment Center at the Nationwide Children’s Hospital. The final sample consisted of 138 males (85%) and 24 females (15%). Seventy-five percent (n=121) of the sample was Caucasian, 15% (n=25) African-American, 6% (n=9) Hispanic, and 4% (n=7) Asian/Pacific Islander.

The final sample included 54 children with PDD-NOS, 54 children with AD, and 54 children with other DDs. Primary psychological and medical diagnoses of the children in the DD group were as follows: Receptive/Expressive Language Disorder (n=18), Global Developmental Delay (n=14), ADHD (n=10), ID (n=7), Learning Disability
(n=3), Down Syndrome (n=1), and Stereotypic Movement Disorder (n=1).

The mean ages across diagnostic groups were as follows: PDD-NOS: 67.4 months (SD=34.8), AD: 62.7 (SD=26.3), and DD: 65.4 (SD=30.3). There were no significant differences between groups in terms of age \[F(2, 159)=.33, p=.72\]. Mean NVIQ across groups were as follows: PDD-NOS: 81.7 (SD=21.4), AD: 78.0 (SD=20.3), DD: 82.1 (SD=19.6). Mean verbal IQ (VIQ) across groups were: PDD-NOS: 69.8 (SD=18.7), AD: 64.8 (15.9), DD: 79.3 (SD=19.7). Mean Full Scale IQ (FSIQ) between groups were: PDD-NOS: 80.1 (22.2), AD: 73.9 (19.7), DD: 80.6 (19.3). Significant differences between groups were not evident for NVIQ or FSIQ scores \[F(2, 159)=.66, p=.52; F(2, 159)=1.7, p=.19, \text{respectively}\]. Significant differences between groups emerged only for VIQ scores \[F(2, 159)=5.7, p=.004\], in which the AD group had significantly lower scores than the DD group \(p=.004\). A summary of participant characteristics is presented in Table 2.

<table>
<thead>
<tr>
<th></th>
<th>PDD-NOS</th>
<th>AD</th>
<th>DD</th>
<th>(F)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean, SD)</td>
<td>67.4 (34.8)</td>
<td>62.7 (26.3)</td>
<td>65.4 (30.3)</td>
<td>.33</td>
<td>.72</td>
</tr>
<tr>
<td>NVIQ (mean, SD)</td>
<td>81.7 (21.4)</td>
<td>78.0 (20.3)</td>
<td>82.1 (19.6)</td>
<td>.66</td>
<td>.52</td>
</tr>
<tr>
<td>VIQ</td>
<td>73.8 (18.7)</td>
<td>64.8 (15.9)</td>
<td>79.3 (19.7)</td>
<td>5.7</td>
<td>.004(^a)</td>
</tr>
<tr>
<td>FSIQ</td>
<td>80.1 (22.2)</td>
<td>73.9 (19.7)</td>
<td>80.6 (19.3)</td>
<td>1.7</td>
<td>.19</td>
</tr>
<tr>
<td>ADOS Social</td>
<td>6.1 (2.3)</td>
<td>9.2 (2.2)</td>
<td>3.8 (2.7)</td>
<td>67.3</td>
<td>.000(^b)</td>
</tr>
<tr>
<td>Communication</td>
<td>3.5 (1.4)</td>
<td>5.3 (1.6)</td>
<td>1.9 (1.4)</td>
<td>68.4</td>
<td>.000(^b)</td>
</tr>
<tr>
<td>Soc+Comm</td>
<td>9.6 (3.3)</td>
<td>14.6 (2.9)</td>
<td>5.8 (3.8)</td>
<td>93.4</td>
<td>.000(^b)</td>
</tr>
<tr>
<td>Stereotyped Beh</td>
<td>1.1 (1.1)</td>
<td>2.0 (1.9)</td>
<td>.35 (.9)</td>
<td>18.9</td>
<td>.000(^c)</td>
</tr>
</tbody>
</table>

\(^{a}\) AD<DD, \(p = .004\)

\(^{b}\) AD>PDD-NOS>DD, \(p < .001\)

\(^{c}\) AD>PDD-NOS>DD, \(p < .05\)

Table 2. Demographic Characteristics of Sample by Diagnosis and Age
Informants

The informants of children diagnosed with PDD-NOS consisted of 42 mothers, 11 fathers, and one guardian, with a mean age of 36.3 years (SD=7.1 years). The highest level of education was as follows: one informant attended grade school (2%), three attended high school (5.5%), six graduated from high school (11%), 15 attended college (28%), 15 graduated from college (28%), 3 attended graduate or professional school (5.5%), and 11 indicated “other” or declined to answer (20%).

The informants of children diagnosed with AD consisted of 45 mothers and 9 fathers, with a mean age of 34.1 years (SD=6.9 years). The highest level of education was as follows: one informant attended grade school (2%), six attended high school (11%), 10 graduated from high school (19%), 13 attended college (24%), 14 graduated from college (26%), 3 attended graduate or professional school (5%), and seven indicated “other” or declined to answer (13%).

The informants of children in the DD group consisted of 40 mothers, 13 fathers, and one guardian, and had a mean age of 34.3 years (SD=6.5). The highest level of education was as follows: one informant attended grade school (2%), four attended high school (7%), eight graduated from high school (15%), 13 attended college (24%), 13 graduated from college (24%), seven attended graduate or professional school (13%), and eight indicated “other” or declined to answer (15%). The informants in the three groups did not differ significantly in age [F(2, 140)=1.52, p=.22] or level of education ($\chi^2=7.59$, $p=.82$).

Instruments
Diagnostic Assessment Measures

The Autism Diagnostic Observation Schedule-Generic (ADOS-G; Lord et al., 1999). The ADOS-G was designed to provide a method for standardized observation of social interaction, communication, and play behavior. The ADOS-G comprises four modules made up of specific activities designed to elicit specific behaviors to be assessed. The modules are differentiated by expressive language skill, so an individual is only administered one module at any certain point in time. Cutoff scores are provided for AD and for autistic spectrum disorders. Of the children in the PDD-NOS group, 25 (46%) were administered Module 1, 14 (26%) were administered Module 2, and 15 (28%) were administered Module 3. Forty-eight of the 54 children (88%) in the PDD-NOS group met the cutoff for autistic spectrum disorders (n=32) or autism (n=16), with the remaining six children (12%) within two points of the cutoff for autistic spectrum disorders. Of the children in the AD group, 28 (52%) were administered Module 1, 17 (31%) were administered Module 2, and nine (17%) were administered Module 3. Forty-two of the children in the AD group (77%) met the autism cutoff, 10 (19%) met the autism spectrum disorders cutoff, and two (4%) were within two points of the autism spectrum disorders cutoff. Of the children in the DD group, 16 (30%) were administered Module 1, 22 (40%) were administered Module 2, and 16 (30%) were administered Module 3. Forty-four children in the DD group were below the cutoffs (81%), and ten (19%) met the autism spectrum disorders cutoff by a range of 1-3 points.

Depending on the child’s age and verbal skills, cognitive functioning was assessed with the Bayley Scales of Infant Development – Second Edition (Bayley, 1993), the Leiter International Performance Scale - Revised (Roid & Miller, 1997), the Mullen

Measure of PDD Symptoms

The Pervasive Developmental Disorder Behavior Inventory (PDDBI; Cohen & Sudhalter, 1997). The PDDBI is an informant-based rating scale that assesses symptoms of PDDs as well as adaptive and maladaptive behaviors. It was developed for children between the ages of 1.5 and 12.5 years. There are two versions of the PDDBI; one that is completed by parents and one completed by teachers. The parent version was used in the current study. It consists of 176 questions that are organized into subscales and rated on a four point Likert scale (0=never; 1=rarely; 2=sometimes/partially; 3=often/typically). An Autism Composite Score is generated using the scores from the following subscales; (1) Sensory/Perceptual Approach Behaviors, (2) Social Approach Behaviors, (3) Social Pragmatic Problems, (4) Phonological Skills, (5) Semantic/Pragmatic Ability, and (6) Semantic/Pragmatic Problems.

Select subscales were used for the current study. Although they are included in the Autism Composite Score, the Phonological Skills Semantic/Pragmatic Ability subscales were not used in the current study. Both subscales assess aspects of language that are not directly related to core PDD symptoms, such as speech production (ability to make vowel, consonant, and diphthong speech sounds), use of negatives, morphemes, and qualifiers, and affective tone.
Examples of items contained in the selected subscales are provided in Table 3. Social impairment was measured using the Social Pragmatic Problems and Social Approach Behaviors subscales. The Social Pragmatic Problems subscale consists of 12 items assessing social approach problems including how the individual approaches others as well as awareness of social issues. The internal consistency of each subscale was evaluated using Chronbach’s alpha. The internal consistency of this subscale was .87 in the current sample. The Social Approach Behaviors subscale consists 36 items that assess nonverbal social behaviors, including various forms of eye contact, positive affective and social interactions, use of gestures, social interactions, and play. The internal consistency of this subscale was .94 in the current sample.

Communication impairment was measured using the Semantic/Pragmatic Problems subscale, which consists of 12 items assessing problems with language comprehension or production, including aberrant vocal prosody, echolalia, perseveration, and tangential speech. The internal consistency of this subscale was .88.

Repetitive behaviors were measured using the Ritualisms/Resistance to Change and the Sensory/Perceptual Approach Behaviors subscales. The Ritualisms/Resistance to Change subscale consists of 12 items that assess complex ritualistic behaviors, willingness to engage in new activities, and adjustment to changes in routine. The internal consistency of this subscale was .87 in the current sample. The Sensory/Perceptual Approach Behaviors subscale consists of 20 items that assess stereotyped behaviors that are directed toward stimulating the sensations of vision, taste, smell, audition, touch, or the vestibular system. The internal consistency of this subscale was .90 in the current sample.
**PDDBI Subscales/items**

**Social Approach Behaviors**
- Looks when called or praised
- Looks at others in order to share experiences with them
- Shows affection (e.g., hugs, kisses) toward caregivers, friends, etc.
- Smiles in anticipation of teasing, tickling, etc.
- Nods yes and/or shakes head no
- Initiates simple social play with others
- Shows complex imaginative toy play (e.g., feeds doll, makes Superman toy fly)
- Physically or verbally comforts others
- Imitates peek-a-boo

**Social Pragmatic Problems**
- Approaches others inappropriately
- Overly serious in social situations
- Has problems understanding the need to be polite or has problems understanding social relationships
- Laughs or smiles for no apparent reason or laughs or smiles at the wrong time
- Ignores the social approaches of peers
- Actively avoids peers when approached

**Semantic/Pragmatic Problems**
- Says a words, phrases, or sentences that are out of context or repeats words or phrases heard earlier but out of context
- Perseverates on words or phrases
- Talks to himself/herself during a conversation with others
- Talks about topics and assumes that his/her conversational partner understands when he/she is talking about

**Sensory/Perceptual Approach Behaviors**
- Stares or looks out of sides of eyes at objects
- Rubs or taps own face or arms repetitively
- Flaps hands
- Jumps repetitively
- Spins objects repetitively

**Ritualisms/Resistance to Change**
- Resists changing from one activity to another
- Upset when schedule or order of the routine is changed
- Carries or holds on to objects (e.g., toys, paper clips, strings)
- Insists that others repeat words or actions

Table 3. Summary of items in PDDBI subscales
Measure of Psychiatric and Behavioral Problems

The Child Behavior Checklist (CBCL; Achenbach & Edelbrock, 1991) is an empirically-derived checklist completed by caregivers that measures psychopathology in children. Caregivers rate the presence of behaviors associated with childhood psychopathology on a three point Likert scale (0=never; 1=sometimes; 2=always).

Different versions of the CBCL exist for children 1.5-5 years old and for those from 6-18 years of age. In order to compare rates of psychiatric and behavioral problems between the preschool and school age samples, analyses were conducted only on the subscales that are generated by both versions of the CBCL. Specific subscales analyzed in the current study included: Anxiety/Depression, Somatic Complaints, Attention Problems, Withdrawn, Aggression, and Oppositional Behavior subscales. Table 4 lists examples of items included in the CBCL subscales used in the current study.

The Anxiety/Depression subscale contains items assessing symptoms of separation anxiety, phobias, generalized anxiety, and depression. The preschool version of this subscale contains eight items and had an internal consistency of .75 in the current sample. The school age version of this subscale included 13 items and had an internal consistency of .69 in the current sample.

The Somatic Complaints subscale includes items that assess for physical ailments such as aches and pains, headaches, nausea, and gastrointestinal symptoms. This subscale contains 11 items in the preschool and school age versions and had an internal consistency of .50 in the preschool group and .67 in the school age group.

The Attention Problems subscale includes items that assess for symptoms of ADHD. This subscale consists of six items in the preschool version and had an internal

52
consistency of .71 in the current sample. The school age version consists of ten items and had an internal consistency of .80.

The Withdrawn subscale assesses for symptoms of social withdrawal. The preschool and school age versions of this subscale consist of eight items. The preschool version had an internal consistency of .82 and the school age version had an internal consistency of .61.

The Aggression subscale includes items that assess verbally or physically aggressive behavior. The preschool version contains 19 items and had an internal consistency of .94. The school age version consists of 18 items and had an internal consistency of .89.

The Oppositional Behavior subscale consists of items assessing defiance, disobedience at home and school, and angry moods. The preschool version contains six items and had an internal consistency of .88. The school age version consists of five items and had an internal consistency of .71.
<table>
<thead>
<tr>
<th>CBCL Subscales</th>
<th>Summary of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety/Depression</td>
<td>- Gets too upset when separated from parents (P)</td>
</tr>
<tr>
<td></td>
<td>- Clings to adults or to dependent (P)</td>
</tr>
<tr>
<td></td>
<td>- Appears unhappy for no good reason (P)</td>
</tr>
<tr>
<td></td>
<td>- Fears going to school (S)</td>
</tr>
<tr>
<td></td>
<td>- Fears he/she might think or do something bad (S)</td>
</tr>
<tr>
<td></td>
<td>- Feels worthless/inferior (S)</td>
</tr>
<tr>
<td></td>
<td>- Feels/complains that no one loves him/her (S)</td>
</tr>
<tr>
<td></td>
<td>- Self-conscious or easily embarrassed (P &amp; S)</td>
</tr>
<tr>
<td></td>
<td>- Too fearful or anxious (P &amp; S)</td>
</tr>
<tr>
<td></td>
<td>- Nervous, high strung, tense (P &amp; S)</td>
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<tr>
<td></td>
<td>- Cries a lot (P &amp; S)</td>
</tr>
<tr>
<td>Somatic Complaints</td>
<td>- Constipated, doesn’t move bowels (P)</td>
</tr>
<tr>
<td></td>
<td>- Diarrhea or loose bowels (P)</td>
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<tr>
<td></td>
<td>- Doesn’t eat well (P)</td>
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<tr>
<td></td>
<td>- Feels dizzy or lightheaded (S)</td>
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<tr>
<td></td>
<td>- Overtired without good reason (S)</td>
</tr>
<tr>
<td></td>
<td>- Aches or pains (without medical cause) (P &amp; S)</td>
</tr>
<tr>
<td></td>
<td>- Headaches (without medical cause) (P &amp; S)</td>
</tr>
<tr>
<td></td>
<td>- Nausea (without medical cause) (P &amp; S)</td>
</tr>
<tr>
<td>Attention Problems</td>
<td>- Poorly coordinated or clumsy (P)</td>
</tr>
<tr>
<td></td>
<td>- Quickly shifts from one activity to another (P)</td>
</tr>
<tr>
<td></td>
<td>- Fails to finish things s/he starts (S)</td>
</tr>
<tr>
<td></td>
<td>- Daydreams or gets lost in thoughts (S)</td>
</tr>
<tr>
<td></td>
<td>- Impulsive or acts without thinking (S)</td>
</tr>
<tr>
<td></td>
<td>- Inattentive or easily distracted (S)</td>
</tr>
<tr>
<td></td>
<td>- Can’t concentrate/pay attention for long (P &amp; S)</td>
</tr>
<tr>
<td></td>
<td>- Can’t sit still, restless, or hyperactive (P &amp; S)</td>
</tr>
<tr>
<td>Aggression</td>
<td>- Demands must be met immediately (P)</td>
</tr>
<tr>
<td></td>
<td>- Doesn’t seem to feel guilty after misbehaving (P)</td>
</tr>
<tr>
<td></td>
<td>- Easily frustrated (P)</td>
</tr>
<tr>
<td></td>
<td>- Hits others (P)</td>
</tr>
<tr>
<td></td>
<td>- Cruelty, bullying, or meanness to others (S)</td>
</tr>
<tr>
<td></td>
<td>- Destroys own things (S)</td>
</tr>
<tr>
<td></td>
<td>- Teases a lot (S)</td>
</tr>
<tr>
<td></td>
<td>- Threatens people (S)</td>
</tr>
<tr>
<td></td>
<td>- Gets in many fights (P &amp; S)</td>
</tr>
<tr>
<td></td>
<td>- Destroys things belonging to his/her family or other children (P &amp; S)</td>
</tr>
</tbody>
</table>

Table 4. Summary of items in CBCL subscales
Table 4 continued

<table>
<thead>
<tr>
<th>Oppositional Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Physically attacks others (P &amp; S)</td>
</tr>
<tr>
<td>- Screams a lot (P &amp; S)</td>
</tr>
<tr>
<td>- Temper tantrums or hot temper (P &amp; S)</td>
</tr>
<tr>
<td>- Defiant (P)</td>
</tr>
<tr>
<td>- Angry moods (P)</td>
</tr>
<tr>
<td>- Uncooperative (P)</td>
</tr>
<tr>
<td>- Argues a lot (S)</td>
</tr>
<tr>
<td>- Disobedient (P &amp; S)</td>
</tr>
<tr>
<td>- Sullen, stubborn, or irritable (P &amp; S)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Withdrawn</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Avoids looking others in the eye (P)</td>
</tr>
<tr>
<td>- Doesn’t answer when people talk to him/her (P)</td>
</tr>
<tr>
<td>- Seems unresponsive to affection (P)</td>
</tr>
<tr>
<td>- Shows little affection towards people (P)</td>
</tr>
<tr>
<td>- Would rather be alone than with others (S)</td>
</tr>
<tr>
<td>- Refuses to talk (S)</td>
</tr>
<tr>
<td>- Too shy or timid (S)</td>
</tr>
<tr>
<td>- Doesn’t get involved with others (P &amp; S)</td>
</tr>
</tbody>
</table>

(P), (S): indicates item is included in the preschool or school age versions of the CBCL, respectively

Measure of Adaptive Functioning

The *Scales of Independent Behavior – Revised* (SIB-R; Bruininks, Woodcock, Weatherman, & Hill, 1996). The SIB-R is a comprehensive measure of adaptive behavior. It contains 14 subscales that produce an overall Broad Independence score as well as domain scores for the following areas: motor skills (e.g. fine and gross motor abilities), social interaction (e.g. interaction with others, cooperating, playing), language and communication (e.g. expressive and receptive language skills), personal living skills (e.g. eating, toileting, dressing, hygiene), and community living skills (e.g. counting skills/use of money, following safety rules). Total and domain standard scores have a mean of 100 and a standard deviation of 15. Each subscale contains between 16-20 items.
that range in terms of developmental difficulty. Norms are provided for individuals from infants through 80 years of age. It can be administered as a rating scale or as an interview.

Procedure

All participants were evaluated for PDDs by a multidisciplinary team. Diagnostic evaluations at the Developmental Assessment Program consisted of two clinic visits. The first consisted of a parent interview and child observation, and the second consisted of the administration of cognitive and autism-specific assessments. In total, the evaluations lasted between six and ten hours. Prior to the evaluation, parents completed and returned a referral packet, including the PDDBI, SIB-R, and the CBCL.

Assessments were conducted by multidisciplinary teams, including developmental pediatricians, speech and language pathologists, and psychologists. On the second clinic visit, trained graduate or postdoctoral students administered measures of intellectual and adaptive functioning, as well as the ADOS. Diagnoses were made in accordance with DSM-IV-TR criteria by consensus agreement between the developmental pediatrician and clinical psychologist. A diagnosis of PDD-NOS was given when one of the following three conditions were met: the child demonstrated fewer than six of the behaviors necessary to receive a DSM-IV diagnosis of AD, or the child missed the threshold in one of the three symptom domains, or when the age of onset was after three years. Diagnostic conclusions were reached by taking all of the aforementioned information into account. Results of the diagnostic evaluation, assessments of adaptive and cognitive functioning, and completed assessment measures were retrieved from patient charts. Consecutive cases were included if all assessment measures were complete.
Individuals from different diagnostic groups (PDD-NOS, AD, DD) were matched on age (within 24 months), gender, ethnicity, and NVIQ. NVIQ scores from the Stanford-Binet, 5th ed. (n=83), Leiter International Performance Scales (n=25), WISC-IV (n=13), or WPPSI (n=10), were available for 81% of the sample. For the remaining participants, the Bayley Infant Scales of Development (n=20) or Mullen Scales of Early Learning (n=11) were used to assess cognitive functioning. These latter two instruments do not produce a NVIQ score. In these cases, the total cognitive development score was used. The mean age of participants who received the Bayley or Mullen was 29.2 months (SD=3.4). It was assumed that the young age of this group reduced the emphasis on verbal skills in determining a cognitive development score, and therefore the total score would be an adequate estimate of their NVIQ. Because different instruments were used and in order to increase reliability of analyses, NVIQ scores were converted to the following categories: 1=below 26, 2=26-40, 3=41-55, 4=56-70, 5=71-90, 6=91-110, 7=above 110. Groups were matched on these ordinal categories. To assess the effect of age on PDD symptoms and adaptive and behavior problems, each of the three matched groups were separated by age into preschool (2-5 years), and school age (6-12 years) groups.

Data Analysis

Primary Analyses

A series of 3 (diagnosis) x 2 (age) MANOVAs were performed to examine differences between groups on the total and subscale scores of the PDDBI, CBCL and SIB-R. Tukey HSD tests were performed to localize significant differences between groups on subscale scores. Pearson correlations between subscale scores and NVIQ were
also performed to assess the influence of level of functioning on each symptom domain. Correlations were calculated separately for the PDD (PDD-NOS and AD combined) and DD groups.

*Secondary Analyses*

Cluster analysis was used to assess whether meaningful clinical groups could be identified based on similarities in behavioral profiles. Cluster analysis applies multivariate heuristics to sort entities into groups such that within group variance is minimized and between group variance is maximized. Subscale scores of the PDDBI were submitted to cluster analysis. Several methods of cluster analysis exist (Miligan & Cooper, 1987). K-means method of cluster analysis was used, as it was found to produce good recovery of cluster structure when compared to other cluster analytic techniques (Miligan & Cooper, 1987). Two- through six-cluster solutions were examined. The pseudo-F statistic (Beale, 1969) was used to evaluate the cluster solutions. The extent to which diagnostic groups could be distinguished based on the cluster analysis was evaluated by comparing clinical diagnosis with cluster assignments.

Stepwise discriminant function analysis was used to determine which PDD symptoms would most effectively predict group membership. Discriminant analysis is used to determine which variables discriminate between two or more naturally occurring groups (Press & Wilson, 1978). Two discriminant analyses were performed; the first identified symptoms that could distinguish between PDD and DD groups when PDD-NOS and AD groups were combined, and the second identified symptoms that could distinguish between PDD-NOS, AD, and DD groups.
Items included in the first discriminant analysis were those that showed significant differences between PDD (AD and PDDNOS) and DD groups. *T*-tests were performed on the PDDBI items from the Social Approach Behaviors, Social Pragmatic Problems, Semantic Pragmatic Problems, Rituals/Resistance to Change, and Sensory/Perceptual Approach Behaviors subscales to identify items that differed significantly between groups. Items with a significant Bonferroni-corrected *p*-value (.05/number of items per subscale) were selected for the discriminant analysis.

Items included in the second discriminant analysis were those that showed significant differences between PDD-NOS, AD, or DD groups. MANOVAs were performed on the items comprising the subscales listed above to identify items that differed significantly between the three groups. Items with a significant Bonferroni-corrected *p*-value were selected for the discriminant analysis.
CHAPTER 3

RESULTS

Primary Analyses

Differences between Groups in PDD Symptoms

MANOVA results of differences in PDD symptoms across diagnostic and age groups are presented in Table 5. For the PDDBI Autism Composite Scores, the effect of diagnosis was significant \[ F(2, 159)=5.8, p=.004 \]. Tukey post-hoc analyses indicated that the PDD-NOS and AD groups had significantly higher scores than the DD group \( p=.006, p=.02 \), respectively). Significant differences between PDD-NOS and AD groups were not observed in either age sample (preschool: PDD-NOS: 57.2, SD=22.0, AD: 56.7, SD=31.1, DD: 44.8, SD=20.9; school age: PDD-NOS: 54.4, SD=20.9, AD: 51.2, SD=12.9, DD: 42.2, SD=14.7). There was not a statistically-significant effect of age \[ F(1, 160)=1.2, p=.26 \]. The interaction between diagnosis and age was also not significant \[ F(2, 159)=.09, p=.91 \].

Impairment in Social Interaction

On the Social Approach Behaviors subscale of the PDDBI there was not a statistically significant effect of diagnosis \[ F(2, 159)=2.00, p=.14 \]. Scores were equivalent for the PDD-NOS and AD groups (preschoolers: PDD-NOS: 55.9, SD=11.5,
AD: 57.2, SD=10.9; school age: PDD-NOS: 52.4, SD=11.9, AD: 54.4, SD=11.5). The DD group had higher scores in both age ranges (preschool: 61.8, SD=10.1; school age: 55.4, SD=13.9). Lower scores indicate a higher level of impairment. Age trends indicated increased impairment with age. This was statistically significant \(F(1, 160)=5.45, p=.02\). The interaction between diagnosis and age was not significant \(F(2, 159)=.38, p=.69\).

On the Social Pragmatic Problems subscale, a significant effect of diagnosis emerged \(F(2, 159) = 5.86, p = .004\). Tukey post-hoc analyses indicated that the PDD-NOS and AD groups had significantly higher scores than the DD group \(p=.006, p=.02\), respectively). Significant differences between PDD-NOS and AD groups were not evident in either age sample (preschool: PDD-NOS: 54.0, SD = 15.2, AD: 50.6, SD = 11.5, DD: 47.7, SD=13.5; school age: PDD-NOS: 51.4, SD = 10.6, AD: 50.7, SD = 10.5, DD: 42.2, SD=11.3). Higher scores indicate higher levels of impairment. There was not a statistically significant effect of age \(F(1, 160)=1.91, p=.17\). The interaction between diagnosis and age was also not significant \(F(2, 159)=.71, p=.49\).

**Impairment in Communication**

On the Semantic Pragmatic Problems subscale, there was not a statistically significant effect of diagnosis \(F(2, 159)=.87, p=.42\). Scores were similar across diagnostic groups in both age ranges (preschool: PDD-NOS: 54.9, SD = 12.5, AD: 51.8, SD = 10.2, DD: 53.7, SD = 12.1; school age: PDD-NOS: 51.7, SD = 8.5, AD: 53.1, SD = 9.1, DD: 47.8, SD = 7.9). There was also not a statistically significant effect of age \(F(1, 160)=2.56, p=.11\).

**Restricted/Repetitive Behaviors**
On the Rituals/Resistance to Change subscale of the PDDBI there was a significant effect of diagnosis \(F(2, 159)=3.27, p=.04\). Tukey post-hoc tests indicated that the PDD-NOS group had significantly higher scores than the DD group \(p=.03\). Scores were higher for the preschool PDD-NOS group (60.3, SD=13.7) as compared to the AD or DD groups (53.2, SD=12.2; 56.0; SD=11.5). In the school age sample, scores for the PDD-NOS and AD groups were similar (53.6, SD=10.3; 54.1, SD=11.7), and higher than those for the DD group (46.4, SD=10.5). A significant effect of age emerged such that the older groups had higher scores on this subscale \(F(1, 160)=7.86, p=.006\). The interaction between diagnosis and age approached significance \(F(2, 159)=2.91, p=.06\).

On the Sensory/Perceptual Approach Behaviors subscale, the effect of diagnosis was significant \(F(2, 159)=2.98, p=.05\). Tukey post-hoc tests revealed that the PDD-NOS group had significantly higher scores than the DD group \(p=.04\). There was no difference in scores between PDD-NOS and AD groups (preschool: PDD-NOS: 51.9, SD=12.3, AD: 50.6, SD=12.2, DD: 46.8, SD=10.3; school age: PDD-NOS: 53.3, SD=11.1, AD: 50.7, SD=10.4, DD: 47.9, SD=10.8). The effect of age was not significant \(F(1, 160)=.25, p=.62\). The interaction between diagnosis and age was also not significant \(F(2, 159)=.06, p=.94\).

In summary, on core PDD symptoms, significant differences did not emerge between PDD-NOS and AD groups. The PDD-NOS and AD groups had significantly higher scores than the DD group on the Autism Composite and Social Pragmatic Problems subscales. The PDD-NOS group had significantly higher scores than the DD group on both subscales measuring restricted and repetitive behaviors. The effect of age
was significant for the Social Approach and Rituals/Resistance to Change subscales. Children in the older age group had more impaired Social Approach behavior and fewer symptoms in the Rituals/Resistance to Change domain.
## Table 5. Results of MANOVA Analyses of Differences in PDD Symptoms between Diagnostic Groups by Age

<table>
<thead>
<tr>
<th></th>
<th>Overall PDD Symptoms</th>
<th>Social Impairment</th>
<th>Communication Impairment</th>
<th>Restricted/Repetitive Behaviors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Score (mean ± SD)</td>
<td>MANOVA</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Preschool</strong></td>
<td><strong>School Age</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PDD-NOS</td>
<td>AD</td>
<td>DD</td>
<td>PDD-NOS</td>
<td>AD</td>
</tr>
<tr>
<td><em>Autism Composite</em></td>
<td>57.2±22.0</td>
<td>56.7±31.1</td>
<td>44.8±14.8</td>
<td>54.4±20.9</td>
</tr>
<tr>
<td><em>age (1,160)</em></td>
<td>1.29</td>
<td>.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Social Approach</em></td>
<td>55.9±11.5</td>
<td>57.2±10.9</td>
<td>61.8±10.1</td>
<td>52.4±11.9</td>
</tr>
<tr>
<td><em>age (1,160)</em></td>
<td>5.45</td>
<td>.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Social Pragmatics</em></td>
<td>54.0±15.2</td>
<td>50.6±11.5</td>
<td>47.7±13.5</td>
<td>51.4±10.6</td>
</tr>
<tr>
<td><em>age (1,160)</em></td>
<td>1.91</td>
<td>.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Semantic Pragmatics</em></td>
<td>54.9±12.5</td>
<td>51.8±10.2</td>
<td>53.7±12.1</td>
<td>51.7±8.5</td>
</tr>
<tr>
<td><em>age (1,160)</em></td>
<td>2.56</td>
<td>.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Rituals</em></td>
<td>60.3±13.7</td>
<td>53.2±12.2</td>
<td>56.0±11.5</td>
<td>53.6±10.3</td>
</tr>
<tr>
<td><em>Sensory</em></td>
<td>51.9±12.3</td>
<td>50.6±12.2</td>
<td>46.8±10.3</td>
<td>53.3±11.1</td>
</tr>
</tbody>
</table>

**PDD-NOS>DD (p=.006), AD>DD (p=.02); b PDD-NOS>DD (p=.03); c PDD-NOS>DD (p=.04)**
**Differences between Groups in Psychiatric and Behavioral Problems**

MANOVA results of differences in psychiatric and behavioral problems across diagnostic and age groups are presented in Table 6.

**Anxiety and Affective Symptoms**

On the Anxiety/Depression subscale, the effect of diagnosis was significant \([F(2, 159)=5.68, p=.004]\). Tukey post-hoc tests revealed that the PDD-NOS group had significantly higher scores than the AD group \((p=.003)\). The PDD-NOS group had higher scores than the AD group in both age groups (preschool: 60.1, SD=8.7 vs. 53.3, SD=5.5; school age: 58.7, SD=8.2 vs. 56.4, SD=6.1). In the preschool age range, the DD group had scores between those of the PDD-NOS and AD groups (56.9, SD=7.2). In the school age sample, the DD group had scores below those of the other two groups (55.8, SD=6.5). There was not a statistically-significant effect of age \([F(1, 160)=.02, p=.88]\). The interaction between diagnosis and age was also not significant \([F(2, 159)=1.69, p=.19]\).

Scores on the Somatic Complaints subscale indicated that the effect of diagnosis was significant \([F(2, 159)=3.58, p=.03]\). Tukey post-hoc tests indicated that the PDD-NOS group had significantly higher scores than the AD group on this subscale \((p=.02)\). The PDD-NOS group had higher scores than the AD group in both age ranges (preschool: 58.9, SD=7.6 vs. 55.3, SD=6.9; school age: 58.6, SD=7.4 vs. 55.2, SD=5.4). In both age ranges, the scores for the DD group fell between those of the PDD-NOS and AD groups (preschool: 57.8, SD=7.6 school age: 55.4, SD=6.5). There was not a statistically-significant effect of age \([F(1, 160)=.79, p=.38]\). The interaction between diagnosis and age was also not significant \([F(2, 159)=.42, p=.66]\).
Attention Symptoms

On the Attention Problems subscale a significant effect of diagnosis did not emerge \[F(2, 159)=2.37, p=.09\]. Differences in scores did not exist between the diagnostic groups in either age range (preschool: PDD-NOS: 63.8, SD=8.6, AD: 60.1, SD=7.9, DD: 61.8, SD=9.7; school age: PDD-NOS: 68.9, SD=9.3, AD: 66.6, SD=10.0, DD: 63.4, SD=10.4). Age trends revealed that these symptoms increase with age across diagnostic groups. This effect was significant \[F(1, 160)=8.79, p=.004\]. The interaction between diagnosis and age was not significant \[F(2, 159)=.98, p=.38\].

Conduct Problems

On the Aggression subscale, a significant effect of diagnosis did not emerge \[F(2, 159)=.95, p=.39\]. Differences between diagnostic groups did not emerge in either age range (preschool: PDD-NOS: 62.7, SD=13.2, AD: 59.4, SD=11.2, DD: 62.6, SD=12.4; school age: PDD-NOS: 63.9, SD=10.2, AD: 61.1, SD=8.3, DD: 61.0, SD=13.2). The effect of age was not significant \[F(1, 160)=.05, p=.83\].

On the Oppositional Behavior subscale the effect of diagnosis was not significant \[F(2, 159)=.97, p=.38\]. Differences between diagnostic groups did not emerge for either age range (preschool: PDD-NOS: 60.1, SD=10.0, AD: 58.2, SD=9.1, DD: 60.0, SD=9.1, school age; PDD-NOS: 58.2, SD= 9.1, AD: 60.4, SD=8.2, DD: 59.0, SD=9.6). The effect of age was also not significant \[F(2, 160)=.86, p=.35\].

Social Problems

On the Withdrawn subscale, a significant effect of diagnosis emerged \[F(2, 159)=8.47, p<.000\]. Tukey post-hoc tests indicated that the PDD-NOS and AD groups had significantly higher scores than the DD group \(p<.000, p=.009\), respectively). No
differences emerged between the PDD-NOS and AD groups (preschool: PDD-NOS: 71.7, SD=11.8, AD: 70.0, SD=10.9, DD: 60.9, SD=9.3; school age: PDD-NOS: 67.4, SD=12.2, AD: 66.3, SD=8.6, DD: 62.3, SD=9.4). There was not a statistically-significant effect of age \([F(1, 160)=1.29, p=.26]\). The interaction between diagnosis and age was also not significant \([F(2, 159)=1.02, p=.36]\).

In summary, the only differences to emerge between PDD-NOS and AD groups were higher scores in the PDD-NOS group on the Anxiety/Depression and Somatic Complaints subscales. The PDD-NOS and AD groups had significantly higher scores on the Withdrawn subscale as compared to the DD group. The effect of age was significant for the Attention Problems subscale such that the children in the older age range had significantly higher scores.
### Table 6. Results of MANOVA Analyses of Differences in Psychiatric/Behavior Problems between Diagnostic Groups by Age

<table>
<thead>
<tr>
<th></th>
<th>Preschool PDD-NOS</th>
<th>School Age PDD-NOS</th>
<th>MANOVA</th>
<th>Effect</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anxiety/Affective</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety/Depression</td>
<td>60.1±8.7</td>
<td>53.3±5.5</td>
<td></td>
<td>dx (2, 159)</td>
<td>5.68</td>
<td>.004</td>
</tr>
<tr>
<td></td>
<td>56.9±7.2</td>
<td>58.7±8.2</td>
<td></td>
<td>age (1, 160)</td>
<td>.02</td>
<td>.88</td>
</tr>
<tr>
<td>Somatic Complaints</td>
<td>58.9±7.6</td>
<td>55.3±6.9</td>
<td></td>
<td>dx (2, 159)</td>
<td>3.58</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>57.8±7.6</td>
<td>58.6±7.4</td>
<td></td>
<td>age(1, 160)</td>
<td>0.79</td>
<td>.38</td>
</tr>
<tr>
<td><strong>Attention Symptoms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention Problems</td>
<td>63.8±8.6</td>
<td>60.1±7.9</td>
<td></td>
<td>dx (2, 159)</td>
<td>2.37</td>
<td>.09</td>
</tr>
<tr>
<td></td>
<td>61.8±9.7</td>
<td>68.9±9.3</td>
<td></td>
<td>age (1, 160)</td>
<td>8.79</td>
<td>.004</td>
</tr>
<tr>
<td><strong>Conduct Problems</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggression</td>
<td>62.7±13.2</td>
<td>59.4±11.2</td>
<td></td>
<td>dx (2, 159)</td>
<td>0.95</td>
<td>.39</td>
</tr>
<tr>
<td></td>
<td>62.6±12.4</td>
<td>63.9±10.2</td>
<td></td>
<td>age (1, 160)</td>
<td>0.05</td>
<td>.83</td>
</tr>
<tr>
<td>Oppositional Behavior</td>
<td>60.1±10.0</td>
<td>58.2±9.1</td>
<td></td>
<td>dx (2, 159)</td>
<td>0.97</td>
<td>.38</td>
</tr>
<tr>
<td></td>
<td>60.0±9.1</td>
<td>58.2±9.1</td>
<td></td>
<td>age (1, 160)</td>
<td>0.86</td>
<td>.35</td>
</tr>
<tr>
<td><strong>Social Problems</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Withdrawn</td>
<td>71.7±11.8</td>
<td>70.0±10.9</td>
<td></td>
<td>dx (2, 159)</td>
<td>8.47</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>60.9±9.3</td>
<td>67.4±12.2</td>
<td></td>
<td>age (1,160)</td>
<td>1.29</td>
<td>.26</td>
</tr>
</tbody>
</table>

\(^{a}\) PDD-NOS>AD (p=.003); \(^{b}\) PDD-NOS>AD (p=.02); \(^{c}\) PDD-NOS>AD (p=.01); \(^{d}\) PDD-NOS>DD (p<.000), AD>DD (p=.009)
Differences between Groups in Adaptive Behavior

MANOVA results of differences in adaptive behavior across diagnostic and age groups are presented in Table 7. On the Broad Independence scale of the SIB-R, a significant effect of diagnosis emerged \( F(2, 159)=4.68, p=.01 \). Tukey post-hoc tests indicated that the AD group had significantly lower scores than the DD group \( p=.01 \). The DD sample had higher scores than the other two groups in both age samples (preschool: PDD-NOS: 73.5, SD=15.1, AD: 71.4, SD=18.5, DD: 81.1, SD=14.1; school age: PDD-NOS: 54.5, SD=23.7, AD: 61.6, SD=23.3, DD: 69.2, SD=22.6). Age analyses indicated that for all three groups, adaptive behavior scores decreased with age. The effect of age was significant \( F(1, 160)=18.71, p<.001 \). The interaction between diagnosis and age was not significant \( F(2, 159)=.79, p=.46 \).

On the Social/Communication subscale, the effect of diagnosis was significant \( F(2, 159)=6.06, p=.003 \). Tukey post-hoc tests indicated that the DD group had significantly higher scores than the PDD-NOS \( p=.005 \) and AD \( p=.002 \) groups. In both age groups, the DD sample had higher scores than the other two groups (preschool: PDD-NOS: 70.7, SD=21.3, AD: 69.3, SD=23.9, DD: 82.9, SD=18.3; school age: PDD-NOS: 58.1, SD=27.5, AD: 62.4, SD=27.8, DD: 74.5, SD=19.2). Age trends indicated that for all three diagnostic groups, scores decreased with age. The effect of age was also significant \( F(1, 160)=6.28, p=.01 \). The interaction between diagnosis and age was not significant \( F(2, 159)=.22, p=.81 \).

On the Motor subscale of the SIB-R, a significant effect of diagnosis did not emerge \( F(2, 159)=1.92, p=.15 \). Scores between the PDD-NOS and AD groups were similar (preschool: 88.9, SD=15.9 vs. 89.3, SD=21.3, school age: 64.3, SD=26.5 vs. 77.7,
Scores for the DD group were higher than the other two groups in the preschool sample (92.4, SD=15.2), but fell between the PDD-NOS and AD group scores in the school age sample (74.5, SD=24.4). Age trends indicated that for all three diagnostic groups, motor skills decreased with age. This effect was significant \( F(1, 160)=28.9, p<.000 \). The interaction between diagnosis and age was not significant \( F(2, 159)=1.25, p=.29 \).

On the Personal Living subscale of the SIB-R, there was a statistically-significant effect of diagnosis \( F(2, 159)=3.00, p=.05 \). Tukey post-hoc tests indicated that the PDD-NOS had significantly lower scores than the DD group \( p=.04 \). Scores for the DD group were higher than those for the other two groups in both age samples (preschool: PDD-NOS: 70.3, SD=19.0, AD: 72.2, SD=16.5, DD: 75.2, SD=21.8; school age: PDD-NOS: 60.2, SD=21.3, AD: 70.5, SD=20.6, DD: 73.9, SD=20.3). The effect of age was not significant \( F(2, 160)=1.83, p=.18 \). The interaction between diagnosis and age was also not significant \( F(2, 159)=.84, p=.44 \).

On the Community Living subscale, the effect of diagnosis was significant \( F(2, 159)=3.16, p=.04 \). Tukey post-hoc tests revealed that the difference in scores between the PDD-NOS and DD groups approached significance \( p=.06 \). Scores for the DD group were higher than for the other two diagnostic groups in both age samples (preschool: PDD-NOS: 75.6, SD=16.9, AD: 71.2, SD=23.3, DD: 83.2, SD=13.7; school age: PDD-NOS: 57.6, SD=22.0, AD: 62.7, SD=19.6, DD: 67.6, SD=24.4). Age trends indicated that for all three diagnostic groups, functioning decreased with age. The effect of age was significant \( F(1, 160)=18.72, p<.001 \). The interaction between diagnosis and age was not significant \( F(2, 159)=.75, p=.47 \).
In summary, significant differences between the PDD-NOS and AD groups did not emerge with respect to adaptive behavior. Both groups had significantly lower scores than the DD group on the Social/Communication subscale as compared to the DD group. The PDD-NOS group had significantly lower scores than the DD group on the Personal Living and Community Living subscales. The AD group had significantly lower scores than the DD group on the Broad Independence Scale. The effect of age was significant for the Broad Independence, Social/Communication, Motor Skills, and Community Living subscales, such that the older age group had lower scores.
<table>
<thead>
<tr>
<th></th>
<th>Score (mean ± SD)</th>
<th>MANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preschool</td>
<td>School Age</td>
</tr>
<tr>
<td></td>
<td>PDD-NOS</td>
<td>AD</td>
</tr>
<tr>
<td>Broad Independence</td>
<td>73.5±15.1</td>
<td>71.4±18.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social/Communication</td>
<td>70.7±21.3</td>
<td>69.3±23.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Skills</td>
<td>88.9±15.9</td>
<td>89.3±21.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal Living</td>
<td>70.3±19.0</td>
<td>72.2±16.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community Living</td>
<td>75.6±16.9</td>
<td>71.2±23.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*a AD < DD (p=.01); b PDD-NOS < DD (p=.005), AD < DD (p=.02); c PDD-NOS < DD (p=.04); d PDD-NOS < DD (p=.06)

Table 7. Results of MANOVA Analyses of Differences in Adaptive Behavior between Diagnostic Groups by Age
Correlations between NVIQ and Subscale Scores

For the PDD groups, NVIQ was significantly correlated with the following PDD symptom subscales: Social Approach Behaviors ($r = .32, p = .001$), Social Pragmatic Problems ($r = -.23, p = .02$), Sensory/Perceptual Approach Behaviors ($r = -.34, p < .001$). In terms of psychiatric and behavior problems, NVIQ was significantly negatively correlated with the Attention Problems subscale ($r = -.26, p = .006$), and the Aggression subscale ($r = -.24, p = .01$). NVIQ was significantly correlated with all five subscales of the SIB-R: Broad Independence ($r = .58, p < .001$), Social/Communication ($r = .60, p < .001$), Motor ($r = .46, p < .001$), Personal Living ($r = .36, p < .001$), Community Living ($r = .51, p < .001$).

For the DD group, NVIQ was significantly correlated with the Semantic Pragmatic Problems subscale of the PDDBI ($r = .32, p = .02$). In terms of psychiatric and behavior problems, NVIQ was significantly negatively correlated with the Attention Problems subscale ($r = -.28, p = .04$). NVIQ was significantly correlated with four out of the five subscales of the SIB-R: Broad Independence ($r = .44, p = .001$), Social/Communication ($r = .43, p = .001$), Motor ($r = .40, p = .003$), Community Living ($r = .50, p < .001$). Table 8 summarizes the results of correlations between NVIQ and subscale scores for PDD and DD groups.
<table>
<thead>
<tr>
<th></th>
<th>PDD Group (n=108)</th>
<th>DD Group (n=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PDDBI Subscales</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Autism Composite</td>
<td>-.15</td>
<td>-.09</td>
</tr>
<tr>
<td>Social Approach</td>
<td>.32**</td>
<td>.24</td>
</tr>
<tr>
<td>Social Pragmatic Problems</td>
<td>-.23</td>
<td>.03</td>
</tr>
<tr>
<td>Semantic Pragmatic Problems</td>
<td>.13</td>
<td>.32</td>
</tr>
<tr>
<td>Sensory/Perceptual</td>
<td>-.34**</td>
<td>-.14</td>
</tr>
<tr>
<td>Rituals/Resistance to Change</td>
<td>-.04</td>
<td>.01</td>
</tr>
<tr>
<td><strong>CBCL Subscales</strong></td>
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<td></td>
</tr>
<tr>
<td>Anxiety/Depression</td>
<td>-.06</td>
<td>-.04</td>
</tr>
<tr>
<td>Somatic Complaints</td>
<td>.11</td>
<td>.09</td>
</tr>
<tr>
<td>Attention Problems</td>
<td>-.26*</td>
<td>-.28</td>
</tr>
<tr>
<td>Aggression</td>
<td>-.24*</td>
<td>.03</td>
</tr>
<tr>
<td>Oppositional Behavior</td>
<td>-.14</td>
<td>-.001</td>
</tr>
<tr>
<td>Withdrawn</td>
<td>-.06</td>
<td>-.17</td>
</tr>
<tr>
<td><strong>SIB-R Subscales</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broad Independence</td>
<td>.58**</td>
<td>.44**</td>
</tr>
<tr>
<td>Social/Communication</td>
<td>.60**</td>
<td>.43**</td>
</tr>
<tr>
<td>Motor Skills</td>
<td>.46**</td>
<td>.40*</td>
</tr>
<tr>
<td>Personal Living</td>
<td>.36**</td>
<td>.10</td>
</tr>
<tr>
<td>Community Living</td>
<td>.51**</td>
<td>.50**</td>
</tr>
</tbody>
</table>

* p ≤ .01; ** p ≤ .001

Table 8. Correlations between NVIQ and Subscale Scores for PDD and DD Groups

**Secondary Analyses**

**Cluster Analysis**

Results of the cluster analysis of PDD symptoms indicated that a three-cluster solution best fit the data. The pseudo-$F$ statistic indicated that the two-, three- or four-cluster solution fit the data. Based on empirical criterion (pseudo $F$) and clinical meaningfulness, the three-cluster solution was selected. The two-cluster solution was discarded because it provided very little differentiation between diagnostic groups. The four-cluster solution was discarded because very few individuals were classified into the
fourth cluster. PDD-NOS and AD groups could not be distinguished in the three-cluster solution. The clusters in the three-cluster solution were characterized as follows: (1) **Cluster 1, Subthreshold PDD Symptoms**: Members of this cluster (35% of the sample) had an even PDDBI profile that suggested subthreshold social and communication impairment and few restricted/repetitive behaviors, (2) **Cluster 2, Language Impaired, Ritualistic**: Members of this cluster (32% of the sample) had a PDDBI profile suggesting higher rates of symptoms in the communication domain as well as the Rituals/Resistance to Change domains, (3) **Cluster 3, Typical Autism**: Members of this cluster (33% of the sample) had a PDDBI profile suggesting high rates of symptoms in the social, communication, and restricted/repetitive behaviors domain. Cluster 1 (Subthreshold PDD Symptoms) was composed of 22 children with DD (39%), 18 children with AD (32%), and 17 children with PDD-NOS (30%). Cluster 2 (Language Impaired, Ritualistic) was composed of 20 children with DD (38%), 17 children with AD (33%), and 15 children with PDD-NOS (29%). Cluster 3 (Typical Autism) was composed of 22 children with PDD-NOS (42%), 19 children with AD (36%), and 12 children with DD (22%). Table 9 summarizes the means and standard deviations of PDDBI subscale scores for the three cluster solution.
Table 9. Means and Standard Deviations of PDDBI Subscale T-Scores for the Three-Cluster Solution

<table>
<thead>
<tr>
<th></th>
<th>Cluster 1 (n=57)</th>
<th>Cluster 2 (n=52)</th>
<th>Cluster 3 (n=53)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social Approach</strong></td>
<td>51.7 (13.4)</td>
<td>64.1 (7.5)</td>
<td>53.2 (9.7)</td>
</tr>
<tr>
<td><strong>Social Pragmatic Problems</strong></td>
<td>41.6 (7.9)</td>
<td>44.6 (7.8)</td>
<td>62.2 (10.4)</td>
</tr>
<tr>
<td><strong>Semantic Pragmatic Problems</strong></td>
<td>46.6 (6.3)</td>
<td>51.9 (9.3)</td>
<td>58.4 (11.3)</td>
</tr>
<tr>
<td><strong>Rituals</strong></td>
<td>43.5 (6.5)</td>
<td>53.9 (9.2)</td>
<td>65.1 (9.5)</td>
</tr>
<tr>
<td><strong>Sensory</strong></td>
<td>42.9 (6.4)</td>
<td>45.8 (8.1)</td>
<td>62.4 (7.6)</td>
</tr>
<tr>
<td><strong>Autism Composite</strong>**</td>
<td>41.5 (12.5)</td>
<td>41.4 (8.1)</td>
<td>70.8 (22.9)</td>
</tr>
</tbody>
</table>

*Higher scores indicate less impairment on this subscale
**This variable was not included in the cluster analysis

**Discriminant Function Analyses**

The first discriminant function analysis identified items that could predict group membership between PDD (PDD-NOS and AD) and DD groups. Based on *p* values of <.004 to <.001, five items differed significantly between groups. In descending order of significance, these items were: item 2, “stares or looks out of sides of eyes at objects” [*t*(160)=3.58, *p*<.001]; item 18, “spins objects in a repetitive manner” [*t*(160)=3.47, *p*=.001]; item 130, “shows active awareness of toy representation of object or animal (i.e. makes sounds of toy animal, etc.)” [*t*(160)=3.42, *p*=.001]; item 41, “ignores the social approaches of people his/her own age” [*t*(160)=3.38, *p*=.001]; and item 30, “insists on taking the same route from one place to another” [*t*(160)=3.15, *p*=.002].

A stepwise discriminant function analysis was performed using these five items to determine which combination of items most accurately classified children as PDD or DD.
The following three items produced optimal discrimination when used together: item 30 (insists on taking the same route from one place to another), item 41 (ignores the social approaches of people his/her own age), and 130 (uses toy to represent object or animal). These three items correctly classified 68% of the sample; 68% and 67% of children with PDD and DD, respectively were correctly classified.

The second discriminant analysis identified which PDD symptoms distinguish between PDD-NOS, AD, and DD. Based on p values of <.004 to <.001, seven items differed significantly between groups. In descending order of significance, these items were: item 41, “ignores the social approaches of people his/her own age” [F(2, 160)=10.90, p<.001]; item 125, “selects his/her own toy to play with and allows others to play along” [F(2, 160)=8.98, p<.001]; item 126, “watches others and plays near them” [F(2, 160)=8.52, p<.001]; item 127, “initiates simple social play with others” [F(2, 160)=8.18, p=.001]; item 130, “shows active awareness of toy representation of object or animal”, [F(2, 160)=7.25, p=.001]; item 43, “actively avoids other people who are his/her own age when approached by them” [F(2, 160)=6.30, p=.003]; and item 39, “has problems understanding the need to be polite, or has problems understanding social relationships” [F(2, 160)=5.80, p=.004].

The discriminant analysis revealed that the optimal discrimination occurred when using the following two items: 41 (ignores social approaches of peers), and 130 (uses toy to represent object or animal). These two items correctly classified 52% of the sample; 33%, 48%, and 75% of the children with PDD-NOS, AD, and DD respectively. A summary table of group classification using these variables is presented in Table 10.
<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>PDD-NOS</th>
<th>AD</th>
<th>DD</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDD-NOS</td>
<td>18 (33%)</td>
<td>16 (30%)</td>
<td>20 (37%)</td>
<td>54 (100%)</td>
</tr>
<tr>
<td>AD</td>
<td>12 (22%)</td>
<td>26 (48%)</td>
<td>16 (30%)</td>
<td>54 (100%)</td>
</tr>
<tr>
<td>DD</td>
<td>4 (8%)</td>
<td>9 (17%)</td>
<td>41 (75%)</td>
<td>54 (100%)</td>
</tr>
<tr>
<td>Total</td>
<td>53</td>
<td>52</td>
<td>57</td>
<td>162</td>
</tr>
</tbody>
</table>

Table 10. Summary Table of Group Classification Using Discriminant Function Analysis
CHAPTER 4

DISCUSSION

*Differences between Groups in PDD Symptoms*

Overall, analyses of differences between diagnostic groups in PDD symptoms supported the prediction that significant differences would not be observed between PDD-NOS and AD groups when groups were matched on level of cognitive functioning. Significant differences between PDD-NOS and AD groups did not emerge for any of the subscales used to assess PDD symptoms. This is in contrast to previous studies that have reported a significant difference between groups in social impairment and repetitive behaviors as measured by the ADI-R and ADOS (Chakrabarti & Fombonne, 2005; deBruin et al., 2006; Lord et al. 2000; Robertson et al., 1999; Walker et al., 2004).

It is likely that the discrepancy in results can be attributed to several methodological differences between the current study and previous studies. The current study used a non-diagnostic measure to compare groups on PDD symptoms. Only three groups have used independent measures to compare subtype differences (Gadow et al., 2004, 2005; Verte et al., 2006; Walker et al., 2000). To increase the validity of studies examining subtype differences on PDD symptoms, the outcome measure should be independent of those used to make the diagnosis.

An additional methodological difference is that, unlike other studies, this one controlled for level of functioning. Of the previous studies that have used a non-
diagnostic measure, only one controlled for IQ. In that study, Verte et al. (2006) included only children with an IQ greater than 80, which restricts the extent to which conclusions can be applied to the entire population of individuals with PDDs.

Finally, this study used a comparison group composed of children with disorders that are similar to PDDs. Of the ten reviewed studies, six included a control group. Of these, in only two studies was the control group composed of children with ID or DDs. Examining differences between diagnostic groups requires a control group composed of similar disorders in order to establish whether differences between groups are due to the PDD itself or is something that is also associated with similar disorders. Lord and Corsello (2005) recommended that comparison groups in studies of PDDs include children with ID and language impairments.

The lack of differences in PDD symptomology between children with PDD-NOS and AD converges with the conclusion drawn by Witwer and Lecavalier (2008). Following their review of the literature, they concluded that previously-reported subtype differences might be a function of differences in IQ as opposed to true differences between groups. While it is clear that IQ is a salient dimension underlying differences between PDD subtypes, its role in moderating PDD symptom severity needs further investigation.

Correlational analyses in the PDD group indicated a significant association between NVIQ and both subscales of the PDDBI measuring social impairment. A positive correlation was found between NVIQ and the Social Approach Behaviors subscale, indicating more adaptive social behavior in children with higher NVIQ. A
negative correlation was found between NVIQ and the Social Pragmatic Problems subscale, indicating more social impairment with lower NVIQ.

The association between level of functioning and social impairment in PDDs has been well-documented (Borden & Ollendick, 1994). Despite the association between level of functioning and symptom severity, these dimensions should not be misunderstood to be equivalent. In a study of families with more than one child diagnosed with PDD, it was shown that while level of functioning was similar between affected siblings, symptom severity was not (MacLean, Szatmari, Jones, Bryson, Mahoney, Bartolucci, et al., 1999). In this study, adaptive behavior was used as the measure of level of functioning. It was concluded that although both dimensions (level of functioning and symptom severity) underlie the phenotypic variation in autism, they are distinct factors and may have different etiological mechanisms.

In the PDD sample, NVIQ was also significantly negatively associated with the Sensory/Perceptual Approach subscale in the restricted and repetitive behaviors domain of the PDDBI. It has been shown that the presence of repetitive behaviors in individuals with PDDs may be moderated by level of functioning (Bodfish et al., 2000). Furthermore, recent studies suggest that different forms of restricted and repetitive behaviors are associated with level of functioning (Szatmari et al., 2006; Cuccaro et al., 2003). These groups have found that the domain of repetitive behaviors is composed of two factors: repetitive sensory motor actions and resistance to change. Similar to the current study, Szatmari et al., and Cuccaro et al. both found a significant negative correlation was found between level of functioning and repetitive sensory motor actions. Cuccaro et al. proposed that repetitive sensory motor actions may be an index of low cognitive ability.
and not necessarily specific to PDDs, while behaviors representing resistance to change may be more specific to PDDs.

It has also been suggested that restricted and repetitive behaviors might index autism severity (Bodfish et al., 2000). If PDD-NOS is indeed a less severe form of AD, one might expect fewer restricted and repetitive behaviors in this group. In the current study, differences did not emerge between PDD-NOS and AD groups with respect to either form of restricted and repetitive behaviors. It may be that previously-reported differences between PDD subtypes in this domain can be accounted for by level of functioning, as was reported by Lord et al. (2000).

The subscale of the PDDBI measuring communication impairments was not significantly correlated with NVIQ in the PDD sample. When interpreting this result, it is important to keep in mind that the subscale used to assess communication impairment in the current study assessed difficulties in the pragmatic use of speech. Pragmatic communication is defined as the appropriate use and interpretation of verbal and non-verbal language in relation to social situations (Rapin, 1996). Pragmatic deficits in communication are part of the definition of AD. Studies that have compared children with AD to control groups matched on IQ or mental age have consistently indicated that children with AD show impaired pragmatic language skills relative to matched controls (Tager-Flusberg et al., 2005; Tager-Flusberg, 2000). This indicates that the pragmatic aspect of language impairment that composes the core communication deficit in PDDs cannot be accounted for by cognitive impairment alone. Indeed, when children with AD are compared to groups matched on general language ability, IQ, or mental age on other aspects of language, such as receptive or expressive phonological, syntactic,
morphological, or semantic ability, no differences emerge between groups (Capps, Kehres, & Sigman, 1998; Norbury & Bishop, 2002).

Contrary to the results of the PDD group, in the DD group, the only subscale of the PDDBI that showed a significant correlation with NVIQ was the subscale measuring communication impairment. A negative correlation was found between NVIQ and the Semantic/Pragmatic Problems subscale, indicating that children with lower NVIQ had more communication impairment. Taken with the results of the PDD group, this suggests that whereas pragmatic deficits in children with DDs can be partially accounted for by cognitive ability, in children with PDDs, pragmatic language deficits are accounted for by their PDD diagnosis. This is consistent with research comparing language ability in children with AD and matched controls that have indicated that pragmatics are a core and defining deficit in AD.

Of interest is the finding that the scores on some subscales of the PDDBI were not significantly different between the PDD and DD groups. The DD group provided a very stringent comparison group, with nearly 80% of the children in this sample meeting criteria for a language disorder, cognitive impairment, or a developmental disability. It has been noted in the literature that children with developmental language disorders, ID, or other DDs demonstrate impairment in socialization, language, or restricted behavior, and thus have symptoms resembling those of PDDs (Einfeld & Tonge, 1996; Bishop & Norbury, 2002).

*Differences between Diagnostic Groups on Psychiatric and Behavior Problems*

It was predicted that the PDD-NOS and AD groups would have greater rates of psychiatric and behavior problems as compared to the DD group. This hypothesis was
partially supported in that overall, scores for the PDD-NOS group were higher on all scales as compared to the other two groups, with the AD group generally occupying the intermediate position.

Contrary to the hypothesis that no differences between PDD-NOS and AD groups would emerge in psychiatric and behavior problems, results indicated greater anxiety and affective symptoms in the PDD-NOS group as compared to the AD group. These results are consistent with previously published reports on differences between PDD subtypes in psychiatric and behavior problems. Although neither study controlled for IQ, Gadow et al. (2005) and Weisbrot et al. (2005) both found higher rates of anxiety symptoms in children with PDD-NOS as compared to those with AD.

Interpretation of the results of previous studies has been limited, as level of functioning was not taken into consideration. It has previously been unclear whether the higher level of anxiety in children with PDD-NOS is a function of the association between higher IQ and greater anxiety symptoms. In light of the current results, it appears that the tendency towards greater anxiety in children with PDD-NOS is not fully due to a higher level of functioning. In a study examining differences in anxiety and mood symptoms between children with Asperger’s Disorder and AD, Kim et al. (2000) examined the role of IQ in predicting anxiety symptoms. This group did not find evidence that NVIQ or verbal IQ alone predict anxiety symptoms, but did find that a higher verbal – nonverbal split accounted for a portion of the variance in anxiety and mood symptoms. In the current study, there was not a significant difference in VIQ between PDD-NOS and AD groups. Additionally, correlational analyses indicated that NVIQ was not significantly correlated with the Anxiety/Depression subscale for the PDD
or DD groups. The current results suggest that the greater levels of anxiety and affective problems in children with PDD-NOS as compared to those with AD may not be an artifact of IQ but rather might represent a true difference between groups.

Of note is that the PDD-NOS and AD groups had essentially equivalent scores as the DD group on the Attention Problems subscale. It is important to remember that approximately 20% of the DD group was composed of children with a clinical diagnosis of ADHD. The finding that children with PDD diagnoses have equal, or higher, symptoms of ADHD as children with the diagnosis is not novel (Luteijn et al., 2000). It does, however, emphasize the fact that co-morbid attention problems in children with PDDs occur frequently. Currently, the DSM-IV does not permit the diagnosis of ADHD when a PDD is also diagnosed. Due to the functional impairment caused by ADHD symptoms, this is an issue that may warrant revision in the coming version of the DSM.

**Differences between Diagnostic Groups on Adaptive Behavior**

As predicted, the current study did not find significant differences in adaptive behavior between PDD-NOS and AD groups when matched on NVIQ. These results are in contrast to those of Walker et al. (2004), who found that children with PDD-NOS had higher scores on the communication, daily living skills and socialization subscales of the Vineland Adaptive Behavior Scales. This discrepancy can be accounted for by differences in IQ between subgroups in the Walker et al. study.

Also consistent with the hypothesized results is the finding that the AD and PDD-NOS groups had lower adaptive behavior scores as compared to the DD group. This is consistent with the substantial discrepancy between cognitive ability and adaptive functioning that is characteristic of children on the autism spectrum (Klin, Saulnier,
Sparrow, Cicchetti, Lord, & Volkmar, 2007). Similar to the results of Tomanik et al. (2007) these results support the use of an adaptive behavior measure in the clinical assessment of PDDs. As stated previously, the DD group used in the current study was composed of children with behavioral profiles similar to those with PDDs, and represents children who are referred to a tertiary autism clinic for a diagnostic assessment. Despite being matched to the PDD groups on cognitive functioning, differences in adaptive behavior emerged. The addition of an adaptive behavior measure to a diagnostic battery may assist in differentiating PDDs from closely related disorders.

**Changes in Symptom Expression with Development**

Investigations of changes in symptom expression with development can help distinguish differences between the PDD-NOS and AD groups and can assist in validating PDD subgroups. For example, if it was found that relative to children with AD, PDD symptoms in children with PDD-NOS had different symptom endorsements with age this may provide evidence for a distinction between these diagnostic categories.

According to Robins and Guze (1970), if diagnostic groups differ in terms of symptom change or prognosis, this can provide evidence of valid distinctions between groups. Contrary to the expectation that social symptoms would improve for the PDD-NOS group with age, significant diagnosis by age interactions on measures of PDD symptoms were not found. Significant interactions were also not found with respect to changes in psychiatric or behavior problems. The current results indicate that differences do not exist between subtypes with respect to rates of symptoms in preschool versus school age groups.
The effect of age was significant for two PDDBI subscales: Social Approach Behaviors, and Rituals/Resistance to Change. For both subscales, scores were lower in the older group. For the Social Approach Behaviors subscale, this indicates that children in the older group had more impaired social approach behavior. Higher rates of symptoms of social impairment in older children with PDDs are consistent with previous studies comparing social symptoms in preschool and school age children (Lord et al., 2006). On the Rituals/Resistance to Change subscale, lower scores in the older group indicates fewer symptoms in this age range. The PDD-NOS and DD groups showed the biggest difference in scores between age groups. This is consistent with the results of Lord et al. (2006), who found a trend of decreasing rates of repetitive behaviors in school age children with PDD-NOS as compared to those in the preschool age range. The assessment measure in the study by Lord et al. was the ADOS, which is not ideal to measure restricted and repetitive behaviors since the domain score is based solely on the observations within the time span of the assessment. Other researchers have suggested that symptoms of resistance to change in children with AD emerge later in life (Stone, Hoffman, Lewis, & Ousley, 1994). Studies of ritualized behavior in children with DD also indicate that these symptoms increase with age (Thompson & Berkson, 1985).

For all three diagnostic groups, adaptive behavior scores were significantly lower in the school-age children. This effect may be due to the slightly lower average NVIQ of the school-age groups relative to the preschool group. Despite this, the adaptive behavior scores for the school-age sample are on average a standard deviation or more below the NVIQ scores, emphasizing the impairment in acquisition of real-life skills. These results
emphasize the failure of children with DDs to acquire adaptive skills at a rate commensurate with their chronological development.

Secondary Analyses

Results of the cluster analysis indicated that the empirically-derived clusters did not correspond to clinical diagnoses. Although three clusters were identified and each contained approximately 1/3 of the total sample, the distribution of individuals with PDD-NOS, AD, and DD were similar within each cluster. Considerable diagnostic overlap was found within each cluster.

Given the significant differences between PDD and DD groups on the PDDBI subscales, one might expect that the DD group would form its own cluster. However, nearly 40% of the DD group was included in the Language Impaired, Ritualistic cluster. This cluster was characterized primarily by high scores on the Semantic/Pragmatic Problems subscale. An examination of the diagnostic make-up of the DD group helps to explain this result. Thirty-three percent of this group had a diagnosis of a language disorder. As discussed earlier with respect to differential diagnosis of PDD-NOS, children with developmental language disorders can evidence similar deficits in pragmatic communication as children with PDDs. Because the subscale included in the current study assessed specifically for pragmatic language deficits, it is likely that some children in the DD group had high scores on this subscale and were classified in the cluster that best reflected language impairment.

In contrast to previous studies, in the current study, PDD-NOS and AD groups could not be reliably differentiated using cluster analysis. One factor that could explain the difference in results is the use of an independent measure in the current study. As
discussed previously, Verte et al. (2006) used the ADI-R to diagnose subtypes and also as the dependent variable in the cluster analysis. The resulting distinct PDD-NOS and AD clusters are therefore likely due to the criteria used to define these subtypes rather than empirical differences between them. The discrepancy in results may also be due to differences in how level of functioning was controlled. In the study by Verte et al. (2006), level of functioning was controlled by restricting the sample to high-functioning children, and Shen et al. (2007) did not account for level of functioning between groups. In both of these studies, it is possible that cognitive functioning may have played a role in the formation of subgroups.

Discriminant function analysis was used to shed light on the types of symptoms that discriminate PDD and DD groups. Analyses performed prior to the discriminant function analysis identified five items that were significantly different between PDD and DD groups. Three out of the five items assessed restricted and repetitive behavior. Of these three items, two assessed sensory/motor behaviors (*staring out of sides of eyes, spinning objects*) and one assessed insistence on sameness (*insists on taking same route*). All three of these items were significantly higher in the PDD group. These results might appear to be in contrast to the notion that symptoms from the ‘insistence on sameness’ domain of restricted and repetitive behavior are better indicators of PDDs (Cuccaro et al., 2003). However, when the most discriminating of these five items were identified in the discriminant function analysis, the two items assessing sensory/motor actions were not selected.

The discriminant function analysis revealed that a set of three PDD symptoms most accurately differentiated the DD group from the PDD group. The three items
consisted of one item from each of the three core domains of PDDs. Social impairment was represented by the item “ignores social approaches by peers,” communication was represented using the item “uses toys to represent objects or animals,” and restricted and repetitive behaviors were represented by the item “insists on taking the same route.” Deficits in symbolic and imaginative play have been shown to be early indicators of communication impairment in PDDs (Rogers, Cook, & Meryl, 2005). When PDD-NOS and AD were combined into one category, these three items had a correct classification rate of 68%. This combination of items correctly classified PDD (68%) and DD (67%) groups equally. When used together, items from the three domains of PDDs appear to have only mild success in distinguishing PDDs from similar disorders.

Items that significantly differed between PDD-NOS, AD, and DD groups, included six items assessing social deficits and one item assessing communication impairment. The items assessing social impairment were evenly split between those that represent maladaptive social skills (ignoring social approaches, actively avoiding peers, problems understanding the need for politeness or social relationships) and items that assess adaptive social skills (allows others to play, watches others and plays near them, initiates social play). Items assessing social impairment appear to be more heavily represented in the analysis in which the aim was to distinguish PDD-NOS, AD, and DD. This is consistent with views that regard the autism spectrum as a dimension of deficits in social interaction (Wing, 2005). In these models, the severity of social impairment differentiates PDD-NOS from disorders at each of its boundaries.

The discriminant function analysis revealed that when the most significantly discriminating items are used, only a 52% correct classification rate is achieved. While
these items appeared to perform relatively well in discriminating PDD-NOS and AD from the DD group, the majority of the misclassification occurred due to classifying PDD-NOS as AD, and AD as PDD-NOS. This is likely due to the fact that none of the items included in the discriminant function analysis showed significant differences between PDD-NOS and AD groups. Taken with the results of the cluster analysis, it appears that when level of functioning is accounted for, PDD-NOS and AD groups cannot be distinguished based on empirical methods using parent-reported symptoms.

The results of the secondary analyses need to be interpreted in light of the limitations of the statistical techniques used. Discriminant function analysis and cluster analysis are both highly sample-dependent techniques (Press & Wilson, 1978; Milligan & Cooper, 1987). Comparisons of results between studies and the generalization of results are hampered due to this limitation. Additionally, there is a difference between statistical and clinical significance. Simply put, just because a statistically-significant result is found within the context of a research study, it does not mean that the results will be of practical or clinical significance. An examination of the mean PDDBI subscale scores within each cluster illustrates this point. Although clusters were identified as statistically significant from one another using the pseudo-$F$ statistic, there were relatively small differences between clusters with respect to the mean PDDBI scores. The extent to which a 5-10 point difference in a subscale score would be clinically meaningful in distinguishing subtype differences is uncertain. It is the responsibility of researchers to interpret such results in terms of their clinical implications.
Limitations

Strengths of the current study included a well-characterized sample, groups matched on level of functioning, a measure of PDD symptoms completed by parents who were “blind” to their child’s diagnosis, and the use of a non-diagnostic measure of PDD symptoms.

Limitations of the current study relate to the instruments used. The PDDBI is useful in that it assesses a wide range of PDD symptoms that are not derived exclusively from the DSM-IV. However, the subscales that assess communication deficits do not all measure core features of PDDs. As a result, the current study was limited to the use of one subscale to assess for differences in communication impairment between groups. Although relevant and consistent results emerged using the Semantic/Pragmatic Problems subscale, it limited the extent to which communication items were represented in the group comparisons and discriminant function analysis. The use of a more comprehensive or widely-used measure, such as the ADI-R, may have produced more readily-interpretable results. The assessment of psychiatric and behavior problems was limited to the subscales included on the CBCL, and further limited by the differences in subscales produced by the Preschool and School Age versions. Finally, the SIB-R is limited in that there are fewer items that apply to children at younger ages or lower levels of functioning. This contributed to reduced variance in scores in the younger age group.

The PDDBI, CBCL and SIB-R were all completed by parents. Scores on these measures are subject to parents’ interpretation of items. Although the parent responses on the SIB-R were verified during the assessment, this was not done systematically. Interviews administered by clinicians, such as the ADI-R, or Vineland Adaptive Behavior
Scales, may have improved the reliability and validity of item endorsements due to greater objectivity and experience with PDDs in clinicians as compared to caregivers.

Limitations also include the absence of a DSM-IV checklist or standardized measure of DSM symptomatology used in the diagnostic assessment. Although the clinicians employed in the current study are very experienced with diagnosing and assessing PDDs according to DSM-IV criteria, a standardized measure would have contributed to greater reliability of diagnosis, and the examination of patterns of symptom endorsement between groups.

Studies of PDD-NOS are hampered by the absence of a gold standard for diagnosis. As discussed previously, the reliability and validity of DSM-IV criteria in the diagnosis of PDD-NOS is not ideal. Furthermore, the diagnostic stability of PDD diagnoses in preschool children indicate that on average, only 30% of children diagnosed with PDD-NOS retain the diagnosis into early childhood (Lord et al., 2006; Kleinman et al., 2008). This creates a problem for studies that aim to better characterize PDD subtypes in young children, as it is unclear how reliable the subtypes are at this age. Despite these limitations, the only way to improve upon the current diagnostic system is to research it as it is currently written, without making modifications.

The final sample included only 36% of the initial pool of subjects. Although the matching procedure was partially responsible for reducing the sample size, the largest group of subjects was discarded due to missing data. Cognitive functioning and adaptive behavior scores were not available for all of the participants due to behavior problems that prevented reliable assessment of IQ, or families not returning to the clinic for their
second appointments. This may have introduced a sampling bias, as the children for whom scores were available may be those with less severe behavior problems.

Children with Asperger’s Disorder were also excluded. The study would have been improved if this group were included, as it would have contributed to further refinements of the boundaries of PDD-NOS. Comparisons between all three PDD subtypes would have further contributed to the elucidation of PDD-NOS as a distinct subtype.

Groups were matched on cognitive functioning based on scores from a variety of assessment measures, including some that do not produce a NVIQ. This may have decreased the comparability of IQ scores between subjects and decreased the precision of the matching procedure. This problem was minimized by using ordinal scores to match groups, however, a uniform cognitive measure would have allowed for a more precise matching procedure.

An additional limitation of the current study includes the cross-sectional design, which limits inferences in terms of the developmental trajectory of these disorders. Because of this, interpretations regarding age trends will need to be further investigated in studies employing a longitudinal design.

**Implications and Directions for Future Research**

The results of the current study contribute to contemporary research examining the validity of PDD-NOS as a diagnostic category by providing a clinical description of the disorder and specifying it’s boundaries with AD. In doing so, the current study adhered to the first three phases of the method proposed by Robins and Guze (1970) to validate psychological disorders. Results of the analyses demonstrated that when level of
functioning is controlled for, PDD-NOS cannot be discriminated from AD. The only
distinction between PDD-NOS and AD to emerge in the current study is the presence of
greater anxiety and affective symptoms in children with PDD-NOS.

Common conceptualizations of the autism spectrum have focused on social
impairment as the primary metric of the continuum (Wing, 2005). The view that PDD-
NOS represents a “mild PDD” implies that the primary difference between AD and PDD-
NOS is milder social deficits in the latter group. The current study did not find
differences between groups on social impairment. In light of these results, the notion of
an autism spectrum that is differentiated by the degree of impairment in PDD symptoms
does not seem to be sufficient to capture the true variability among PDD subtypes. IQ
appears to be an additional salient dimension of the heterogeneity found in PDDs. As
found in this study, when differences in level of functioning are eliminated between
groups, so are the differences in PDD symptoms.

The DSM and ICD diagnostic systems do not include information regarding
cognitive functioning and instead rely solely on PDD symptoms to classify subtypes.
This system implies that PDD subtypes differ in the number and severity of PDD
symptoms, which may not be the case, as differences may be better explained by IQ.
Results of this study support the proposals by other researchers to incorporate level of
functioning into classification systems for PDDs (Lord, Leventhal, & Cook, 2001;
Szatmari, 2000). Accounting for cognitive functioning would enhance the validity of
classification systems, as it would reduce the possibility that differences between
subtypes are due to level of functioning. Additionally, utilizing a metric of level of
functioning in the classification of PDDs would also benefit studies aiming to identify
etiological mechanisms. Skuse (2007) argued that genetic risk factors that are specific to PDDs require the study of individuals with PDDs who do not have cognitive impairments. A classification system that includes level of functioning would contribute to easier identification of subgroups.

The proposal to account for level of functioning in the classification of PDDs raises the question of the appropriate metric to be used to measure this variable. One possibility is NVIQ, as it is independent from the communication deficits associated with PDDs. However, some argue that IQ scores are poor measures of level of functioning because they are based on performance in the artificial setting of the testing environment (Szatmari et al., 2002). A more ecologically valid assessment might be obtained by using measures of adaptive behavior, which measure skill performance in real-life situations (Volkmar, Carter, Sparrow, & Cicchetti, 1993). Further studies are needed to assess the usefulness of these constructs in the classification of PDDs.

The initial proposal for the DSM-V classification of PDDs blends well with the results of the current study. According to this proposal, the categories of AD, Asperger’s Disorder, and PDD-NOS would be collapsed into one spectrum of autistic disorders, called Autism Spectrum Disorders (Lord, 2009). Instead of being classified by subtype, individuals would receive dimensional severity estimates on the following two symptom domains: social/communication, and restricted and repetitive behaviors (including stereotyped language). The results of the current study supports the notion of collapsing PDD-NOS and AD categories, as differences in core features did not emerge. As was also suggested by the results of the current study, this proposal incorporates level of functioning into the classification system. Verbal abilities as well as level of cognitive
impairment are accounted for. Diagnostic criteria within the DSM-V symptom domains would be operationalized according to age level (preschool, childhood, adolescent/adult) and verbal level (non-verbal, phrase speech, and fluent speech). Additionally, qualifiers would be added to the diagnosis to denote ID, language delay, and comorbid genetic disorders.

Revisions to the DSM-IV will ultimately be judged on whether they result in greater validity of diagnoses. Modifications that achieve this goal are those that promote correct identification of the disorder, improve the clinical decision making, and promote progress in the understanding of the disorder’s etiology (Kraemer, Shrout, & Rubio-Stipec, 2007). Based on the lack of empirical evidence supporting the distinction of PDD subtypes, it appears that the proposed model for the DSM-V improves upon our current model, yet this is still an empirical question. Establishing the validity of a psychiatric nosology is a process of bootstrapping, which denotes a cyclical process of using research knowledge to develop a diagnostic algorithm, using the algorithm to develop additional research knowledge, and then further refining the algorithm (Kraemer et al., 2007).

The finding that children with PDD-NOS have higher rates of anxiety and affective problems than children with AD needs to be explored further. It is possible that this difference between groups may reflect true discrepancies in patterns of comorbidity between PDD subtypes. However, because the CBCL is not a DSM-based rating scale, it can assess for anxiety symptoms but not anxiety disorders. Conversely, this finding prompts consideration of to what extent the anxiety symptoms endorsed by children with PDD-NOS reflect impairments associated with the PDD itself. It may be that the
differences between groups in anxiety and affective symptoms reflect subtype differences in the manifestation of the core deficit of reciprocal social interaction.

Items included on the Anxiety/Depression subscale included those that indicate impaired social skills, such as social avoidance, social anxiety, and social withdrawal. Such symptoms may be indicators of impairment in social interactions that distinguish PDD-NOS from AD but are not currently included in our classification systems. If so, this would suggest subtype differences in the manifestation of PDD symptoms and would indicate the need to explore the utility of incorporating these symptoms into current classification schemes. It has been suggested by others that in developing a more accurate definition of PDD-NOS, it might be worthwhile to consider the use of symptoms not currently used in the DSM and ICD definitions of PDDs, such as symptoms of anxiety and mood disturbance (Buitelaar et al., 1999).

Clinical implications of these findings include the need for routine assessment for psychopathology in children diagnosed with PDD-NOS. In addition to possibly being of use with respect to classification, the presence of co-morbid disorders has clear treatment implications. Treatments that have been shown to be effective for anxiety or mood disorders may be indicated for children with PDD-NOS who present with significant anxiety or mood disturbance.

Future research is needed to replicate the current results. Additional studies of subtype differences that account for level of functioning are necessary to confirm the current results. Such studies will contribute towards a reliable clinical description of PDD-NOS. Once this is achieved, the field can move forward to the next steps in the Robins and Guze (1970) process of validating psychiatric disorders.
Additional studies are also necessary to clarify the patterns of associated psychiatric and behavior problems in PDD subtypes. Studies that investigate the extent to which symptoms of Social Anxiety Disorder or Separation Anxiety Disorder reflect clinical variants of the social impairment characteristic of PDDs appear to be warranted. The use of interviewer-based assessments of anxiety symptoms may help to distinguish anxiety symptoms from those related to PDDs. Another approach might be to use established psychopharmacological or behavioral treatments to treat the anxiety symptoms and assess the residual impairment and the extent to which anxiety and PDD symptoms overlap.

Longitudinal studies are needed to explore further the differences in symptom trajectory between PDD subgroups. Differences in age-related symptom expression can help to refine existing PDD subgroups by providing evidence for similar or distinct courses of the disorder. Results of such studies may indicate the need for the merging of diagnostic categories on the basis of similar outcomes across groups, or for the separation of categories based on distinctly different outcomes.

Despite the lack of support in the current study for the distinction between PDD-NOS and AD, PDD-NOS should not be discarded as a diagnostic category. Current classification systems do not offer an alternative for children who do not meet criteria for AD. The prevalence of these individuals and the impairment caused by the disorder are sufficient reasons to retain the diagnostic category of PDD-NOS. The field will benefit, however, from sustained efforts to better characterize this group of individuals. Foremost in this research is the identification of the demarcations within the PDD spectrum that can inform the creation of valid subtypes. Further refinement and clarification of the clinical
description of PDD-NOS will contribute to a more reliable classification system and more consistency in the diagnosis and research of this disorder.


impairment, pragmatic language impairment, and high-functioning autism. *International Journal of Language and Communication Disorders, 37, 227-251.*


