2012

Comparing symptoms of Autism Spectrum Disorders using the current DSM-IV-TR diagnostic criteria and the proposed DSM-V diagnostic criteria

Julie A. Worley
Louisiana State University and Agricultural and Mechanical College

COMPARING SYMPTOMS OF AUTISM SPECTRUM DISORDERS USING THE CURRENT *DSM-IV-TR* DIAGNOSTIC CRITERIA AND THE PROPOSED *DSM-V* DIAGNOSTIC CRITERIA

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctoral of Philosophy

in

The Department of Psychology

By
Julie A. Worley
B.A., Indiana University of Pennsylvania, 2003
M.S., Philadelphia College of Osteopathic Medicine, 2005
M.A., Louisiana State University, 2009
August, 2012

Table of Contents

Abstract

Children diagnosed with Autistic Disorder (AD), Asperger's Disorder (AS), and Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS) share overlapping diagnostic criteria. As a result, there has been an enduring debate regarding the appropriateness of the current categorical classification system used to diagnose this group of disorders, commonly referred to as Autism Spectrum Disorders (ASD). Ongoing research examining the boundaries of the disorders comprising the spectrum have yielded inconsistent findings in symptom differences; therefore, the American Psychiatric Association has proposed revisions for the upcoming version of the *Diagnostic and Statistical Manual of Mental Disorders* (i.e., *DSM-5*). Revisions include dropping all subcategories of ASD and including one dimensional category that is all encompassing. Thus, the aim of the current study was to compare symptoms of ASD in children and adolescents who met criteria for ASD according to only the *DSM-IV-TR* (i.e., DSM-IV-TR group) to those who met criteria according to the forthcoming version of the *DSM* (i.e., DSM-5 group) and to those that were typically developing (i.e., control group). Using the *Autism Spectrum Disorders – Diagnosis for Children,* participants in the DSM-IV-TR and DSM-5 groups did not score significantly different from each other on overall autism symptoms, but both groups scored significantly different from the control group. Upon further investigation, the DSM-IV-TR and DSM-5 groups scored significantly different in the core domain area of Nonverbal Communication/Socialization. Additionally, different symptom profiles predicted group membership when participants were classified as ASD or typically developing according to the *DSM-IV-TR* versus the *DSM-5* diagnostic criteria. Implications of these findings and the implications of the proposed changes to the ASD diagnostic category for the *DSM-5* are discussed.

Introduction

Autism Spectrum Disorders (ASD) are a group of neurodevelopmental disorders that share overlapping diagnostic criteria related to deficits in communication, deficits in socialization, and restricted interests and repetitive behaviors. Due to these overlapping diagnostic criteria, controversy regarding the differences between disorders comprising the spectrum is longstanding (Matson, Nebel-Schwalm, & Matson, 2007; Tantum, 1988). Thus, an aim of research has been on parceling out differences among the disorders encompassed under the umbrella term of ASD (e.g., Eisenmajer et al., 1996; Noterdaeme, Wriedt, & Höhne, 2010; Ozonoff, South, & Miller, 2000; Piven, Bailey, Ranson, & Arndt, 1997; Rinehart, Bradshaw, Moss, Brereton, & Tonge, 2001; Tonge, Brereton, Gray, & Einfeld, 1999). To date, the question remains as to whether less severe forms of ASD represent clusters of symptoms distinct from other disorders on the autism spectrum or are just variants of other established and recognized disorders (Matson & Wilkins, 2008). However, the failure to find any consistency in differences between these disorders advises that they do not have discrete boundaries, but instead exist on a continuum ranging in symptom severity (Manijiviona & Prior, 1995). More specifically, it has been suggested that Asperger's Disorder (AS) and Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS) are less severe forms of Autistic Disorder (AD; Eisenmajer et al., 1996; Prior et al., 1998; Szatmari, Archer, Fisman, Streiner, & Wilson, 1995). In addition, the lack of the identification of biological markers provides further debate in regards to the reliable distinction between subtypes of ASD (Palmen & Engeland, 2004). Thus, can the variability in clinical phenotype that distinguishes the various ASDs be accepted without known variability in genotypes?

Due to the ambiguity surrounding the boundaries of the various disorders comprising the autism spectrum, proposed revisions for the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (*DSM-5*, American Psychiatric Association [APA], 2011) include dropping the subcategories of ASD and instead having one dimensional category. Amalgamating all disorders comprising the spectrum into one diagnostic category will result in greater heterogeneity within the ASD diagnostic category, greater than the heterogeneity of symptoms that currently exists within either AD, AS, or PDD-NOS. However, this major revision proposed for the *DSM-5* should maintain the sensitivity of ASD diagnoses while increasing the specificity (APA, 2011). As such, individuals who present with less severe symptoms of ASD may no longer be diagnostically identified. Therefore, the aim of the current study was to compare ASD symptomatology in children and adolescents who only met diagnostic criteria for ASD according to the *DSM-IV-TR* (APA, 2000) to those who met criteria according to the proposed *DSM-5* and to those who were typically developing. The children and adolescents included in the current study were evaluated in regards to their overall scores and factor scores on the *Autism Spectrum Disorders – Diagnosis for Children* (*ASD-DC*; Matson & Gonzalez, 2007).

Secondly, the current study determined how the DSM-IV-TR and DSM-5 groups could be differentiated from typically developing children. That is, did different symptom profiles discriminate between typically developing children and children meeting either the current only or future diagnostic criteria for ASD? The literature review below outlines research conducted on differentially diagnosing within the autism spectrum. This review highlights the inconsistencies in the research to date, which ultimately assisted in proposing the new dimensional approach to diagnosing ASD.

History of Autism Spectrum Disorders

Leo Kanner (1943) was the first to describe a group of children who presented with three common behavioral characteristics including social detachment, communication deficits, and stereotypical behavior. These clusters of symptoms became known as early infantile autism (Kanner, 1951). Although the diagnostic criteria of AD have been amended since 1943, the symptoms first described by Kanner largely remain consistent with the current definition.

The eleven children first encountered by Kanner all had deficits in communication. That is, they either never developed the ability to speak (n = 3) or were able to verbally communicate (n = 8), but communication was not typical. Of those who were verbal, echolalia was common (i.e., repetition of previously heard phrases), pronouns were reversed (e.g., you instead of I), inflection errors were made (i.e., questions instead of comments), and spoken words lacked meaning (e.g., saying yes for everything, not just during affirmations).

Another commonality observed by Kanner was the children's desire for structure. That is, the children encountered by Kanner desired sameness in regards to routine, organization of furniture and other household items, and play objects. These children functioned best when surrounded by a predictable environment (Kanner, 1951). Furthermore, if changes were made, it was only the child who was able to make them (1951). Any disruptions to routines, unless made by the child, caused the child to become upset.

Lastly, Kanner described what he considered the core characteristic of AD, the inability to relate to others in a typical way. This resulted in the children's tendency to be aloof and their desire to be alone. The children he encountered preferred interacting with objects over people, likely because they had more control over objects and objects remained more consistent. In

addition, the children he described often failed to make eye contact, were uninterested in others conversations, and played alone instead of with their peers.

Thirty years later, Kanner conducted a follow up study of the eleven children he encountered and described in his seminal 1943 paper. Although the three main consistencies in the behavioral phenotype of the disorder remained evident, heterogeneity of symptoms of ASD were also apparent (Kanner, 1971). In addition, deficits in cognition were reported for these children (1971), even though Kanner's first description indicated such deficits were not associated with ASD (Kanner, 1943).

In 1944, Hans Asperger, encountered a number of children whose symptom presentation was similar to those described by Kanner. Coincidentally, Asperger also used the terminology autistic to describe these children and labeled this constellation of symptoms as "autistic psychopathology" (Frith, 1991). Autistic psychopathology is now known as Asperger's Disorder, coined by Lorna Wing (Wing, 1981). Although these observations were made only a year after Kanner's description of early infantile autism, the work of Asperger did not become popular until translated by Frith (1991). As a result, AS was not acknowledged as a separate diagnostic category until its addition into the *DSM-IV* (APA, 1994) and the *International Classification of Diseases, Tenth Edition* (ICD-10; World Health Organization [WHO], 1992).

Asperger (1944) described the symptoms of the children he observed as the following: they had very intense interests, had deficits in nonverbal communication, verbally communicated with others (although speech was often verbose, pedantic, and monotone), were emotionally disconnected, lacked empathy, lacked social skills, had poor coordination of motor movements, and were often in the average range of cognitive functioning (Attwood, 2007; Schopler,

Mesibov, & Kunce, 1998). In addition, the children he described did not typically reveal symptoms until after 36 months of age (Tantum, 1988).

In an attempt to bring attention to the syndrome described by Asperger and to differentiate it from Kanner's autism, Van Krevelen reviewed the work of both. First, Van Krevelen and Kuipers (1962) highlighted that Kanner referred to the symptoms as a course, whereas Asperger described the symptoms as traits representing stability. Nearly a decade later, Van Krevelen (1971) again reviewed the work by both Kanner and Asperger in order to outline more specific differences between the two disorders. By his conclusions, the following differences existed: age of diagnosis (infancy for AD and elementary age for AS), attainment of developmental milestones (AD able to walk first and AS able to talk first), socialization (prognosis poorer for AD), eye contact (nonexistent for AD and evaded for AS), and language (non functional for AD and functional, but one sided for AS). In sum, Van Krevelen indicated that it was "unmistakably clear that early infantile autism and autistic psychopathology are two entirely different nosological syndromes" (Van Krevelen, 1971, p. 84).

More recently, Mayes, Calhoun, and Crites (2001) reexamined the descriptions of the children initially encountered by Asperger (1944). In contrast to Van Krevelen's (1971) conclusions, Mayes and colleagues concluded that the four children initially described by Asperger (1944) would now meet current diagnostic criteria for AD. Thus, Mayes and colleagues failed to find a distinction between the two groups of children described by Kanner and Asperger when utilizing the current diagnostic criteria.

Diagnostic Classification of ASD

Making diagnostic decisions within the autism spectrum has long been a source of controversy. Initial confusion among the disorder and its accurate diagnosing stemmed from the

term autism that Kanner chose to label the syndrome. The term autism was first coined by Eugene Bleuler (1913) and his use of the term was to describe a feature exhibited by those diagnosed with schizophrenia. Thus, clinicians and researchers alike believed that autism as described by Kanner, was the childhood form of schizophrenia (Kanner, 1965; Rutter, 1968). However, there were notable differences between the term as described by Kanner and Bleuler and also differences between autism and schizophrenia that helped to distinguish these two disorders. The term autism as described by Kanner referred to a disorder that involved the failure to ever develop relationships with others (Kanner, 1965). However, the term autism as described by Bleuler referred to a symptom of a disorder, involving social withdraw (Bleuler, 1913).

Nearly three decades after the initial description of Autism, Rutter (1968, 1972, 1978) conducted seminal work in differentiating autism from schizophrenia. The following trends were observed for those with autism, with the opposite remaining true for schizophrenia. First, symptoms including hallucinations and/or delusions were not present in those meeting criteria for autism. Second, there was no significant family history in autism. Next, intellectual disability was often comorbid in autism. Fourth, autism presented with a stable course of illness. In addition, there was a higher male to female ratio in autism. Lastly, autism peaked during infancy and schizophrenia peaked in the adolescent years. These differentiations assisted in adding autism into the diagnostic nomenclature; however to date, differential diagnosis within ASD continues to remain a source of debate among professionals in the field. This continued debate along with advances made in the field has led to many changes in the diagnostic categories and symptoms comprising these categories. Diagnostic changes have been made in regards to the course of the illness, age of onset, and the broadening and narrowing of symptom definitions.

DSM-III. In 1980, the diagnostic category of Pervasive Developmental Disorders (PDD) was first entered into the *DSM-III* (APA, 1980). The inclusion of this diagnostic category assisted in officially distinguishing autism from childhood schizophrenia. Five disorders comprised this diagnostic category and included Infantile Autism, Residual Infantile Autism, Childhood Onset Pervasive Developmental Disorder (COPDD), Residual COPDD, and Atypical Autism (Volkmar & Klin, 2005). The main areas of impairment were in interpersonal relationships, impairment in communication, and bizarre responses to the environment. These symptoms had to be observed prior to 30 months of age and present without hallucinations/delusions. However, if symptoms manifested themselves after 30 months of age, the diagnosis would be specified as childhood onset PDD. The criteria for infantile autism included the "lack of responsiveness to other people, deficits in language development, and if speech is present, peculiar speech patterns such as immediate and delayed echolalia, metaphorical language, pronominal reversal" (APA, 1980, p. 89). Diagnostic criteria for childhood onset PDD included impairment in social relationships, and three of "excessive anxiety, constricted or inappropriate affect, resistance to change in the environment, oddities of motor movement, abnormalities of speech, hyper or hypo-sensitivity to sensory stimuli, and self-mutilation" (APA, 1980, p. 91) with onset between 30 months and 12 years. Again, there had to be an absence of delusions/hallucinations.

DSM-III-R. Revisions made in the *DSM-III-R* (APA, 1987) included changing infantile autism to AD and COPDD and residual infantile autism were dropped. In addition, PDD-NOS was now entered into the diagnostic nomenclature. Eight of 16 diagnostic criteria had to be met for a diagnosis of AD. Two of these criteria had to be in the area of impairment in reciprocal social interaction, one in the area of qualitative impairment in communication, and one in the

area of restricted repertoire of activities and interests. The onset for the diagnosis was specified as infancy or as early childhood (i.e., after 36 months of age).

DSM-IV. The *DSM-IV* (APA, 1994) included the five spectrum disorders that are currently recognized: AD, AS, Rett's Disorders, Childhood Disintegrative Disorder (CDD), and PDD-NOS. The age of onset criteria was added when revisions were made for the *DSM-IV* (APA, 1994; Volkmar & Klin, 2005), with delays in at least one of the core areas of impairment needing to be evident prior to 36 months of age. As abovementioned, AS was first introduced into the diagnostic nomenclature in the *DSM-IV,* after field trials yielded reliable diagnoses of the disorder. After determining that the definition of autism was too broad in the *DSM-III-R*, the field trial was conducted partly to ensure that the full range of ASD symptom expression was covered within the diagnostic categories. Secondly, the field trial assisted in determining the validity of the addition of other diagnoses on the spectrum. During the field trials, a sample of 977 children were evaluated in regards to symptomology indicative of diagnoses of CDD, Rett's, AD, and AS. Interrater reliability of diagnoses when differentiating between autism and other ASDs was excellent (k = .85). Furthermore, reliability was lower when following the *DSM-III* and *DSM-III-R* diagnostic systems when compared to the *International Classification of Diseases, Tenth Edition (ICD-10;* World Health Organization [WHO], 1992). Thus, the inclusion of AS in the *DSM-IV* appeared warranted (Volkmar et al., 1994).

DSM-IV-TR. No noteworthy revisions were made to the *DSM-IV-TR* (APA, 2000) in regards to the diagnostic categories or criteria of the autism spectrum disorders. The diagnostic categories and criteria remained consistent from the earlier edition, the *DSM-IV* (APA, 1994).

DSM-5. The *DSM-5* is set to be published in 2013 (APA, 2011). The proposed changes to the diagnostic criteria for ASDs are significant and include dropping all subcategories and

instead having one dimensional category. Thus, the diagnosis of ASD would comprise individuals now falling under the diagnostic labels of AD, PDD-NOS, AS, and CDD. Individuals previously meeting diagnostic criteria for Rett's Disorder would no longer be considered under this diagnostic label. The reason for the dimensional approach to diagnosing is multifaceted: due to the overlapping diagnostic criteria that is thought to exist on a spectrum that ranges in severity (Matson & Minshawi, 2006; Nebel-Schwalm & Matson, 2008; Steyn & Le Couteur, 2003), due to the lack of specific biological markers differentiating any one ASD diagnosis from another, and because individuals meeting diagnostic criteria for the various ASDs typically differ from each other on the associated features of the disorders (e.g., adaptive behavior and cognitive ability) and not on the core symptoms of autism (Eisenmajer et al., 1996; Allen et al., 2001). In regards to symptoms of ASD, three main diagnostic domains remain for the proposed revisions. The first domain now represents impairments in social communication and social interaction and all symptoms of the following must be present: "deficits in social-emotional reciprocity; deficits in nonverbal communicative behaviors used for social interaction; and deficits in developing and maintaining relationships appropriate to developmental level." Second, two of the following in the domain of restricted interests and repetitive behaviors are required to meet diagnostic criteria: "stereotyped or repetitive speech, motor movements, or use of objects; excessive adherence to routines, ritualized patterns of verbal or nonverbal behaviors, or excessive resistance to change; highly restricted, fixated interests that are abnormal in intensity of focus; and hyper-or hypo-reactivity to sensory input or unusual interest in sensory aspect of environment". The third domain refers to the age of symptom presentation: "symptoms must be present in early childhood (but may not become fully manifest until social demands exceed limited capacities)". Also, these symptoms must cause impairment in the everyday functioning of the individuals.

Furthermore, severity ratings are also provided for the social communication and restricted interests and repetitive patterns of behaviors domains, ranging from one to three. Greater severity in ASD symptomology and more severe impairments in everyday functioning are represented by the highest severity rating, a three (APA, 2011).

Current Diagnostic Criteria

Autistic Disorder (AD). A total of six criteria from the three core areas of impairment (i.e., qualitative impairment in social interaction, in communication, and restricted and repetitive patterns of behavior/interests) must be met in order for a child to receive a diagnosed of AD. More specifically, to meet criteria in the domain of socialization, two of the following have to be present: "impairment in the use of multiple nonverbal behaviors; failure to develop peer relationships; lack of spontaneous seeking to share enjoyment; and lack of social or emotional reciprocity" (APA, 2000, p. 75).

In addition, one impairment in the communication domain has to be present. Symptoms in this domain are "delay in, or total lack of, the development of spoken language; in individuals with adequate speech, marked impairment in the ability to initiate or sustain a conversation with others; repetitive use of language or idiosyncratic language; and lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level" (APA, 2000, p. 75). Lastly, to meet criteria for AD, a child has to display at least one symptom in the domain restricted, repetitive, and stereotyped patterns of behavior/interests. Symptoms in this domain include "preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal in intensity or focus; apparently inflexible adherence to specific, nonfunctional routines or rituals; stereotyped and repetitive motor mannerisms; and persistent preoccupation with parts of objects" (APA, 2000, p.75).

Asperger's syndrome (AS). The core features defining AS include impairments in social interaction and restricted interests and repetitive behaviors; however, these symptoms must manifest themselves without significant delays in language acquisition, cognition, and adaptive skills. According to the *DSM-IV-TR,* current diagnostic criteria for AS includes two impairments in the area of social interaction and one impairment in repetitive and stereotyped patterns of behavior/interests (APA, 2000).

Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS). Unfortunately, the diagnostic criteria for PDD-NOS are ambiguous and the boundaries of this disorder are much less studied (Buitelaar, Van der Gaag, Klin, & Volkmar, 1999). PDD-NOS is often diagnosed according to what it is not (Matson & Boisjoli, 2007). Therefore, the diagnosis is often made when the number of criteria specified for a diagnosis of AD are not met or age of onset criteria for AD is not met (Buitelaar et al., 1999). Thus, if children exhibit social impairments along with either communication impairments or restricted interests or repetitive behaviors and do not meet criteria for AS or AD, then a diagnosis of PDD-NOS is given (APA, 2000). As a result, PDD-NOS is often considered a sub-threshold diagnostic category as individuals diagnosed with PDD-NOS have less autism symptomology when compared to those diagnosed with AD or AS (Walker et al., 2004). Due to the ambiguity around the diagnostic criteria of PDD-NOS, clinicians are much less confident when diagnosing this disorder over other ASDs (Buitelaar et al., 1999).

Differential Diagnosis of ASD

Although AS, AD, and PDD-NOS are all currently considered separate diagnostic entities, debate regarding the differentiation between them remains. That is, is AS the high functioning form of autism and is PDD-NOS a mild form of autism? Therefore, to follow in accordance with the *DSM-IV-TR* categorical approach to diagnosing within ASD (APA, 2000), researchers have examined the differences between the various ASDs. Diagnostic difficulties arise because of overlapping symptoms (Freeman, Cronin, & Candela, 2002), and furthermore, because symptom expression varies from individual to individual (Volkmar & Klin, 2005). Differential diagnosis is also problematic due to the majority of research being conducted solely on AD and the differences between AD and AS, even though PDD-NOS is the most frequently diagnosed ASD (Mayes, Volkmar, Hooks & Cicchetti, 1993).

Further compounding differential diagnoses is that the clinical presentation of ASDs may change over time. Therefore, depending on the time and age of assessment, a child or adolescent may meet criteria for different ASDs (Attwood, 1998; Cox et al., 1999; Eaves & Ho, 2004; Gillberg, 1998; Kleinmen et al., 2008; Lord et al., 2006; Worley, Matson, Mahan, Kozlowski, & Neal, 2011). For example, Lord and colleagues (2006) examined the diagnostic stability of AD and PDD-NOS in children over a seven year timeframe (i.e., from age 2 to age 9 years). At age 9, 14 of the initial 46 children diagnosed with PDD-NOS retained the original diagnosis, 27 met criteria for AD, with the remaining 5 children no longer meeting criteria for either ASD. Of the 84 children initially diagnosed with AD, 71 retained the initial diagnosis 7 years later, 12 were diagnosed with PDD-NOS, and the remaining 1 participant no longer met criteria for an ASD. However, even with diagnostic status changes, over 95% of the children studied maintained a diagnosis on the autism spectrum (Lord et al., 2006). More recently, Worley and colleagues

(2011) examined the diagnostic stability of 114 toddlers diagnosed with either AD or PDD-NOS over a timeframe ranging from 4 to 13 months. Twenty toddlers retained their AD diagnosis, but two changed to PDD-NOS. Eight toddlers retained their PDD-NOS diagnosis; however, eight also changed from PDD-NOS to AD. Although 32.5% of the diagnostic classifications changed, all diagnoses remained on the autism spectrum (Worley et al., 2011). These results provide support for a spectrum versus categorical approach to diagnosing ASDs.

Cluster and Taxometric Analyses

In an attempt to examine the underlying latent structure of symptoms of ASDs, researchers have investigated the ability to statistically separate participants based on their symptoms profiles. For example, Prior and colleagues (1998) conducted a cluster analysis of children (N = 135) diagnosed with an ASD. Even though three separate clusters emerged (i.e., autistic-like, Asperger's-like, and mild PDD), the clusters children were grouped in did not correspond to their clinical diagnoses. For example, only approximately half of those in the sample with a clinical diagnosis of AD were grouped in the autistic-like cluster, with the other half divided between the remaining two clusters. Thus, Prior and Colleagues (1998) suggested a spectrum approach to diagnosing over a categorical one. More specifically, they suggest that the autism spectrum is one that ranges in severity of social and cognitive impairment, and that early developmental history (e.g., language development) was not useful in differentiating between groups. Results such as these provide confusion since the major diagnostic difference between AD and AS according to the *DSM-IV-TR* (APA, 2000) takes into account early language development.

Elsewhere, Verté and colleagues (2006) utilized a sample of 135 children and conducted a cluster analysis using the subscales from the *Autism Diagnostic Interview-Revised* (*ADI-R;*

Lord, Rutter, & LeCouteur, 1994). Fifty-seven of these children were diagnosed with high functioning autism (HFA), 47 with AS, and 31 with PDD-NOS. Three clusters emerged: HFA, PDD-NOS, and a combined cluster of HFA and AS. Again, agreement between the placement of a child in a cluster and their clinical diagnosis was not observed. As a result, Verte and associates concluded that instead of representing distinct clusters, the three groups differed in severity of symptoms, mostly related to social skill deficits and repetitive behaviors and restricted interests. Thus, a dimensional approach to diagnosing was suggested from these results. Providing further support for a dimensional approach to diagnosing are results from a taxometric analysis of toddlers at risk for or already diagnosed with developmental delays (Boisjoli, 2010). Utilizing a sample of 1149 toddlers, Boisjoli (2010) reported that the underlying structure of symptoms of ASD represent a dimensional taxon.

In contrast to the above reviewed studies, other researchers have provided support for a categorical classification within ASD through empirical analysis. For instance, Eaves, Ho, and Eaves (1994) utilized a sample of 166 children who met criteria for an ASD to determine if clinically meaningful groups of children emerged using cluster analytic techniques. Four subtypes emerged (i.e., typically developing autism, low-functioning, high-functioning [Asperger/schizoid], and hard-to-diagnose), and these subtypes were related to participants clinical diagnoses. For example, all but 22% of the children in cluster 1 had diagnoses of autism. Although, those with clinical diagnoses of AS were grouped into cluster 1 (n = 6) and cluster 4 (n = 4). Therefore, what was left unanswered was whether AS is distinct from HFA. The current study only supported that a subtype of children emerged who demonstrated borderline-average IQ, verbal communication, and poor social skills (Eaves et al., 1994).

Elsewhere, researchers have conducted literature reviews to summarize the findings of cluster and taxometric analyses. Szatmari (1992) examined the taximetrics of ASD to determine if valid and reliable subtypes could be distinguished. Through conducting a literature review (N = 20), he concluded that aside from autism, three other subgroups emerged; AS and a high and a low functioning atypical group (i.e., based on IQ). However, no ecological differences (e.g., gender ratio and IQ) were consistently reported between autism and AS (Szatmari, 1992). Thus, Szatmari questioned if AD and AS differed in terms of symptomology simply due to differences in developmental levels. More recently, Beglinger and Smith (2001) conducted a review of studies that attempted to subtype ASD. In their review of the literature, the following trends were found: three to four subtypes of ASD typically emerged and these subtypes were reliability differentiated from non ASD conditions, taking into account developmental level accounted for a large amount of the variance in the heterogeneity of symptoms of ASD, and lastly, most studies have provided support for a dimensional approach to diagnosing ASD. Thus, Beglinger and Smith proposed a new model for classifying ASDs based on developmental level, social skills, and repetitive behaviors. The results of this classification system would be four subtypes of ASD (e.g., Aloof, Most Autistic; Passive/Aloof; Passive; Active-But-Odd, Least Autistic). The proposed classification system was consistent with other research, suggesting that language development is not useful in distinguishing between the disorders comprising the autism spectrum (Mayes and Calhoun, 2001).

Overlapping Symptoms of the Disorders

The etiologies of the various ASDs are relatively unknown, but what is know is that they have overlapping symptoms as outlined in the diagnostic criteria. More specifically, diagnostic criteria comprising the socialization and repetitive behaviors and restricted interests domains are

exactly the same for AS and AD. The same symptoms related to social deficits in AD and AS are also symptomatology associated with a diagnosis of PDD-NOS, but are less specified (APA, 2000). Some researchers have reported no differences between ASD diagnoses when examining the overlapping symptoms of these disorders (Eisenmajer et al., 1996; Allen et al., 2001). For example, Eisenmajer and colleagues (1996) found no differences between children diagnosed with HFA or AS on the overlapping features of the two disorders, but instead found differences in cognition (no delays for AS) and communication/imagination (no impairments for AS). Onozoff and colleagues (2000) reported no significant differences in social skills or repetitive behavior between those diagnosed with HFA and AS when examining current behavior presentation (Onozoff et al., 2000). However, by history, those with HFA had more impairment in social interaction, communication, and repetitive behaviors and restricted interests and developed the use of single words at a later age when compared to those with AS (Ozonoff et al., 2000). More recently, a sample of children with Intelligence Quotients (IQ) above 70, classified as HFA or AS, were compared on symptoms of ASD through the use of the *Childhood Autism Rating Scale – Tokyo Version* (*CARS-TV*; Tachimori, Osada, & Kurita, 2003; Koyama, Tachimori, Osada, Takeda, & Kurita, 2007). No group differences emerged when examining total symptom endorsement on the *CARS-TV*. The total score was the sum of the items that comprised the *CARS-TV:* relationships, imitation, affect, body use, adaptation to change, visual and auditory responses, anxiety, verbal and nonverbal communication, activity level, cognition, and relationships to objects. Elsewhere, Allen and colleagues (2001) examined children diagnosed with PDD-NOS (n = 18), with AD (n = 176), or with language disorders or low IQ (n = 311). On a measure of verbal ability, children diagnosed with PDD-NOS and AD did not score

significantly different from each other, although those diagnosed with PDD-NOS had less impairment in verbal ability (Allen et al., 2001).

In contrast, other researchers have found significant differences in ASD symptomology between the disorders comprising the autism spectrum (Buitelaar et al., 1999; Koyama et al., 2007; Walker et al., 2004). As reviewed above, Koyama and associates (2007) found no significant differences in overall ASD symptoms as measured by the *CARS-TV*. However, when examining individual items on the same measure, children with HFA scored significantly worse on verbal communication and nonverbal communication items when compared to children diagnosed with AS (Koyama et al., 2007). Additionally, Buitelaar and colleagues (1999) utilized data from the *DSM-IV* field trial to examine symptom differences between diagnoses of PDD-NOS (n = 29) and AD (n = 189). First, participants meeting diagnostic criteria for AD had significantly more impairment in the three core symptom domains. Second, the diagnostic criteria of "preoccupation with restricted patterns of interest" and "lack of varied spontaneous make-believe play" best differentiated the two groups, with 77% of the cases being predicted correctly. These two criteria were associated with a diagnosis of AD whereas the key diagnostic criteria for PDD-NOS were "failure to develop friendships" and "lack of social or emotional reciprocity".

More recently, Walker and colleagues (2004) examined symptom differences between children diagnosed with AS, PDD-NOS, or AD as measured by the *ADI-R* (Lord et al., 1994) and the *Autism Behavior Checklist* (*ABC*; Krug, Arick, & Almond, 1980). Subscales of the *ADI-R* and the *ABC* were significantly different between groups. More specifically, subjects diagnosed with PDD-NOS had less symptoms of repetitive/stereotyped behavior and difficulty in relating to others when compared to those with AS. When compared to children with AD, those with PDD-

NOS had less verbal and nonverbal impairments, less social impairments, and less repetitive/stereotyped behaviors. In sum, children with PDD-NOS presented with impairments across the three symptom domains, but exhibited fewer symptoms of ASD, when compared to those with AD and AS (Walker et al., 2004).

Differences AD and AS in regards to language development and use has also been a large source of debate in differential diagnosing. As aforementioned, diagnostic criteria within the communication domain for autism indicates that one of the following must be evident: a delay or the absence of verbal communication, deficits in the ability to facilitate or maintain conversations, or repetitive language use (APA, 2000). In contrast, the *DSM-IV-TR* indicates that to meet diagnostic criteria for AS, there has to be an absence of "clinical significant general delay in language" (APA, 2000, p. 84). Although delays in the development of language cannot be present to meet diagnostic criteria for AS, diagnostic tools and research supports that some language delay or abnormality in language use should not rule out a diagnosis of AS. For example, Church, Alisanski, and Amanullah (2000) conducted retrospective chart reviews of 40 children diagnosed with AS. Echolalia was reported for 15% of their sample and 96% were receiving speech and language interventions. Thus, even if speech is developed, difficulties in modifying language appropriately may be a concern (e.g., tone, pitch, and rhythm; Attwood, 2007).

Dating back to the first observations of children with AS and autism, language differences were evident between the two as described by Kanner (1943) and Asperger (1944/1991). According to Frith (1991) those described by Kanner presented with "echolalia, pronoun reversal, and difficulties in generalizing word meanings" and for those presented by Asperger "clever-sounding language, invented words and generally spoke more like grown-ups"

(p. 10). Research on language differences between AS and AD has continued since these early observations. Mayes and Calhoun (2001) conducted a study to determine the validity of utilizing delays in the development and use of language when distinguishing between AD and AS. Their sample included 47 children diagnosed with AS or AD who all had IQ scores at or above 80. These children were partitioned into two groups according to the presence or absence of a speech delay. Children with and without delays in the development of speech did not different on the core domains and associated areas of ASD (i.e., social interaction, perseveration, somatosensory disturbance, atypical developmental pattern, mood disturbance, and attention and safety problems) as measured by the *Checklist for Autism in Young Children* (Mayes and Calhoun, 1999; Mayes and Calhoun, 2001). In addition, children who initially had a delay in speech development did not score significantly different from those who did not on a measure of expressive language, which assessed for "modulation, making odd noises, repetitive vocalizations, idiosyncratic jargon, echolalia, idiosyncratic speech, perseverative speech, sporadic and infrequency speech, rote phrases, nonsensical speech, and improper use of pronouns" (p. 87). Lastly, all children in their study met the communication domain criteria for AD. Thus, the absence or presence of delays in the development and use of language had no relationship to the functioning of these children at later ages and, therefore, may not be helpful in differentiating AD and AS (Mayes and Calhoun, 2001).

In a similar study, Szatmari and colleagues (2009) examined the developmental trajectories of symptoms of ASD in children and adolescents diagnosed with either AS or AD. Children were partitioned into groups of AS or AD according to the presence or absence of language impairment. Children in the study were assessed over a number of years: ages 6-8, ages 10-14, ages 14-17, ages 17-19 and were administered the same battery of interviews and

assessments at each time interval. There were significant differences in communication and socialization scores as measured by the *Vineland Adaptive behavior Scales* (VABS; Sparrow, Balla, & Cicchetti, 1984) at each assessment time between the two groups. Thus, in opposition to Mayes and Calhoun (2001), Szatmari and colleagues (2009) suggest that differentiating the two groups based on language impairment is useful in the categorical classification of ASDs. Corroborating Szatmari and colleague's findings, Ozonoff and colleagues (2000) examined the differences between children and adolescents diagnosed with HFA or AS in cognition, symptoms of ASD, and early developmental history. In regards language development, children with HFA performed worse than subjects diagnosed with AS on a measure of expressive language. However, no differences between the two groups emerged when examining receptive language abilities (Ozonoff et al., 2000).

In sum, it has been suggested that clinicians conduct formal assessments of speech and language skills (Freeman et al., 2002), which can help to differentiate between the two disorders. However, using standardized tests to assess language skills may lead to erroneous results, as they may not be sensitive to the specific language patterns exhibited by children with AS (Attwood, 2007).

Neuroanatomical Differences

Neuroanatomical studies examining differences between typically developing individuals and individuals diagnosed with an ASD have been conducted. For instance, Piven and colleagues (1997) examined a group of adults diagnosed with AD and a control group matched for age. Regions of the corpus callosum i.e., body and posterior section) were smaller in those with AD than in the control group. In another study, Toal and colleagues (2010) examined the volumes of gray and white matter between those diagnosed with an ASD (i.e., AD and AS) compared to a

group of typically developing adults. Participants with ASD had significant reductions in the volume of gray matter in the following areas when compared to the control group: right cerebellum, the right inferior temporal gyrus, and the left parahippocampal gyrus (Toal et al., 2010). However, the question remains as to whether there are similar or other neuroanatomical findings that differentiate between subtypes of ASD (i.e., AS and AD).

At this point, the most consistent finding in regards to neuroanatomical differences between the ASDs is in brain volume (Lotspeich et al., 2004; Palmen & van Engeland, 2004). For example, Lotspeich and colleagues (2004) findings indicated that in male children and adolescents, brain volume was larger for those with HFA compared to those with AS. Courchesne, Carper, and Akshoomoff (2003) conducted an investigation of brain growth in children diagnosed with AD (n = 17) and PDD-NOS (n = 5). Measurements of head circumference were not significantly different at birth between the two groups; however this nonsignificant difference was not maintained at follow-up 6 to 14 months later. The head circumference of participants increased 2.19 and .58 for participants diagnosed with AD and PDD-NOS, respectively. Thus, those with more severe symptoms of ASD had greater head growth over the first year of life (Courchesne et al., 2003).

In addition, other neuroanatomical differences between the various ASDs have been reported, but with less consistency. McAlonan and colleagues (2008) examined gray matter volume in children and adolescents diagnosed with either AS, HFA, or who were typically developing. Although the volume of gray matter was not significantly different between groups, the thalamus and pallidum were significantly larger in those with AS compared to those with HFA (McAlonan et al., 2008). However, differences in gray matter volume have been reported between subtypes of ASD by other researchers. For instance, Toal and colleagues (2010)

compared gray matter volume of adults diagnosed with AD or AS. Again, the overall volume of gray matter was not significantly different between groups, however the volume of gray matter in specific brain regions was different. That is, in language regions (e.g., right superior temporal lobe) there was a significant increase in the volume of gray matter in individuals diagnosed with AD, but not with AS (Toal et al., 2010).

Inconsistent findings across studies in regards to neuroanatomical differences may not necessarily mean that differences do not exist. Lotspeich and colleagues (2004) examined neuroimages across two sites using the same sample of participant's consisting of male children and adolescents diagnosed with either low functioning autism (LFA), HFA, AS, or controls. Intersite differences were found across the two medical departments for IQ and cerebellum measures. As such, the failure of consistent results for neuroanatomical investigation may be due to differences across sites (e.g., MRI systems differing in magnetic field strength).

Neuropsychological Differences

The neuropsychological profiles of children diagnosed with an ASD have been examined and compared to those without ASD. For instance, Robinson, Goddard, Dritschel, Wisley, and Howlin (2009) examined differences in the planning ability, mental flexibility, and response inhibition between children diagnosed with ASD (i.e., HFA or AS) and typically developing controls. The only significant difference that emerged was that children with ASD demonstrated poorer planning, as they took significantly more moves to complete problems in Tower of London tasks (ToL: Culbertson & Zillmer, 2005) and more often violated the rules (Robinson et al., 2009).

Neuropsychological tests have also been conducted to examine differences between children with various diagnoses on the autism spectrum. For example, researchers examined the

ability to shift attention between children diagnosed with either HFA or AS (Rinehart et al., 2001). Children with HFA responded at a slower rate compared a control group on tasks that required attention shifts from local to global levels (i.e., detail to whole), however children diagnosed with AS did not. Unfortunately, both groups were only compared to the control group and not to each other in this study (Rinehart et al., 2001).

Ozonoff and colleagues (2000) conducted a study that enabled the comparison of executive functioning between individuals diagnosed with AS and AD. No significant differences emerged between children and adolescents with HFA or AS on a ToL task and intradimensional/extradimensional shift task. However, when compared to a control group, participants with AS scored significantly worse on the tests of executive functioning, whereas the HFA group did not. Elsewhere, differences in processing speed on linguistic, visuospatial, and linguistic-visuospatial tasks between children with AS and HFA were examined. Sahyoun, Soulières, Belliveau, Mottron, and Mody (2009) utilized a sample of adolescents and adults with IQs in the normal range and partitioned them into three groups: AS, HFA, and controls. No between group differences emerged in regards to accuracy or response times on the processing speed tests.

In addition to the above, the cognitive profiles of children and adolescents diagnosed with ASD have been examined. First, Walker and colleagues (2004) conducted a study that specifically assessed IQ differences between children diagnosed with AD (n = 216), AS (n = 33), and PDD-NOS (n = 21), using the *Leiter International Performance Scales* (Levine, 1986). Children with PDD-NOS and AS did not differ significantly from each other in terms of IQ. However, those with PDD-NOS and AS both scored significantly higher than those with AD.

When comparing individuals diagnosed with AS or AD, those with AS consistently score higher on measures of verbal IQ (Koyama et al., 2007; Noterdaeme et al., 2010). Taking a closer look, those with AS score higher on subtests of vocabulary and comprehension. However, those with HFA have been found to score significantly higher on the subtest of coding (Koyama et al., 2007). Elsewhere, Noterdaeme and colleagues (2010) reported that children with AS scored significantly higher on all verbal subtests and the subtest of picture arrangement within the performance domain. In yet another study, Klin, Pauls, Schultz, and Volkmar (2005) examined differences in the cognitive profiles of individual's ages 8 through 32 years diagnosed with an ASD. Interestingly, they examined these differences based on different approaches when partitioning the participants into comparison groups. Diagnostic groups were formed using either the *DSM-IV* (APA, 1994) diagnostic criteria or based on the participants language development (speech delayed or not). When examining the cognitive profiles of individuals with AS or AD grouped according to *DSM-IV* diagnostic criteria, there were no differences between groups on full scale IQ, verbal IQ (VIQ), or Performance IQ (PIQ). However, a significant difference emerged when examining the difference in VIQ and PIQ scores between those with AD (mean difference = 7.5) and those with AS (mean difference = 23). In contrast, when examining the cognitive profiles of the participants with AS and AD grouped according to history of speech delay, no significant differences emerged in any of the prior mentioned profiles (Klin et al., 2005).

Social Skills

Impairments in social skills are the primary deficits underlying a diagnosis of ASD and these deficits persist throughout life (White, Keonig, & Scahill, 2007). Without early and successful interventions, these deficits can permeate to other areas of functioning including

social development, emotional development, and academic success (Rao, Biedel, & Murray, 2008). Researchers have identified specific deficits in social skills that are associated with the ASD population. Deficits identified include matching emotional expression, role-taking, imitation, orienting to social based stimuli, joint attention, functionality of play, and emotion recognition (Baron-Cohen, 1988; Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998; Kuusikko et al., 2009; Mundy, Sigman, & Kasari, 1990; Smith & Bryson, 1994; Stone, Lemanek, Fishel, Fernandez, & Altemeier, 1990). However, the social phenotype in ASD is heterogeneous (Klin, Jones, Schultz, Volkmar, & Cohen, 2002). As such, some researchers have suggested that differentially diagnosing between ASD should be accomplished through the measurement of social ability, within a developmental context (Gillham, Carter, Volkmar, & Sparrow, 2000). For example, Gillham and associates (2000) reported that 48% of the variance in the classification in ASD could be accounted for by social skills.

Researchers have conducted investigations comparing the social skill deficits between children diagnosed with AD and AS. For example, Tonge and colleagues (1999) utilized a sample of children and adolescents with diagnoses of HFA (n = 75) or AS (n = 52) to examine differences in symptoms of psychopathology and behaviors. Using the *Developmental Behavior Checklist* (Einfeld & Tonge, 1994; 1995), Tonge and colleagues (1999) reported that participants with AS had significantly more trouble socially relating to others and were more antisocial. A year later, Szatmari and colleagues (2000) utilized a sample of children diagnosed at 4 to 6 years of age with either AS (n = 20) or AD (n = 46), all with an IQ above 70. On the socialization domain of the *VABS* (Sparrow et al., 1984), participants with AS scored a standard deviation above participants with AD, representing more skills in this area. At a two year follow up (i.e. ages 6 to 8 years), the scores on the socialization domain of the *VABS* correlated highly with the

initial scores, indicating that the developmental trajectory remained similar and the spread of scores between the two disorders remained consistent (Szatmari et al., 2000).

In a more recent study, Shoemaker (2009) conducted an investigation of social skill differences between children and adolescents diagnosed with either AD (n = 16) or PDD-NOS (n = 16) using the *Matson Evaluation of Social Skills in Youngster* (*MESSY;* Matson, 1988). When examining the total social skills score yielded from the *MESSY,* no significant differences emerged between the two groups. Also, no significant differences emerged between the two groups on the subscale "inappropriate social skills." In contrast, children and adolescents diagnosed with PDD-NOS scored significantly lower than those diagnosed with AD on the appropriate social skills factors, indicating more appropriate social skills for participants with PDD-NOS.

Taxometric and cluster analyses have also been utilized to identify subgroups of ASD based on social skills. For example, in an epidemiological study conducted by Wing and Gould (1979), the quality of social interaction, abnormalities of speech, abnormalities of activities, repetitive routines, and patterns of interest were utilized to determine if subgroups emerged. Using a sample of 132 children and adolescents, three subtypes of autism emerged and were classified based on social ability. Wing and Gould labeled the three groups as aloof, passive, and odd. Children with "typical autism" were most likely to comprise the aloof group. In addition, those in the aloof group more likely to be nonverbal, engage in stereotypies, have poor language comprehension, not engage in symbolic activities, and required sameness in their routines. Those in the passive and odd groups more often engaged in echolalia, engaged in repetitive activities, and had higher IQs when compared to those in the aloof group. In addition, those in the passive

group were the most likely to engage in pronoun reversal and those in the odd group had the best language comprehension (Wing & Gould, 1979).

Other groups of researchers have investigated the usefulness of Wing and Gould's subtypes of ASD based on social ability (e.g., Bordon & Ollendick, 1994; O'Brien, 1996). Bordon and Ollendick (1994) examined the validity of Wing and Gould's subtypes using a sample of 53 children diagnosed with an ASD. All participants were assigned into one of the social subtypes (aloof, passive, or odd) by raters. In addition, each child was assessed via the *Childhood Autism Rating Scale* (*CARS*; Schopler, Reichler, & Renner, 1986), the *VABS* (Sparrow et al., 1984), and the *Autism Diagnostic Observation Schedule* (*ADOS*; Lord et al., 1989). Subtype differences were significant for the following variables: *CARS* total score, *VABS* age equivalents, and the domains of reciprocal social interaction, language/communication, and stereotyped behavior/restricted interests from the *ADOS*. In addition, participants classified as aloof had the highest severity of autism symptoms and level of IQ impairment decreased when progressing through the social subtypes, from aloof to passive to odd. When utilizing IQ as a covariate and again examining ADOS scores, only reciprocal social interaction was significantly different between subtypes. Thus, a large amount of variance in language and stereotypies/restricted interests differences between social subtypes of ASD could be accounted for by IQ. Results from Bordon and Ollendick's study support the social subtyping classification scheme. Thus, using these markers of social skills allows for the accurate prediction of differences in the behavioral symptoms of autism.

Most recently, O'Brien (1996) examined the validity and reliability of the *Wing Subgroups Questionnaire* (*WSQ*; Castelloe & Dawson, 1993), which was developed to classify children into one of the social subtypes described by Wing and Gould (1979). A total of 42

children were rated on the *WSQ* and the *ABC* (Krug et al., 1980). First, interrater reliability of the *WSQ* was examined and was above .77 for both the passive and odd groups, but was lower for the aloof group at .60. Next, correlations were computed between the scores yielded from the *WSQ* for the three social subtypes. Negative and nonsignificant correlations emerged between the scores for the three social subtypes on the *WSQ*, indicating distinct constructs. Furthermore, validity was demonstrated by examining differences between the social subtypes (as determined by the *WSQ*) on communication, social interaction, social response, stereotypic behavior, and temper/physical aggression. The odd group had the best communication skills, more often initiated social interaction, and were more socially responsive. The aloof group had the worst communication skills, had the least initiation of social interaction, were the least responsive to social interactions, and had the highest scores for stereotypies. The passive group had scores in between the aloof group and odd group in communication, social interaction, and social responsiveness. In conclusion, the *WSQ* is a reliable and valid tool that can be used to diagnose subtypes of ASD, as *WSQ* social subtypes were found to be highly correlated with clinical diagnoses of subtypes of ASD (Castelloe & Dawson, 1993).

Other researchers have also provided further support for the successful distinction among ASDs based on social variability (Beglinger & Smith, 2001; Ingram, Takahashi & Miles, 2008; Prior et al., 1998). First, Prior and colleagues (1998) utilized cluster analytic techniques to differentiate 135 children diagnosed with either HFA, AS, or related PDD based on behaviors and developmental history. Three clusters emerged during the analysis. Cluster A contained the highest proportion of those with diagnoses of AD, cluster B with the highest percentage of diagnoses of AS, and cluster C had the highest percentage of children with PDD related diagnoses. However, half of the participants diagnosed with AD were about evenly assigned to

cluster B and cluster C. Although based on their results, both a dimensional and categorical approach to diagnosing could be argued, significant differences between cluster A and cluster B emerged in regards to social skills. That is, the following items were significantly associated with Cluster A: no anticipation of being held, dislikes physical affection, does not bring toys or objects for shared pleasure or interest, does not point things out to share pleasure or interest, no reciprocation in games, makes embarrassing remarks in public, no peer friendship, inappropriate selection of person to whom to show affections, and does not spontaneously say hello. Items that were significantly associated with cluster B were: impaired use of nonverbal signals during social interaction, does not spontaneously wave goodbye, wants friends, and has one friend with the same circumscribed interest. In sum, the results of Prior and colleagues (1998) study signifies that symptoms more significantly associated with cluster B relate to advanced skills of social development.

More recently, Ingram and colleagues (2008) conducted a taxometric analysis on 481 children diagnosed with an ASD. The aim of their study was to determine which phenotypes would classify children into subgroups of ASD. When taking language acquisition and repetitive behaviors/restricted interests into account, a dimensional taxon was supported. However, when examining variables related to social interaction/communication and IQ, a categorical taxon was supported. Thus, social skills assist in differentiating ASDs from one another, even though other core features of ASDs (e.g., restricted interests/repetitive behaviors) do not.

Conclusions on Differential Diagnosing

At best, distinctions between the disorders comprising the autism spectrum remain controversial. Due to the lack of consistent differences between the various ASDs, it has been suggested that it may be that there are indeed no differences (Lotspeich et al., 2004). Even still,

studies have highlighted that prognosis may be better for those diagnosed with AS compared to HFA even if symptom differences on the core domain features do not emerge between the two (Tantum, 1988). However, because there is an exact overlap in symptoms of AD and AS and a lack of specific diagnostic criteria for PDD-NOS, some have suggested amending the current diagnostic criteria (Buitelaar et al., 1999; Walker et al., 2004). Others believe that a symptom specific approach should be adopted. Thus, incorporating more specific symptoms indicative of each diagnosis (Matson & Wilkins, 2008) instead of only using the overlapping diagnostic criteria would better differentiate the diagnostic groups within the spectrum. Nonetheless, differences found between the disorders tend to relate to areas other than the diagnostic criteria (Freeman et al., 2002).

However, methodological differences may account for the failure to find these distinctions. First, researchers conducting investigations on differences between the various ASDs often adapt the diagnostic criteria (Klin, Volkmar, Sparrow, Cicchetti, & Rouker, 1995). As such, the lack of consistent findings may be a consequence of varying and inconsistent definitions and diagnostic criteria of ASDs utilized in the studies. For example, some include motor clumsiness in the AS definition whereas others do not (Szatmari et al., 1995). In addition, information is often obtained from retrospective reports (Mayes, Calhoun, & Crites, 2001) instead of using current behavioral observations. Retrospective reports are problematic if recalling events after a long duration. Furthermore, if the person being assessed has already received an ASD diagnosis, then the established diagnosis may sway the results of the assessment (Wimpory, Hobson, Williams, & Nash, 2000).

Lastly, inclusion criteria for participants in the various studies reviewed may also account for the inconsistent findings. For example, many researchers have compared children diagnosed

with HFA and AS. However, HFA is not recognized as a diagnostic category. Therefore, how was diagnostic criteria defined for participants classified as HFA? Second, level of cognitive ability was often reported as part of the inclusion/exclusion criteria for research in this area, but the criteria for IQ varies between studies. Some researches include participants with an IQ above 70 (Robinson et al., 2009), others have utilized participants with IQs above 80 (Noterdaeme et al., 2010), and in other studies, IQ level was not part of the inclusion criteria (Toal et al., 2010). Controlling for IQ within a sample of participants diagnosed with AD also limits the generalizability of the results. Largely, this is due to the fact that a greater percentage of individuals diagnosed with AD have a comorbid diagnosis of intellectual disability.

Assessment Measures for ASD

Numerous scales have been developed by researchers to assess for symptoms of ASD. Due to the increasing knowledge of ASD symptomatology, the diagnostic changes over time and the push to identify symptoms at younger ages, these measures are numerous. For example, one review conducted on measures of ASD reported on over 25 that have been psychometrically investigated (Worley & Matson, in press). However, not all of the measures are appropriate to utilize during the diagnostic evaluation. For example, some measures are specific to AS, some cover the full range of ASD symptomatology (i.e., symptoms of PDD-NOS, AD, and AS), and some are for specific age cohorts (e.g., toddlers versus children and adolescents). Thus, the selection of a measure depends on the referral question, the age of the individual, and developmental history (e.g., no delays in language would suggest the use of a scale for AS). For the current study, it was important to utilize a measure that encompassed all symptoms of ASD. Thus, any measures developed specifically to assess for only one of the ASDs (e.g., *ADI-R*; Lord et al., 1994) would not be useful for the current study. Three scales have been developed that are all encompassing: the *Autism Spectrum Disorder-Diagnosis for Child (ASD-DC;* Matson & González, 2007), the *Pervasive Developmental Disorders Behavior Inventory* (*PDDBI;* Cohen & Sudhalter, 1999), and the *Behavior Function Inventory (BFI;* Adrien et al., 2001). As such, a review of these measures and their psychometric properties is outlined below.

Autism Spectrum Disorder-Diagnosis for Children (ASD-DC)

The *ASD-DC* is an informant based measure that is administered to parents or guardians and assesses for symptoms of ASD (Matson & González, 2007). This measure has been psychometrically investigated for children and adolescents ranging in age from 3 through 16 years and takes approximately 10 to 15 minutes to administer. This measure contains 40 items

that are rated based on how the child compares to other children their age and can be rated as: 0 (not a problem or impairment), 1 (mild problem or impairment), or 2 (severe problem or impairment). Factor analysis of these 40 items yielded a four factor solution: nonverbal communication/socialization, verbal communication, social relationships, and insistence of sameness/restricted interests (Matson, Boisjoli, & Dempsey, 2009).

The psychometric properties of the *ASD-DC* are sound. Inter-rater reliability (K_W = .67) was good, and test-retest reliability (K_W = .77) and internal consistency (α = .99) were excellent (Matson, González, Wilkins, & Rivet, 2008). In regards to the validity of the *ASD-DC*, convergent validity was demonstrated through comparisons to the *CARS* (Schopler et al., 1988) and *ADI-R* (Lord et al., 1994). The *ASD-DC* correlated with both of these measures. More importantly, the *ASD-DC* had a higher percentage of correct classification over both the *ADI-R* and the *CARS*. Specifically, the first validity study demonstrated that the *ASD-DC* identified 76.5% of the sample with ASD correctly compared to 58.8% identified correctly by the *CARS* (Matson, Mahan, Hess, Fodstad, & Neal, 2010). In the second validity study, correct classification of ASD diagnoses by the *ASD-DC* was 73% compared to 46% by the *ADI-R* (Matson, Hess, Mahan, & Fodstad, in press).

Most important for the current study, the *ASD-DC* is able to differentiate not only between ASD versus non-ASD (i.e., cutoff score of 33), but also between AD, AS, and PDD-NOS (Matson, González, & Wilkins, 2009). Thus, symptomatology of all ASDs are included in this measure. In addition, using the abovementioned cutoff score of 33, the sensitivity, specificity, and correct classification rate were determined to be 84.3%, 98.2%, and 91.3%, respectively.

Pervasive Developmental Disorders Behavior Inventory (PDDBI)

The *PDDBI* is an informant based measure that assesses for symptoms of ASD in children ages 1.6 through 12.5 years (Cohen & Sudhalter, 1999). Two separate versions are included. The parent version (contains 176 items) and the teacher version (contains 144 items) and items are rated as the following: 0 (never), 1 (rarely), 2 (sometimes/partially), or 3 (often/typically). The items that comprise the *PDDBI* assess for approach-withdrawal problems. Four items within this area are associated with ASD and include sensory/perceptual approach behaviors, ritualisms/resistance to change, social pragmatic problems, and semantic/pragmatic problems. The second area that the *PDDBI* assesses for is receptive/expressive social communication abilities. Two domains within this area are associated with autism and include: social approach behaviors and expressive language. The six domains within the two abovementioned areas are included in the calculation of the total score. To compute the total score, the t-scores for social approach behaviors and expressive language added together are subtracted from the t-scores of the other domains added together (i.e., sensory/perceptual approach behaviors, ritualisms/resistance to change, social pragmatic problems, and semantic/pragmatic problems). A higher severity of autism symptomatology is represented by a higher total score.

The psychometric properties of the *PDDBI* were investigated (Cohen, Schmidt-Lacknew, Romanczyk, & Sudhalter, 2003). Internal consistency ranged from α = .73 to .97 and interrater reliability (i.e., parent-teacher and teacher-teacher) ranged from .28 - .93. Also, similar to the *ASD-DC*, established cutoff scores differentiate not only between ASD versus non-ASD (i.e., 40), but also between AD and PDD-NOS. Thus, symptomatology associated with the spectrum of autism disorders is included in this measure. When examining the sensitivity and specificity of

the established cutoff score of 40, sensitivity was found to range from 89 - 91% and specificity ranged from 80 - 81% for the parent and teacher scales. In regards to the validity of the *PDDBI*, construct validity was demonstrated through empirically derived factors that were consistent with the *PDDBI* subscales. In addition, statistically significant correlations were found between the *PDDBI* and both the *CARS* (Schopler et al., 1986) and *ADI-R* (Lord et al., 1994), demonstrating criterion-related validity (Cohen et al., 2003).

Although this measure has been psychometrically investigated for use with the ASD population, the psychometric properties of the *ASD-DC* were superior to those of the *PDDBI*. Additionally, the *PDDBI* is not suitable for individuals over the age of 12. As such, the *PDDBI* was not selected for use in the current study.

Behavior Function Inventory (BFI)

The *BFI* is based on 11 neurophysiological functions (i.e., attention, perception, association, intention, motility, imitation, emotion, contact, communication, regulation, and cognition) and provides information on the functional symptomotology of autism (adrien et al., 2001). The *BFI* contains 55 items that are to be rated as follows: 1 (behavior never observed), 2 (sometimes observed), 3 (often observed), 4 (very often observed), or 5 (always observed). The *BFI* scoring should only be completed after a two day observation has been conducted.

Psychometric analyses have been conducted on the *BFI* (Adrien et al., 2001). First, the interrater reliability of the measure was reported to range from K_W = .40 – 1.0 for the items. In addition, a factor analysis of the items was conducted. Results of this analysis yielded a six factor solution including interaction dysfunction, praxis dysfunction, auditory dysfunction, attention dysfunction, islet of ability, and emotional dysfunction. Lastly, an analysis of variance was conducted using *BFI* scores as the dependent variable and diagnostic group (AD, PDD-NOS, and

ID) as the independent variable. Results showed that participants diagnosed with AD scored higher than the participants with PDD-NOS and ID on all factors of the *BFI*. Thus, this measure is sensitive to severity differences exhibited by individuals with various ASD diagnoses.

Due to the length of assessment time required for the *BFI,* it would be difficult to use this measure during assessment sessions. In addition, fewer psychometric properties of the *BFI* have been investigated. Thus, for the purposes of this study, this measure would not be as useful.

Purpose

The forthcoming diagnostic manual will be subsuming AS, AD, and PDD-NOS into one diagnostic category. The criteria associated with this newly proposed diagnostic category will increase the specificity of diagnoses of ASD (APA, 2011), therefore, narrowing the symptom definition. Evaluating symptoms of ASD exhibited by children who will no longer meet the diagnostic criteria for ASD is essential. As such, the purpose of this study was twofold. First, symptoms of ASD in children and adolescents who met only the current diagnostic criteria for ASD were compared to the symptoms of ASD in children and adolescents who met future diagnostic criteria for ASD and to children who do not meet criteria according to either diagnostic definition of ASD. It was hypothesized that children meeting diagnostic criteria according to the *DSM-5* would score significantly higher overall and on all subscales of the *ASD-DC* (Matson & González, 2007) when compared to children and adolescents who only met the *DSM-IV-TR* diagnostic criteria (APA, 2000) and those who were typically developing. It was also hypothesized that participants who only met the *DSM-IV-TR* diagnostic criteria would score significantly higher than the control group.

The second aim of the current study was to determine more specifically how the two diagnostic groups (i.e., DSM-IV-TR and DSM-5) could be differentiated from typically developing children. Thus, did different symptoms of ASD discriminate between typically developing children and children who met either the current or future diagnostic criteria for ASD? It was hypothesized that the same core symptoms (i.e., subscales of the *ASD-DC*) would predict ASD group membership despite the diagnostic system utilized to classify participants.

Methods

Participants

A total of 360 children and adolescents, ages 3 through 16 years, were initially eligible to participate in the current study and were recruited from community organizations, schools, and outpatient clinics across the United States. However, in an effort to make groups parsimonious and to exclude outliers (explained in more detail below), the final sample size consisted of 281 participants. Participants were partitioned into groups according to the *DSM-IV-TR* (APA, 2000) and *DSM-5* (APA, 2011) diagnostic criteria for ASD. The *DSM-IV-TR/ICD-10 checklist* was utilized to determine group membership. This checklist contains 19 items, consisting of criteria for ASD. The psychometric properties of this scale are stable. More specifically, inter-rater reliability (r=.89), test-retest reliability (r = .97), and internal consistency (α = .95) all proved to be strong (González, 2008; Matson, González, et al., 2008). On this checklist, respondents (i.e., parents, caretakers, or guardians) marked a "yes" if the symptom was applicable to their child or "no" if it was not.

All participants were first assessed according to the *DSM-IV-TR* diagnostic criteria (APA, 2000). At least three items had to be endorsed on this assessment for the participant to meet *DSM-IV-TR* diagnostic criteria for an ASD, two impairments in social interaction and one in either communication or repetitive, stereotyped, or restricted patterns (González, 2008; Matson, González, et al., 2008). This cutoff was chosen when the checklist was developed as this allowed for the inclusion of children falling into the diagnostic category of PDD-NOS up through the more severe forms of ASD (González, 2008; Matson, González, et al., 2008). A total of 180 participants met criteria for ASD according to the *DSM-IV-TR* and 166 did not meet criteria for ASD.

Second, all participants were assessed according to the *DSM-5* diagnostic criteria (APA, 2011). For participants to be partitioned into the DSM-5 group, three impairments in socialization and two in restricted interests and repetitive behaviors needed to be endorsed, as outlined in the proposed *DSM-5* diagnostic criteria. The *DSM-IV-TR/ICD-10 checklist* (González, 2008; Matson, González, et al., 2008) includes all three of the social communication and social interaction symptoms listed as criteria in the *DSM-5*. In addition, it includes three of the four symptoms listed in the *DSM-5* under the domain of restricted, repetitive patterns of behaviors, interests, or activities. One of the criteria for restricted interests/repetitive behaviors listed in the *DSM-5* is not included on this checklist (i.e., hyper or hypo-reactivity to sensory input). As a result, some participants that may have met *DSM-5* diagnostic criteria might have been left unidentified. When examining participants in the database who met the socialization requirements and met one criterion for restricted interests/repetitive behaviors, 14 participants were identified. Therefore, if the abovementioned item was on the checklist, then these participants may have met the *DSM-5* diagnostic criteria. To control for this, the 14 participants identified were deleted from the database to ensure that their symptomatology would not be accounted for by being partitioned into one of the other groups. Using the *DSM-5*, 121 participants met criteria for ASD and 225 did not meet criteria. Important to note is that all 121 participants that met *DSM-5* diagnostic criteria also met *DSM-IV-TR* diagnostic criteria (APA, 2000), leaving 59 participants that only met *DSM-IV-TR* diagnostic criteria.

Participants who did not meet diagnostic criteria for ASD according to either the *DSM-IV-TR* (APA, 2000) or the *DSM-5* (APA, 2011) were excluded if they had a parent reported diagnosis of a disorder that shares overlapping symptom presentation to symptoms of ASD. Therefore, participants with diagnoses of Attention-Deficit/Hyperactivity Disorder, Social

Phobia, Intellectual Disability, Language Disorders, or developmental delays were deleted from the database (n = 42) prior to running the analyses. In addition, outliers identified within each group through the use of box plots were removed before conducting the analyses (Field, 2005). A total of 23 cases were determined to be outliers and were removed from the dataset. A total of 281 participants remained for the analyses. Refer to Tables 1and 2 below for demographic information of participants utilized in the subsequent analyses.

Measure

The *Autism Spectrum Disorder-Diagnosis for Children (ASD-DC;* Matson & González, 2007) is an informant-based measure that assesses for symptoms of ASD. Forty items comprise this scale and these items are rated on a 3-point Likert scale. Responses include: 0 (not a problem or impairment), 1 (mild problem or impairment), or 2 (severe problem or impairment). Scores assigned to items are based on how the child compares to other children his/her age. The *ASD-DC* takes approximately 10-15 minutes to complete.

Four factors were empirically derived through factor analysis for the *ASD-DC*: nonverbal communication/socialization, verbal communication, social relationships, and insistence of sameness/restricted interests (Matson, Boisjoli, & Dempsey, 2009). The internal consistency of these four subscales ranged from α = .79 - .92 and the internal consistency of the entire scale was excellent, α = .99. Furthermore, the *ASD-DC* has good interrater reliability (K_W = .67) and excellent test-retest reliability (K_W = .77; Matson, González, et al., 2008).

In addition, cutoff scores have been established for the *ASD-DC* differentiating ASD versus non-ASD and differentiating between the various ASD. First, a cutoff of 33 was established to differentiate between ASD and non-ASD. Using a cutoff of 33, the sensitivity of the *ASD-DC* was 84.3%, specificity was 98.2%, and the overall rate of correct classification was

91.3%. Also, cutoff scores have been developed to differentiate between AD, AS, and PDD-NOS. Although these cutoffs are not important for the current study, it does indicate that symptomatology covering the full range of the autism spectrum disorders are included within the *ASD-DC*.

Convergent validity of the *ASD-DC* was demonstrated with the *CARS* (Schopler et al., 1988) and *ADI-R* (Lord et al., 1994). Significant correlations were reported between both the *ASD-DC* and *CARS*, and the *ASD-DC* and *ADI-R*. In addition, correct classification of ASD diagnosis was superior for the *ASD-DC* over both other measures (Matson et al., in press; Matson et al., 2010).

Procedure

Informants for this study were recruited though advocacy groups, support groups, schools, and through an outpatient clinic. If interested in the study, parents/caretakers/guardians were provided with a packet of information via mail or in person at one of the abovementioned sties. First, informed consent was obtained for those interested in participating. Next, the *ASD-DC*, the *DSM-IV-TR/ICD-10 checklist*, and other measures included in the packet (e.g., measure of social skills) were completed by the parents or caregivers. The directions for each of these measures were printed directly on the questionnaires. These forms were completed either in an outpatient developmental disabilities clinic or at the homes of the children or adolescents. Doctoral level graduate students made follow-up phone calls to families when packets were mailed to ensure clarity of the directions and to answer any questions. For those completing the packets in the outpatient clinic, doctoral level graduate student made themselves available to answer any questions. This study was approved by the Louisiana State University Institutional Review Board.

Part 1 Statistical Analyses

For the first set of analyses, participants were reclassified into three groups. The first group was comprised of participants meeting diagnostic criteria for ASD according to the *DSM-5* (APA, 2011) and was labeled the DSM-5 group (*n* = 120). Participant's meeting only criteria for an ASD according to the *DSM-IV-TR* (APA, 2000) comprised group 2, the DSM-IV-TR group (*n* = 52). Participants not meeting diagnostic criteria for ASD according to either the *DSM-IV-TR* or the *DSM-5* were partitioned into the third group, the control group (*n* = 109). However, no one group could be 1.5 times larger (*n* = 78) than the smallest group in order to control for assumptions of the planned analyses (Field, 2005; Tabachnick & Fidell, 2007). Therefore, 31 participants were randomly deleted from the control group and 42 were randomly deleted from the DSM-5 group, leaving a total of 208 participants for part 1 of the analyses. Refer to Table 1 for the demographic information of participants utilized for part 1 of the analyses.

Table 1. Demographic Information of Participants for Part 1 Analyses.

	Total Sample	**DSM-IV-TR**	**DSM-5**	**Control**
	N = 208	**n = 52**	**n = 78**	**n = 78**
Age: Years				
Mean (SD)	8.28 (3.28)	8.34 (3.34)	8.70 (3.47)	8.19 (2.90)
Range	3-16	3 – 15	3 – 16	3 – 16
Gender				
Male	66.8%	71.2%	80.8%	50.0%
Female	33.2%	28.8%	19.2%	50.0%
Ethnicity				
Caucasian	65.4%	65.4%	47.4%	83.3%
African American	11.5%	13.5%	14.1%	8.0%
Hispanic	3.8%	3.8%	2.6%	5.1%
Other	19.2%	17.3%	35.9%	3.8%

A priori analyses were conducted to determine if the three groups differed from each other on demographic variables of gender, ethnicity, and mean age. Results from an analysis of variance (ANOVA) revealed that the mean age of the groups were not significantly different

from one another. Chi square analyses indicated that the groups were not significantly different in regards to ethnicity, but were for gender, χ^2 (2, N = 208) = 17.24, p < .001. Further preliminary analyses were employed to determine if gender was related to autism symptomatology. Gender was not significantly associated with symptoms of autism for any of the three groups. Taking this latter information into account, the fact that there is a higher male to female ratio in ASD (Fombonne, 2005; Kanner, 1971), and that the core symptoms of ASD do not significantly differ between males and females (Rivet, 2010), the demographic variable of gender was not controlled for in subsequent analyses.

Next, an ANOVA was conducted to determine if significant differences emerged between the three groups on the total score of the *ASD-DC* (Matson & González, 2007). Group membership (i.e., DSM-IV-TR, DSM-5, and control) was entered as the independent variable (IV) and the total score from the *ASD-DC* was utilized as the dependent variable (DV). Post hoc tests were conducted to identify significant differences between the three groups while controlling for the inflation of familywise error rate (Field, 2005; Tabachnick & Fidell, 2007). A power analysis was conducted using G*Power 3 (Faul, Erdfelder, Lang, & Buchner, 2007) to ensure that selected sample size was large enough achieve a power of at least .80. A power of .80 is sufficiently large enough to detect an effect when it exists (Field, 2005). Using a medium effect size, alpha level set to .05, and a sample of 208 participants, the power was determined to be .90.

Third, a multivariate analysis of variance (MANOVA) was conducted to examine how the DSM-IV-TR and DSM-5 groups scored relative to each other on the core symptoms of ASD. To conduct this analysis, group membership was entered as the IV and the subscales of the *ASD-DC* (Matson & González, 2007) were entered as the DVs. The significant main effect was

followed-up with a Roy-Bargmann stepdown analysis. A stepdown analysis was chosen over conducting multiple ANOVAs because this test controls for the inflation of error and takes into account the correlations among the dependent variables (Tabachnick & Fidell, 2007). The correlations between the DV's utilized in the analyses ranged from 0.38 to 0.64, therefore, a stepdown analyses was more appropriate. Prior to running the stepdown analysis, homogeneity of regression was examined for each step (Tabachnick & Fidell, 2007). Results of these analyses indicated that homogeneity of regression was confirmed for the first three steps; therefore, results are robust for the dependent variables of Nonverbal Communication/Socialization, Social Relationships, and Insistence of Sameness/Restricted Interests. However, heterogeneity of regression was found at the last step when the DV Verbal Communication was entered. Therefore, this factor would not be interpretable and was eliminated from the analysis (Tabachnick & Fidell, 2007). A second power analysis was conducted to determine if the sample size selected was large enough to achieve power at or above .80. G*Power 3 (Faul et al., 2007) determined that a power of 1 resulted when using 208 participants, a medium effect size, and alpha set at .05.

The Roy-Bargmann stepdown analyzes the highest priority DV in an ANOVA. Subsequently, each higher priority DV is then utilized as a covariate in an ANCOVA to examine the impact of the lower priority DV's (Stevens, 2009; Tabachnick & Fidell, 2007). The order of entry of the DVs in the stepdown analysis is based on theoretical and/or practical importance and this order is predetermined. Research conducted on the core symptom domains of ASD and the newly proposed core symptom domains for ASD in the *DSM-5* (APA, 2011) were the basis for the predetermined order of entry of the DVs. Social skills are considered the hallmark deficit associated with ASD (White et al., 2009). In addition, social communication and social

interaction is a symptom domain category included in the *DSM-5* (APA, 2011). As such, social skills were assigned the highest priority for the analysis. Two DVs were related to social skills (i.e., Nonverbal Communication/Socialization and Social Relationships). Nonverbal Communication/Socialization was entered first because this DV had a more direct overlap with the newly proposed symptom domain category for the *DSM-5*. Next, the other social skills factor of Social Relationships was entered. Lastly, the DV Restricted Interests/Insistence of Sameness was entered as the lowest priority DV.

Part 2 Statistical Analyses

For the second series of analyses, all 281 participants recruited for the current study were utilized. Participants were grouped two separate ways for the analyses. First, all participants were classified as ASD or non-ASD according to the *DSM-IV-TR* diagnostic criteria (APA, 2000). *A priori* analyses were then conducted to determine if participants in the two groups significantly differed on demographic variables. An ANOVA was conducted to determine if the groups differed from each other on mean age, however, no significant differences emerged. Chi square analyses revealed that both ethnicity, χ^2 (3, N = 281) = 8.78, $p < .05$ and gender, χ^2 (1, N = 281) = 22.83, $p < .001$, were significantly different between groups. Further preliminary analyses were conducted to determine if gender and ethnicity were significantly related to autism symptomatology for both groups. No significant relationship emerged; therefore, these variables were not controlled for in subsequent analyses.

For the second analysis, participants were classified as ASD or non-ASD according to the *DSM-5* diagnostic criteria (APA, 2011). Again, *a priori* analyses were employed to determine if significant differences emerged between the two groups on gender, ethnicity, and age. No differences emerged for ethnicity or age. However, Chi square analyses revealed a significant

gender difference between the two groups. χ^2 (1, N = 281) = 17.52, p < .001. To determine if gender was significantly related to the outcome scores (i.e., symptoms of autism), further analyses were conducted. No significant relationship emerged between gender and symptoms of autism for either of the groups; therefore, it was not controlled for in subsequent analyses. Refer to Table 2 for the demographic information of participants.

Table 2. Demographic information for participants utilized for Part 2 analyses.

	Total Sample	**ASD: DSM-IV-TR**	**Control: DSM-IV-TR**	**ASD: DSM-5**	**Control: DSM-5**
	N = 281	**n = 172**	**n = 109**	**n = 120**	**n = 161**
Age: Years					
Mean (SD)	8.40 (3.28)	8.51 (3.40)	8.22 (3.09)	8.58 (3.44)	8.26 (3.16)
Range	3 – 16	3 – 16	3 – 16	3 – 16	3 – 16
Gender					
Male	67.3%	77.9%	50.5%	80.8%	57.1%
Female	32.7%	22.1%	49.5%	19.2%	42.9%
Ethnicity					
Caucasian	66.5%	55.2%	84.4%	50.8%	78.3%
African American	10.0%	11.6%	7.3%	10.8%	9.30%
Hispanic	3.2%	42.3%	4.6%	1.7%	4.3%
Other	20.3%	30.8%	8.3%	36.6%	8.1%

Next, a logistic regression was conducted to determine which core symptoms of ASD predicted group membership when defining group membership according to the *DSM-IV-TR* diagnostic criteria (APA, 2000). The direct enter method was chosen to conduct the logistic regression, which allowed for the entry of all predictors simultaneously (Tabachnick & Fidell, 2007). Collinearity diagnostics were examined prior to conducting the logistic regression and variables with a tolerance value below .1 and a (variance inflation factor) VIF value greater than 10 were eliminated from subsequent analyses to avoid misleading results (Field, 2003; Leech, Barrett, & Morgan, 2008). The variable Nonverbal Communication/Socialization was not utilized in the regression because the tolerance value was .90 and the VIF value was 11.08. As a

result, only three variables were utilized as predictors: verbal communication, social relationships, and insistence of sameness/restricted interests.

Group membership was entered as the outcome variable and the three subscales from the *ASD-DC* (APA, 2000) were utilized as the predictor variables. The same procedures were then utilized to conduct a second logistic regression. For the second regression, group membership was defined according to the *DSM-5* diagnostic criteria (APA, 2011). Sample sizes for logistic regression require, at a minimum, 20 participants per predictor variable (Leech, Barrett, & Morgan, 2008). Therefore, at least 60 participants were necessary to conduct these analyses. For the current study, 281 participants were utilized for the logistic regressions, far larger than what was required.

Results

Part 1 Analyses

First, an ANOVA was conducted to determine if children and adolescents comprising the three groups differed from each other on overall symptoms of ASD. The assumption of homogeneity of variances was violated, $F(2,205) = 32.88$, $p < .001$. Therefore, the variances between the groups were significantly different. Although the results of the ANOVA should be interpreted with some caution, the regression approach utilized by SPSS to conduct the ANOVA places less importance on this violation (Leech, Barrett, & Morgan, 2008). The main effect of group membership was significant, $F(2,205) = 357.73$, $p < .001$, indicating that the diagnostic groups significantly differed from each other on overall autism symptomatology. Post hoc analyses indicated that participants in both the DSM-5 group ($M = 53.68$) and the DSM-IV-TR group ($M = 48.85$) scored significantly higher (i.e., indicating more symptoms of ASD) than participants in the control group ($M = 2.58$). However, no significant difference emerged between participants in the DSM-5 and DSM-IV-TR groups.

Since the DSM-5 and DSM-IV-TR groups did not significantly differ from each other on total symptoms of autism, a MANOVA was conducted to determine if they differed from each other on the linear combination of the core symptoms of autism. Only factors that met the assumption of homogeneity of regression slopes were utilized (i.e., Nonverbal Communication/socialization, Social Relationships, and Insistence of Sameness/Restricted Interests). Using Wilks' criterion, the combined DVs were significantly affected by group membership, $F(3,126) = 2.82$, $p < .05$. A Roy-Bargmann stepdown analysis was performed on the three DVs utilized in the MANOVA. Only one DV contributed to predicting the differences between participants in the two groups. More specifically, when the factor Nonverbal

Communication/Socialization was entered into the analyses first, the following result emerged, stepdown $F(1,128) = 4.04$, $p < .05$. Participants in the DSM-5 group scored significantly higher on this factor ($M = 21.1$), indicating more symptom severity, than participants in the DSM-IV-TR group ($M = 18.7$). After the pattern of differences measured by the Nonverbal Communication/Socialization factor was entered into the analyses as a covariate, the factor Social Relationships did not contribute to predicting the differences between the two groups, stepdown $F(1, 127) = 2.28$, $p = .133$. Lastly, after the pattern of differences measured by the Nonverbal Communication/Socialization and Social Relationships DVs were controlled for, a nonsignificant difference emerged for the DV Insistence of Sameness/Restricted Interests, stepdown $F(1, 126) = 2.06$, $p = .154$. In sum, when controlling for symptoms in the core domain area of Nonverbal Communication/Socialization, the remaining core symptoms domains (i.e., Social Relationships and Insistence of Sameness/Restricted Interests) did not significantly contribute to predicting differences between the two groups. At the univariate level, both the Nonverbal Communication/Socialization factor, $F(1, 128) = 4.04$, $p < .05$, and the Social Relationships factor, $F(1, 128) = 6.11$, $p < .05$ were significant; however the variance associated with the factor of social relationships was already accounted for by the higher priority DV in the stepdown analysis. Results of the univariate and stepdown analyses are presented in Table 3.

Table 3. Univariate and Stepdown *F*.

Factor	Univariate *F*	*Df*	Stepdown *F*	*Df*
Nonverbal Communication/Socialization	*4.04	1,128	*4.04	1,128
Social Relationships	*6.10	1,128	2.28	1,127
Insistence of Sameness/Restricted Interests	0.01	1,128	2.06	1,126

*Indicates significance at $\alpha < .05$

Part 2 Analyses

Two logistic regressions were conducted to determine which core symptoms of ASD predicted group membership when defining group membership according to the *DSM-IV-TR* diagnostic criteria (APA, 2000) and then according to the *DSM-5* diagnostic criteria (APA, 2011). The predictor variables utilized were the subscales of the *ASD-DC* (Matson & Gonzalez, 2007) that had tolerance values above .1 and VIF values less than 10. The subscales of verbal communication, social relationships, and insistence of sameness/restricted interests all meet these criteria and were utilized in the regression analyses.

First, a logistic regression was conducted to determine which core symptom domains (i.e., factors from the *ASD-DC;* Matson & González, 2007) predicted group membership when participants were classified as ASD or non-ASD according to the *DSM-IV-TR* diagnostic criteria (APA, 2000). A test of the full model with the three predictors entered into the analysis together against the constant only model was significant, χ^2 (3, N = 281) = 332.2, $p < .001$. Thus, as a set, the predictors reliably distinguished between children and adolescents with and without ASD. Nagelkerke's approximate of R^2 was .941. Therefore, the three predictors were able to account for 94.1% of the variance in being identified as ASD or non-ASD. The overall correct classification rate was 98.9%, the correct classification rate for the ASD group was 99.4%, and the correct classification rate for the non-ASD group was 98.2%. All three variables utilized in the regression significantly predicted group membership. As a result, a nested model was not tested and the full model was retained. Refer to Table 3 for regression coefficients and Wald statistics.

The same analysis was conducted to determine which core symptom domains of ASD predicted group membership when grouping participants as ASD or non-ASD according to the

DSM-5 diagnostic criteria (APA, 2011). A test of the full model with the three predictors entered into the analysis together against the constant only model was significant, χ^2 (3, N = 281) = 141.23, p < .001. Thus, as a set, the three predictors reliably distinguished between children and adolescents with and without ASD. The three predictors were able to account for 55.4% of the variance in being identified as ASD or non-ASD. The overall correct classification rate was 79.0%, the correct classification rate for the ASD group was 79.2%, and the correct classification rate for the non-ASD group was 78.9%. Refer to Table 3 for regression coefficients and Wald statistics. According to the Wald criterion, only the variable Social Relationships reliably predicted group membership of ASD or non-ASD, χ^2 (1, N = 281) = 18.99, p < .001. Therefore, the two nonsignificant predictors were dropped from the model to test a nested model. A logistic regression was conducted using only Social Relationships as the predictor and group membership as the outcome variable. The test of the model with only the one predictor entered into the analysis against the constant only model was significant, χ^2 (1, N = 281) = 140.27, p < .001. Thus, the predictor of Social Relationships reliably distinguished between children and adolescents with and without ASD. Nagelkerke's approximate of R^2 was .528. Therefore, the predictor (i.e., Social Relationships) was able to account for 52.8% of the variance in being identified as ASD or non-ASD. The overall correct classification rate for the nested model was 77.6%, for the ASD group was 75.0%, and for the non-ASD group was 77.6%. Given that both the full and nested models were significant, a test of model refinement was conducted. The difference between the likelihood ratios for the two models (i.e., 0.96) was less than the chi-square critical value (i.e., 5.99) for the difference in degrees of freedom between the two models (i.e., 2). Therefore, the full and nested models were not significantly different. As a result, dropping the predictor variables of Verbal Communication and Insistence of

Sameness/Restricted Interests makes no difference in the prediction of ASD group membership; therefore, they were dropped from the final model.

Table 3. Logistic regression predicting ASD or non-ASD group membership.

	Variable	*B*	*SE*	*Wald*	*P*
DSM-IV-TR Full Model					
	Social Relationships	-.419	.174	5.79	.016
	Verbal Communication	-.378	.189	4.01	.045
	Restricted Interests	-.637	.247	6.65	.010
DSM-5 Full Model					
	Social Relationships	-.280	.064	19.0	<.001
	Verbal Communication	-.039	.051	.586	.444
	Restricted Interests	-.022	.068	.107	.744
DSM-5 Nested Model					
	Social Relationships	-.333	.037	82.6	<.001

Discussion

The proposed revisions to the diagnostic category of ASD are significant. As such, the aim of the current study was to determine if the subset of children who will no longer meet diagnostic criteria for ASD have symptoms that align more closely with typically developing children, children that meet future criteria for ASD, or significantly different from both of these groups of children. In other words, although a certain percentage of children will no longer meet diagnostic criteria for ASD, will this subset of children still have significant symptoms of ASD?

It was hypothesized that children meeting only *DSM-IV-TR* diagnostic criteria (APA, 2000) for ASD would score significantly higher (i.e., indicating more symptom severity) than children who were typically developing and significantly lower than those who met future diagnostic criteria for ASD on a measure of autism symptoms (i.e., *ASD-DC;* Matson & González, 2007). This hypothesis was only partially supported. That is, participants meeting only *DSM-IV-TR* criteria for ASD scored significantly higher than the typically developing children, but not significantly different than children meeting *DSM-5* diagnostic criteria (APA, 2011). Thus, children and adolescents that no longer met criteria still had significant symptoms of ASD when compared to children who were typically developing. Even more concerning is that children and adolescents who met current, but not future diagnostic criteria had similar symptom severity of ASD when compared to children and adolescents who continued to meet diagnostic criteria. These results highlight that even though these children will no longer meet diagnostic criteria for ASD, it appears that service delivery will remain important for the treatment of symptoms.

As abovementioned, the hypotheses were only partially supported. The DSM-IV-TR and DSM-5 groups did not score significantly different from each other on total autism symptomatology, which was not predicted. Potential explanations for this finding are numerous.

First, it may be that the subset of children who will no longer meet ASD diagnostic criteria are experiencing significant impairments related to the core symptom domains of ASD. If that is the case, then the proposed revisions may be decreasing sensitivity. This explanation would suggest that that the broader symptom definition utilized in the current diagnostic manual (i.e., *DSM-IV-TR*, APA, 2000) may be a superior classification system.

A second explanation is that differences between the groups may be masked when examining overall autism symptoms and may only emerge when examining the core symptom domains. Therefore, an analysis was conducted utilizing the core symptom domains of ASD (i.e., subscales of the *ASD-DC*, Matson & Gonzalez, 2007) as dependent variables to determine how those in the DSM-IV-TR and DSM-5 groups scored relative to each other. It was hypothesized that significant differences would emerge between the DSM-IV-TR and DSM-5 groups on all core symptoms domains investigated (i.e., Nonverbal Communication/Socialization, Social Relationships, and Insistence of Sameness/Restricted Interests). This hypothesis was only partially supported. That is, the factor of Nonverbal Communication/Socialization contributed to the significant difference between the DSM-IV-TR and DSM-5 groups. Children and adolescents who met *DSM-5* diagnostic criteria (APA, 2011) had significantly more impairment in this area. These results coincide with the proposed diagnostic criteria changes as they will be more stringent in the *DSM-5* when compared to the *DSM-IV-TR* (APA, 2000). Additionally, symptoms related to nonverbal communication and socialization make up one of the two core symptom domains represented in the *DSM-5*.

Next, it was hypothesized that the same core symptoms of ASD would differentiate children with ASD from typically developing children, despite if they were classified according to the *DSM-IV-TR* (APA, 2000) or *DSM-5* (APA, 2011) diagnostic criteria. This hypothesis was

not supported. All core symptom domains of ASD that were analyzed (i.e., Social Relationships, Verbal Communication, and Insistence of Sameness/Restricted Interests) predicted group membership of ASD when participants were classified according to the *DSM-IV-TR* diagnostic criteria. However, only the symptom domain of Social Relationships best predicted group membership when defined according to the *DSM-5* diagnostic criteria. Thus, it appears that narrowing the diagnostic criteria for ASD also alters the core symptom domains that best predict group membership. Although these results were not hypothesized, they align more closely with the current and forthcoming core symptom domains included in the *DSM-IV-TR* and *DSM-5*.

In sum, children in the current study who no longer met criteria for ASD according to the *DSM-5* (APA, 2011) still exhibited significant symptoms of ASD. Additionally, impairments in socialization distinguished between those who met only current criteria and those who met current and future diagnostic criteria. However, the *DSM-5* includes a domain beyond that of nonverbal communication and socialization, the domain that encompasses symptoms of restricted interests and repetitive behaviors. Concerning is that this latter domain did not successfully predict group membership of ASD when partitioning participants based on the *DSM-5* diagnostic criteria. In addition, the same core domain did not contribute to predicting the differences between the DSM-IV-TR and DSM-5 groups. Of all the core symptom domain areas, restricted interests and repetitive behaviors are the least severe among individuals with ASD (Matson, Boisjoli, et al., 2009); therefore, low endorsements of symptoms in this area make findings differences more difficult. Despite this, it may be diagnostically beneficial to place a greater weight and emphasis on the domain of social communication and social interaction.

In addition to the concerns noted above, the proposed changes within the diagnostic category of ASD will likely produce some economic and/or educational consequences. Infants

and toddlers that will no longer meet diagnostic criteria for ASD according to the *DSM-5* (APA, 2011) would possibly still qualify for early intervention services due to delays in meeting developmental milestones. However, what will happen to this subset of children as they age out of early intervention? Fortunately, researchers have provided support for intensive early intervention (Goin-Kochel, Myers, Hendricks, Carr, & Wiley, 2007; Hayward, Eikeseth, Gale, & Morgan, 2009). For example, 78% of the variance of positive treatment outcomes from early intervention can be predicted from the age at which the intervention services began, combined with IQ and imitation skills (Goldstein, 2002). However, what is yet to be established is what services are needed to maintain these gains obtained during early intervention (Matson, Tureck, Turygin, Beighley, & Rieske, in press). Will children who have had success during early intervention retain these gains without treatment throughout their childhood years?

Researchers have reported that even with early intensive behavioral intervention, children on the autism spectrum continue to utilize support upon the beginning of their schooling (Gabriels et al., 2001; Goin-kochel et al., 2007; Sallows & Graupner, 2005). However, the length of time a child is enrolled in a school where treatment is implemented does not significantly predict skill acquisition (Goin-kochel et al., 2007). So, while early intervention is still imperative, the necessity of continued support throughout the childhood years and beyond is unclear. Ongoing research examining the impact of continued service delivery after early intervention services subside is urgent given the changing diagnostic categories and criteria of ASD proposed for the *DSM-5* (APA, 2011). Interventions currently utilized to treat individuals diagnosed with various ASDs are largely consistent and similar treatment methodologies should remain despite the newly proposed diagnostic category. However, payment coverage for these children will likely become an obstacle. About a decade ago, the majority of insurance

companies had exclusions for autism (Peele, Lave, Kelleher, 2002), but most now cover services for those diagnosed. However, it is probable that insurance companies will not provide treatment coverage for children who still exhibit significant symptoms of ASD, but no longer meet diagnostic criteria under the *DSM-5* definition of the disorder.

Another implication of the proposed diagnostic changes will be apparent in incidence and prevalence rates of ASD. With the proposal to narrow the symptom definition, fewer children will meet diagnostic criteria upon the publication of the *DSM-5* (APA, 2011). Thus, a decreasing trend of incidence and prevalence rates should be observed once the *DSM-5* is utilized diagnostically. A decrease in prevalence rates for ASD was observed in the current study when utilizing the *DSM-5* diagnostic criteria compared to the *DSM-IV-TR* (APA, 2000). In the current study, the prevalence of ASD decreased by 32.3% when using the *DSM-5* instead of the *DSM-IV-TR*. Although lower rates of both prevalence and incidence are pleasing, it may come at the cost of providing services to those who still require them.

In closing, the proposed revisions to the diagnostic category of ASD are supposed to increase the specificity of the diagnosis. However, as observed in the current study, children and adolescents who meet current, but not future criteria still exhibit significant symptoms. Thus, it will be critical to determine how this subset of individuals can best be supported if they will no longer hold an ASD diagnosis and may no longer be covered for treatment services.

References

Adrien, J. L., Roux, S., Couturier, G., Malvy, P., Guerin, P., Debuly, S., …Barthélémy, C. (2001). Towards a new functional assessment of autistic dysfunction in children with developmental disorders: The Behavior Function Inventory. *Autism, 5,* 249–264.

Allen, D. A., Steinberg, M., Dunn, M., Fein, D., Feinstein, C., Waterhouse, I., & Rapin, I. (2001). Autistic disorder versus other pervasive developmental disorders in young children: Same or different? *European Child and Adolescent Psychiatry, 10,* 67-78.

American Psychiatric Association (1980). *Diagnostic and Statistical Manual of Mental Disorders (3rd ed.)*. Washington, DC: Author.

American Psychiatric Association (1987). *Diagnostic and Statistical Manual of Mental Disorders (3rd ed. - Revised)*. Washington, DC: Author.

American Psychiatric Association (1994). *Diagnostic and Statistical Manual of Mental Disorders*, (4th ed.). Washington, DC: Author.

American Psychiatric Association (2000). *Diagnostic and Statistical Manual of Mental Disorders-Text Revision, (4th ed.).* Washington, DC: Author.

American Psychiatric Association (2011). *DSM-5* Retrieved February 13, 2011, from www.dsm5.org.

Asperger, H. (1991). 'Autistic psychopathology' in childhood. In U. Frith (ed. & Trans.), *Autism and Asperger syndrome* (pp.37-92). New York: Cambridge University Press. (Original work published in 1944).

Attwood T. (1998). *Asperger's syndrome: A guide for parents and professionals*. London, UK: Jessica Kingsley Publications.

Attwood, T. (2007). *The complete guide to Asperger's syndrome*. London, UK: Jessica Kingsley Publishers.

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

Beglinger, L. J., & Smith, T. H. (2001). A review of subtyping in autism and proposed dimensional classification model. *Journal of Autism and Developmental Disorders, 31,* 411-422.

Bleuler, E. (1913). Autistic thinking. *The American Journal of Insanity, 69,* 873-886.

Boisjoli, J. (2010). *A taxometric analysis of autism spectrum disorders in toddlers*. Unpublished doctoral dissertation. Louisiana State University, Baton Rouge.

Bordon, M. C., & Ollendick, T. H. (1994). An examination of the validity of social subtypes in autism. *Journal of Autism and Developmental Disorders, 24,* 23-37.

Buitelaar, J. L., Van der Gaag, R., Klin, A., & Volkmar, F. (1999). Exploring the boundaries of pervasive developmental disorder not otherwise specified: Analyses of data from the DSMIV Autistic Disorder field trial. *Journal of Autism and Developmental Disorders, 29,* 33-43.

Castelloe, P., & Dawson, G. (1993). Subclassification of children with autism and pervasive developmental disorders: A questionnaire based on Wing's subgrouping scheme. *Journal of Autism and Developmental Disorders, 23,* 229-241.

Church, C., Alisanski, S., & Amanullah, S. (2000). The social, behavioral, and academic experiences of children with asperger syndrome. *Focus on Autism and Other Developmental Disabilities, 15,* 12-21.

Cohen, I. L., Schmidt-Lackner, S., Romanczyk, R., & Sudhalter, V. (2003). The PDD Behavior Inventory: A rating scale for assessing response to intervention in children with pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 33,* 31–45.

Cohen, I. L., & Sudhalter, V. (1999). *PDD Behavior Inventory: Professional manual.* Lutz, FL: Psychological Assessment Resources.

Courchesne, E., Carper, R., & Akshoomoff, N. (2003). Evidence of brain overgrowth in the first year of life in autism. *The Journal of the American Medical Association, 290,* 337-344.

Cox, A., Klein, K., Charman, T., Baird, G., Baron-Cohen, S., Swettenham, J., … Wheelwright, S. (1999). Autism spectrum disorders at 20 and 42 months age: Stability of clinical ADI-R diagnosis. *Journal of Child Psychology and Psychiatry, 40,* 719-732.

Culbertson, W., & Zillmer, E. A. (2005). *TOL- DX Tower of London – Drexel University (2nd edition).* Toronto: Multi-Health Systems.

Dawson, G., Meltzoff, A. N., Osterling, J., Rinaldi, J., & Brown, E. (1998). Children with autism fail to orient to naturally occurring social stimuli. *Journal of Autism and Developmental Disorders, 28,* 479-485.

Eaves, L. C., & Ho, H. H. (2004). The very early identification of autism: Outcome to age 4 ½ - 5. *Journal of Autism and Developmental Disorders, 34,* 367-378.

Eaves, L. C., Ho, H. H., & Eaves, D. M. (1994). Subtypes of autism by cluster analysis. *Journal of Autism and Developmental Disorders, 24,* 3-22.

Einfeld, S. L., & Tonge, B. J. (1994). *Manual for the Developmental Behaviour Checklist (Primary Carer Version).* Melbourne, Australia: Monash University Centre for Developmental Psychiatry.

Einfeld, S. L., & Tonge, B. J. (1995). The Developmental Behaviour Checklist: The developmental and validation of an instrument for the assessment of behavioural and emotional disturbance in children and adolescents with mental retardation. *Journal of Autism and Developmental Disorders, 25,* 81–104.

Eisenmajer, R., Prior, M., Leekman, S., Wing, L., Gould, J., Welham, M., & Ong, B. (1996). Comparison of clinical symptoms in autism and asperger's disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 35,* 1523-1531.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39,* 175-191.

Field, A. (2005). *Discovering statistics using SPSS*. London: Sage Publications.

Fombonne, E. (2005). The changing epidemiology of autism. *Journal of Applied Research in Intellectual Disabilities, 18,* 281-294.

Freeman, B. J., Cronin, P., & Candela, P. (2002). Asperger syndrome or autistic disorder? *Focus on Autism and Other Developmental Disabilities, 17,* 145-152.

Frith, U. (1991). Asperger and his syndrome. In U. Frith (Ed.), *Autism and Asperger syndrome* (pp. 1-36). New York: Cambridge University Press.

Garson, G. D. (2011) *Statnotes: Topics in multivariate analysis: Logistic regression*. Retrieved February 14, 2011, from http://faculty.chass.ncsu.edu/garson/PA765/statnote.htm.

Gillberg, C. (1998). Asperger syndrome and high functioning autism. *British Journal of Psychiatry, 171,* 200-209.

Gillham, J. E., Carter, A. S., Volkmar, F. R., & Sparrow, S. S. (2000). Toward a developmental operational definition of autism. *Journal of Autism and Developmental Disorders, 30,* 269-278.

Goldstein, H. (2002). Communication intervention for children with autism: A review of treatment efficacy. *Journal of Autism and Developmental Disorders, 32,* 373-396.

González, M. L. (2008). *The initial reliability and construct validity of the Autism Spectrum Disorders – Diagnostic in Children (ASD-DC).* Unpublished doctoral dissertation, Louisiana State University, Baton Rouge.

Hayward, D., Eikeseth, S., Gale, C., & Morgan, S. (2009). Assessing progress during treatment for young children with autism receiving behavioural interventions. *Autism, 13,* 613-633.

Ingram, D., Takahashi, T., & Miles, J. (2008). Defining autism subgroups: A taxometric solution. *Journal of Autism and Developmental Disorders, 38,* 950-960.

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child, 2,* 217-230.

Kanner, L. (1951). The conception of wholes and parts in early infantile autism. *American Journal of Psychiatry, 1,* 23-26.

Kanner, L. (1965). Infantile autism and the schizophrenias. *Behavioral Science, 10,* 412-420.

Kanner, L. (1971). Follow-up study of eleven autistic children originally reported in 1943. *Journal of Autism and Childhood Schizophrenia, 1,* 119-145.

Kleinman, J. M., Ventola, P. E., Pandey, J., Verbalis, A.D., Barton, M, Hodgson, S., …Fein, D. (2008). Diagnostic stability in very young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 38,* 606-615.

Klin, A., Jones, W., Schultz, R., Volkmar, F., & Cohen, D. (2002). Defining and quantifying the social phenotype in autism. *American Journal of Psychiatry, 159,* 895-908.

Klin, A., Pauls, D., Schultz, R., & Volkmar, F. (2005). Three diagnostic approaches to asperger syndrome: Implications for research. *Journal of Autism and Developmental Disorders, 35,* 221-234.

Klin, A., Volkmar, F. R., Sparrow, S. S., Cicchetti, D. V., & Rouker, B. P. (1995). Validity and neurpsychological characterization of Asperger syndrome. Convergence with nonverbal learning disabilities syndrome. *Journal of Child Psychology and Psychiatry, 36,* 1127-1140.

Koyama, T., Tachimori, J., Osada, J., Takeda, T., & Kurita, H. (2007). Cognitive and symptoms profiles in asperger's syndrome and high-functioning autism. *Psychiatry and Clinical Neurosciences, 61,* 99-104.

Krug, D. A., Arick, J., & Almond, P. (1980). Behavior checklist for identifying severely handicapped individuals with high levels of autistic behavior. *Journal of Child Psychology and Psychiatry, 21,* 221-229.

Kuusikko, S., Haapsamo, H., Jansson-Verkasalo, E., Hurtig, T., Mattila, M-L., Ebeling, H., … Moilanen, I. (2009). *Journal of Autism and Developmental Disorders, 39,* 938-945.

Leech, N. L., Barrett, K. C., & Morgan, G. A. (2008). *SPSS for intermediate statistics: Use and interpretation.* New York: Psychology Press.

Levine, M. N. (1986) *Leiter International Performance Scale: A handbook.* Chicago, IL: Stoelting.

Lord, C., Risi, S., DiLavore, P. S., Shulman, C., Thurm, A., & Pickles, A. (2006). Autism from 2 to 9 years of age. *Archives of General Psychiatry, 63,* 694-701.

Lord, C., Rutter, M., Goode, S., Heemsbergen, J., Jordan, H., Mawhood, L., & Schopler, E. (1989). Autism Diagnostic Observation Schedule: A standardized observation of communicative and social behavior. *Journal of Autism and Developmental Disorders, 19,* 185-212.

Lord, C., Rutter, M., & LeCouteur, A. (1994). Autism Diagnostic Interview-Revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 24,* 659–685.

Lotspeich, L. J., Hower, K., Schumann, C. M., Fryer, S. L., Goodlin-Jones, B. L., Buonocore, M. H., …Reiss, A.L. (2004). Investigation of neuroanatomical differences between autism and asperger syndrome. *Archives of General Psychiatry, 61,* 291-298.

Manijiviona, J., & Prior, M. (1995). Comparison of asperger syndrome and high-functioning autistic children on a test of motor impairment. *Journal of Autism and Developmental Disorders, 25,* 23-29.

Matson, J. L. (1988). *The Matson Evaluation of Social Skills with Youngsters (MESSY).* Worthington, Ohio: International Diagnostic Systems. Translated into Japanese, German, Chinese, and Spanish.

Matson, J. L., & Boisjoli, J. A. (2007). Differential diagnosis of PDD-NOS in children. *Research in Autism Spectrum Disorders, 1,* 75-84.

Matson, J. L., Boisjoli, J. A., & Dempsey, T. (2009). Factor structure of the Autism Spectrum Disorders-Diagnostic for Children (ASD-DC). *Journal of Developmental and Physical Disabilities, 21,* 195-211.

Matson, J. L., & González, M. L. (2007). *Autism Spectrum Disorders – Diagnosis for Children.* Baton Rouge, La. Disability Consultants, LLC. Translated into Italian, Chinese, Hebrew, and Japanese.

Matson, J. L., Gonzalez, M., & Wilkins, J. (2009). Validity study of the Autism Spectrum Disorders-Diagnostic for Children (ASD-DC). *Research in Autism Spectrum Disorders, 3,* 196-206.

Matson, J. L., González, M. L., Wilkins, J., & Rivet, T. T. (2008). Reliability of the Autism Spectrum Disorders-Diagnostic for Children (ASD-DC). *Research in Autism Spectrum Disorders, 2, 696-706.*

Matson, J. L., Hess, J. A., Mahan, S., & Fodstad, J. C. (in press). Convergent validity of the Autism Spectrum Disorder Diagnostic for Children (ASD-DC) and Autism Diagnostic Interview-Revised (ADI-R). *Research in Autism Spectrum Disorders.*

Matson, J. L., Mahan, S., Hess, J. A., Fodstad, J. C., & Neal, D. (2010). Convergent validity of the Autism Spectrum Disorder Diagnostic for Children (ASD-DC) and Childhood Autism Rating Scales (CARS). *Research in Autism Spectrum Disorders, 4,* 633-638.

Matson, J. L., & Minshawi, N. F. (2006). Early intervention for autism spectrum disorders: A critical analysis. Oxford, England: Elsevier Science Inc.

Matson, J. L., Nebel-Schwalm, M., & Matson, M. L. (2007). A review of methodological issues in the differential diagnosis of autism spectrum disorders in children. *Research in Autism Spectrum Disorders, 1,* 38-54.

Matson, J. L., & Wilkins, J. (2008). Nosology and diagnosis of Asperger's syndrome. *Research in Autism Spectrum Disorders, 2,* 288-300.

Mayes, L., Volkmar, F., Hooks, M., & Cicchetti, D. (1993). Differentiating pervasive developmental disorders not otherwise specified from autism and language disorders. *Journal of Autism and Developmental Disorders, 23,* 79-90.

Mayes, S. D., & Calhoun, S. L. (1999). Symptoms of Autism in Young Children and Correspondence with the DSM. *Infants and Young Children, 12,* 90-97.

Mayes, S. D., & Calhoun, S. L. (2001). Non-significant of early speech delay in children with autism and normal intelligence and implications for DSM-IV Asperger's disorder. *Autism, 5,* 81-94.

Mayes, S. D., Calhoun, S. L., & Crites, D. L. (2001). Does *DSM-IV* Asperger's disorder exist? *Journal of Abnormal Child Psychology, 29,* 263-271.

McAlonan, G. M., Suckling, J., Wong, N., Cheung, V., Lienenkaemper, N., Cheung, C., & Chua, S. E. (2008). Distinct patterns of grey matter abnormality in high-functioning autism and Asperger's syndrome. *The Journal of Child Psychology and Psychiatry, 49,* 1287-1295.

Mundy, P., Sigman, M., & Kasari, C. (1990). A longitudinal study of joint attention and language development in autistic children. *Journal of Autism and Developmental Disorders, 20,* 115-128.

Nebel-Schwalm, M. S., & Matson, J. L. (2008). Differential diagnosis. In J.L. Matson (Ed.), *Clinical assessment and interventions for autism spectrum disorders* (pp. 91-129). Burlington, MA: Elsevier

Noterdaeme, M., Wriedt, E., & Höhne, C. (2010). Asperger's syndrome and high-functioning autism: Language, motor and cognitive profiles. *European Child and Adolescent Psychiatry, 19,* 475-481.

O'Brien, S. K. (1996). The validity and reliability of the Wing Subgroups Questionnaire. *Journal of Autism and Developmental Disorders, 26,* 321-335.

Ozonoff, S., South, M., & Miller, J. N. (2000). DSM-IV-defined Asperger syndrome: Cognitive, behavioral and early history differentiation from high-functioning autism. *Autism, 4,* 29-46.

Palmen, S. J. M. C., & van Engeland, H. (2004). Review on structural neuroimaging findings in autism. *Journal of Neural Transmission, 111,* 903-929.

Piven, J., Bailey, J., Ranson, B. J., & Arndt, S. (1997). An MRI study of the corpus callosum in autism. *The American Journal of Psychiatry, 154,* 1051-1056.

Prior, M., Eisenjamer, R., Leekman, S., Wing, L., Gould, G., Ong, B., & Dowe, D. (1998). Are there subgroups within the autism spectrum? A cluster analysis of a group of children with autism spectrum disorders. *Journal of Child Psychology and Psychiatry, 39,* 893-902.

Rao, P. A., Beidel, D. C., Murray, J. J. (2008). Social skills interventions for children with asperger's syndrome or high-functioning autism: A review and recommendations. *Journal of Autism and Developmental Disorders, 38,* 353-361.

Rinehart, N. J., Bradshaw, J. L., Moss, S. A., Brereton, A. V., & Tonge, B. J. (2001). A deficit in shifting attention present in high-functioning autism but not Asperger's disorder. *Autism, 5,* 67-80.

Rivet, T. T. (2010). *Gender differences in core symptomatology in autism spectrum disorders across the lifespan.* Unpublished doctoral dissertation, Louisiana State University, Baton Rouge.

Robinson, S., Goddard, L., Dritschel, B., Wisley, M., & Howlin, P. (2009). Executive functions in children with autism spectrum disorders. *Brain and Cognition, 71,* 362-368.

Rutter, M. (1968). Concepts of autism: A review of research. *Journal of Child Psychology and Psychiatry, 9,* 1-25.

Rutter, M. (1972). Childhood schizophrenia reconsidered. *Journal of Autism and Childhood Schizophrenia, 2,* 315-337.

Rutter, M. (1978). Diagnosis and definition of childhood autism. *Journal of Autism and*

Childhood Schizophrenia, 8, 139-161.

Sahyoun, C. P., Soulières, I., Belliveau, J. W., Mottron, L., & Mody, M. (2009). Cognitive differences in pictoral reasoning between high-functioning autism and Asperger's syndrome. *Journal of Autism and Developmental Disorders, 39,* 1014-1023.

Schopler, E., Mesibov, G. B., & Kunce, L. J. (1998). *Asperger syndrome or high-functioning autism?* New York: Plenum Press.

Schopler, E., Reichler, R. J., & Renner, B. R. (1986). *The Childhood Autism Rating Scales (CARS) for diagnostic screening and classification of autism.* New York: Irvington.

Shoemaker, M. E. (2009). *Comparing social skills in children with autistic disorder and pervasive developmental disorder not otherwise specified.* Unpublished master's thesis, Louisiana State University, Baton Rouge.

Smith, I. M., & Bryson, S. E. (1994). Imitation and action in autism: A critical review. *Psychological Bulletin, 116,* 259-273.

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

Steyn, B., & Le Couteur, A. (2003). Understanding autism spectrum disorders. *Current Pediatrics, 13,* 274-278.

Stone, W. L., Lemanek, K. L., Fishel, P. T., Fernandez, M. C., & Altemeier, W. A. (1990). Play and imitation skills in the diagnosis of autism in young children. *Pediatrics, 86,* 267-272.

Szatmari, P. (1992). The validity of autistic spectrum disorders: A literature review. *Journal of Autism and Developmental Disorders, 22,* 583-600.

Szatmari, P., Archer, L., Fisman, S., Streiner, D. L., & Wilson, F. (1995). Asperger's syndrome and autism differences in behavior, cognition, and adaptive functioning. *Journal of the American Academy of Child and Adolescent Psychiatry, 34,* 1662-1671.

Szatmari, P., Bryson, S., Duku, E., Vaccarella, L., Zwaigenbaum, L., Bennett, T., & Boyle, M. (2009). Similar developmental trajectories in autism and Asperger syndrome: From early childhood to adolescence. *The Journal of Child Psychology and Psychiatry, 50,* 1459-1467.

Szatmari, P., Bryson, S. E., Streiner, D. L., Wilson, F., Archer, L., & Ryerse, C. (2000). Two-year outcome of preschool children with autism or asperger's syndrome. *American Journal of Psychiatry, 157,* 1980-1987.

Tabachnick, B.C., & Fidell, L.S. (2007). Using multivariate statistics (5^{th} edition). Boston, MA: Pearson Education, Inc.

Tachimori, H., Osada, H., & Kurita, H. (2003). Childhood Autism Rating Scale − Tokyo Version for screening pervasive developmental disorders. *Psychiatry and Clinical Neurosciences, 57,* 113-118.

Tantam, D. (1988). Annotation: Asperger's syndrome. *Journal of Child Psychology and Psychiatry, 29,* 245-255.

Toal, F., Daly, E. M., Page, L., Deeley, Q., Hallahan, B., Bloemen, O., …Murphy, D. G. M. (2010). Clinical and anatomical heterogeneity in autistic spectrum disorder: A structural MRI study. *Psychological Medicine, 40,* 1171-1181.

Tonge, B. J., Brereton, A. V., Gray, K. M., & Einfeld, S. (1999). Behavioural and emotional disturbance in high-functioning autism and Asperger syndrome. *Autism, 3,* 117-130.

Van Krevelen, D. (1971). Early infantile autism and autistic psychopathy. *Journal of Autism and Childhood Schizophrenia, 1,* 82-86.

Van Krevelen, D., & Kuipers, C. (1962). The psychopathology of autistic psychopathy. *Acta Paedopsychiatrica, 29,* 22-31.

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

Volkmar, F. R., & Klin, A. (2005). Issues in the classification of autism and related conditions. In F. R. Volkmar, R. Paul, A. Klin, & D. Cohen (Eds.), *Handbook of Autism and Pervasive Developmental Disorders: Vol. 1. Diagnosis, Development, Neurobiology, and Behavior (pp. 5-41).* Hoboken, New Jersey: John Wiley & Sons, Inc.

Volkmar, F. R., Klin, A., Siegel, B., Szatmaria, P., Lord, C., Campbell, M., …Towbin, K. (1994). Field trial for Autistic disorders in DSM-IV. *The American Journal of Psychiatry, 151,* 1361-1367.

Walker, D. R., Thompson, A., Zwaigenbaum, L., Goldberg, J., Bryson, S. E., Mahoney, W. J., ... Szatmari, P. (2004). Specifying PDD-NOS: A comparison of PDD-NOS, Asperger syndrome, and autism. *Journal of the American Academy of Child & Adolescent Psychiatry, 43,* 172-180.

White, S. W., Keonig, K., Scahill, L. (2007). Social skills development in children with autism spectrum disorders: A review of the intervention research. *Journal of Autism and Developmental Disorders, 37,* 1858-1868.

Wimpory, D. C., Hobson, R. P., Williams, M. G., & Nash, S. (2000). Are infants with autism socially engaged? A study of recent retrospective parental reports. *Journal of Autism and Developmental Disorders, 30,* 525-536.

Wing, L. (1981). *Aspergers syndrome: A Clinical Account Psychological Medicine, 11,* 115-129.

Wing, L., & Gould, J. (1979). Severe impairments of social interaction and associated abnormalities in children: Epidemiology and classification. *Journal of Autism and Developmental Disorders, 9,* 11-29.

World Health Organization. (1992). International classification of diseases (10^{th} ed.). Geneva, Switzerland: World Health Organization.

Worley, J.A., & Matson, J.L. (in press). Diagnostic instruments for core features of ASD. In J.L. Matson & P. Sturmey (Eds.), *International handbook of autism and pervasive developmental disorders.* New York: Springer.

Worley, J.A., Matson, J.L., Mahan, S., Kozlowski, A.M., & Neal, D. (2011). Stability of symptoms of autism spectrum disorders in toddlers: An examination using the Baby and Infant Screen for Children with aUtIsm - Part1. *Developmental Neurorehabilitation, 14,* 36-40.

Vita

Julie Worley was born in May 1981 in Pottstown, Pennsylvania. She earned her Bachelor of Arts degree in psychology from Indiana University of Pennsylvania in 2003 and a Master of Science degree in Psychology from Philadelphia College of Osteopathic Medicine in 2005. She entered the doctoral program in clinical psychology at Louisiana State University in 2007. She completed her master's thesis entitled *Gender Differences in Children Diagnosed with Autism Spectrum Disorders and Comorbid Psychopathology.* She completed her pre-doctoral internship at the Kennedy Krieger Institute at Johns Hopkins University School of Medicine in Baltimore, Maryland. She will be completing a post-doctoral fellowship at the Children's Hospital of Philadelphia at the Center for Autism Research. She will receive the degree of Doctor of Philosophy in August 2012.