9-20-2011

Residual Communication and Social Deficits in Individuals with a History of Autism Spectrum Disorders Who Achieved Optimal Outcomes

Alyssa J. Orinstein
alyssa.orinstein@uconn.edu

Residual Communication and Social Deficits in Individuals with a History of Autism Spectrum Disorders Who Achieved Optimal Outcomes

Alyssa J. Orinstein

A Thesis

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Master of Arts

at the

University of Connecticut

2011

APPROVAL PAGE

Master of Arts Thesis

Residual Communication and Social Deficits in Individuals with a History of Autism Spectrum Disorders Who Achieved Optimal Outcomes

Presented by
Alyssa J. Orinstein, B.S.

Major Advisor

_____

Deborah A. Fein, Ph.D.

Associate Advisor

_____

Marianne Barton, Ph.D.

Associate Advisor

_____

Michael Stevens, Ph.D.

University of Connecticut

2011

Acknowledgements

I would like to thank my advisor, Deborah Fein, and my thesis committee members, Marianne Barton and Michael Stevens, for their knowledgeable input and support. I greatly appreciate the rest of the Optimal Outcome lab, including the graduate students, Molly Helt, Eva Troyb, and Katherine Tyson, for collecting the data and helping me through this process. Additionally, I am grateful for all of our undergraduate research assistants, who entered all of the data and assisted with scoring the measures. Finally, the study could not have been conducted without participants; therefore, I would like to thank all the adolescent and families who participated in our study. This study was supported by the National Institutes of Mental Health grant R01MH076189.

Table of Contents

Abstract

Autism spectrum disorders (ASDs) were once considered lifelong disorders, but a small body of research indicates children with ASDs are capable of gaining skills, such that they no longer meet diagnostic criteria for any ASD. These individuals are considered to have achieved an optimal outcome. This study examined communication and social functioning in a group of adolescents with a history of autism spectrum disorders who have achieved optimal outcomes. Thirty-two such individuals between the ages of eight and twenty-one were matched on age, sex, and nonverbal IQ to 33 individuals with high-functioning autism and 25 typically developing adolescents. The groups were compared on measures of autism symptomatology, adaptive functioning, and pragmatic language. Results indicated that the optimal outcome adolescents were functioning quite well in both the communication and social domains. However, some exhibited subtle residual social deficits, including restricted of a range of directed facial expressions, limited insight in social relationships, and poorer quality of rapport, as compared to the typically developing individuals. Importantly, the optimal outcome adolescents performed better than the adolescents with high-functioning autism on all areas assessed. Thus, the optimal outcome individuals were not experiencing any impairing communication or social deficits.

Autism spectrum disorders (ASD) are characterized by three categories of symptoms: impairment in social interaction, impairment in communication, and restricted, repetitive, or stereotyped interests or behaviors (American Psychiatric Association, 2000). According to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR), the autism spectrum consists of Autistic Disorder, Asperger's Syndrome, and Pervasive Developmental Disorders-Not Otherwise Specified (PDD-NOS). A diagnosis of Autistic Disorder indicates that symptoms are present from each of the three categories. PDD-NOS and Asperger's Disorder are characterized by fewer symptoms than is required for an Autistic Disorder diagnosis (American Psychiatric Association, 2000). ASDs are generally considered lifelong disorders; however, even the earliest studies of adolescents and adults with ASDs show evidence of change in symptomatology over time (DeMyer et al., 1973; Rutter, Greenfeld, & Lockyer, 1967). Most studies of the autism phenotype in adolescence and adulthood have demonstrated a general abatement of symptoms from early childhood (Burd et al., 2002; Gilchrist et al., 2001; Mesibov, Schopler, Schaffer, & Michal, 1989; Rutter, et al., 1967). These general improvements in the symptoms of ASD are most frequent during pre-adolescent through early adolescent period (Kobayashi, Murata, & Yoshinaga, 1992).

Studies have typically shown an overall improvement in the communication domain (Ballaban-Gil, Rapin, Tuchman, & Shinnar, 1996; Boelte & Poustka, 2000; DeMyer, et al., 1973; Piven, Harper, Palmer, & Arndt, 1996), particularly in individuals with higher IQs (McGovern & Sigman, 2005). However, the pattern of improvement varied for different communication skills. Seltzer et al. (2003) utilized retrospective

parent report for a large group of adolescents and adults with ASD and found that there was a significant decrease in impairment between lifetime and current ratings within the communication domain. Specifically, adolescents and young adults with ASD had better use of language, utilized more nonverbal communication, and produced less stereotyped or repetitive language. Nonetheless, individuals were often still atypical, though less severely so, in these areas (Seltzer, et al., 2003). There were also particular communication deficits which a substantial portion of the sample no longer exhibited. Forty-five percent stopped displaying pronomial reversal by follow-up, about one third ceased using neologisms or idiosyncratic language in the present, and about a quarter nodded their heads to communicate "yes" despite not doing so when they were younger (Seltzer, et al., 2003).

In contrast, there were other communication skills that were unlikely to improve with age. These included shaking the head to mean "no," pointing, gesture use, stereotyped language, and asking inappropriate questions (Seltzer, et al., 2003). Rutter et al. (1967) found that many adolescents with ASD who gained speech were echolalic, had atypical prosody, used overly formal language, and/or had repetitive speech. Similarly, another early study noted that common, persistent abnormalities, particularly among higher functioning individuals with ASD, included abnormal prosody and repetitive language (Rumsey, Rapoport, & Sceery, 1985). More recently, Gilchrist et al. (2001) also found difficulties remaining with prosody and repetitive speech, along with a lack of reciprocal conversation and limited gestures. Pragmatic language difficulties also continue throughout the lifespan in individuals with ASD (Whitehouse, Watt, Line, & Bishop, 2009).

Studies generally indicate a trend for an overall improvement in the social domain as well (Boelte & Poustka, 2000; Fecteau, Mottron, Berthiaume, & Burack, 2003; Piven, et al., 1996), particularly in higher functioning individuals with ASD (DeMyer, et al., 1973; McGovern & Sigman, 2005). As with communication skills, changes in the social domain were different for different abilities. Compared with early childhood, improvements were noted in the ability to engage in reciprocal social interactions, form and maintain relationships, and share enjoyment with others. Nonetheless, individuals were often still atypical, though less severely so, in these areas (Seltzer, et al., 2003). There were also particular social deficits on which a substantial portion of the sample were no longer symptomatic. Forty-two percent of children who frequently used others' bodies as an instrument stopped displaying this behavior by follow-up. Over a third of children (36%) had typical social overtures at follow-up but not initially, 26% were currently able to comfort others when they were hurt, sad, or ill, and 24% now sought to share their enjoyment with others, despite not doing so when they were younger. Additionally, at least 20% of adolescents and adults currently showed interest in people and learned to make direct eye contact, direct others' attentions or engage in reciprocal smiling (Seltzer, et al., 2003).

Conversely, there were other social behaviors that were more resistant to improvement over time. These included abnormal responses to social approaches, limited range or inappropriate facial expressions, and decreased offers to share (Seltzer, et al., 2003). Similarly, Rumsey, Rapoport, and Sceery, (1985) found that over half their sample of adults between age 18 and 38 showed a limited range of facial expressions. Many of the high functioning males in their sample also engaged in social behaviors that

were stereotyped, odd, or inappropriate, such as relaying a script or repeatedly touching others' clothing. Another study comparing young adults with ASD to those with receptive language disorder (Howlin, Mawhood, & Rutter, 2000) showed that the individuals with ASD had poorer skills in many aspects of social interactions, including initiation, response and rapport.

Friendship quality has consistently remained impaired in adolescence and adulthood in individuals with ASDs. There has been somewhat of a range in the number of individuals that eventually develop some kind of friendships. Some studies have reported very low percentages, ranging between 0 and 15.8% (DeMyer, et al., 1973; Howlin, 2003; Howlin, et al., 2000; Orsmond, Krauss, & Seltzer, 2004; Shattuck et al., 2007; Whitehouse, et al., 2009). Seltzer et al. (2003) found that quantity and quality of friendships was very unlikely to change over time, as only 4.4% who did not have true friendships between the ages of ten and fifteen did so at the time of the study (mean age of 22). Shattuck et al. (2007) had similar findings in that the increase of individuals with ASD who had friendships was only 7.5% over a period of four-and-a-half years. However, Eaves and Ho (2008) had more promising findings, with 33% of the young adults with ASD in their study reporting at least one close friendship that involved connectedness and mutual enjoyment.

Adaptive communication and social skills are also deficient in individuals with ASD. Some studies have found that adaptive functioning skills improved over time in individuals with ASD (Anderson, Oti, Lord, & Welch, 2009; Freeman, Del'Homme, Guthrie, & Zhang, 1999), others have found that changes varied for each adaptive domain (McGovern & Sigman, 2005), while still others did not find improvement with age (Klin

et al., 2007; Loveland & Kelley, 1988; Schatz & Hamdan-Allen, 1995). Freeman, Del'Homme, Guthrie and Zhang (1999) demonstrated that adaptive social skills in those with ASD improved with age from early childhood through adolescence, regardless of IQ. Communicative adaptive skills also improved with age for all individuals, but improvement was greater for those with higher IQs. Anderson et al. (2009) also noted that social skills improved with age; however, for most of the individuals with ASD, the rate of change was significantly less than for typically developing individuals. Conversely, for a subset of individuals with ASD (about one-quarter), improvement occurred at a rate equal to or greater than the typically developing individuals, which allowed them to reach almost age-appropriate social skills scores. McGovern and Sigman (2005) examined adaptive functioning in individuals with ASD at ages 12-13 and 19-20. They found that adaptive social skills improved between the two time points, but adaptive communication skills did not. Furthermore, in their sample, individuals with higher IQs (≥ 70) improved in their adaptive skills more than individuals with lower IQs (<70). Additionally, none of the studies by Loveland and Kelley (1988), Schatz and Hamdan-Allen (1995), or Kenworthy, Case, Harms, Martin and Wallace (2010) indicated improvement of communication and social adaptive functioning with age in individuals with ASD. Klin et al. (2007) also did not find improvement in adaptive skills over time in their sample of high-functioning individuals with ASD relative to typically developing peers, instead noting an increased disparity with age. This was not due to a loss of skills; rather, this was reflective of a failure by the individuals with ASD to gain skills at the same rate as their peers. Clearly, the research on change in adaptive functioning in

individuals with ASD over time is mixed, and more research needs to be conducted to clarify this picture.

Some research has suggested that adaptive communication and social skills in individuals with ASD are related to IQ and/or autism symptom severity. Early studies by Loveland and Kelley (1988) and Schatz and Hamdan-Allen (1995) showed that adaptive skills are correlated with IQ. Liss et al. (2001) examined a group of pre-adolescent children with ASD and found that there was a strong correlation between adaptive communication and social functioning and IQ. In terms of autistic symptomatology, adaptive social skills for lower-functioning individuals with ASD (nonverbal IQ < 80) were negatively correlated with social impairments; no other correlations between adaptive skills and symptoms were present. However, for higher-functioning individuals with ASD (nonverbal IQ ≥ 80), all adaptive skill domains were significantly correlated with all autistic symptom domains. Kenworthy et al. (2010) found that IQ was correlated with adaptive communication skills but not with adaptive social skills in a group of individuals with high-functioning ASD. Additionally, they found that communication impairment was negatively correlated with adaptive functioning skills, while social impairment was negatively correlated only with social adaptive skills.

However, other research has suggested that, for individuals with high-functioning autism, adaptive communication and social functioning skills (abilities) are distinct from autism communication and social symptoms (disabilities) in their response to treatment and in their relationship to IQ (Klin, et al., 2007). This study found that adaptive behavior scores were substantially below IQ scores in high-functioning children with autism, indicating adaptive impairment despite cognitive potential. A later study

replicated this finding that high-functioning ASD children (IQ>70) have significantly higher IQ scores than adaptive functioning scores (Perry, Flanagan, Dunn Geier, & Freeman, 2009). A study by Sallows and Graupner (2005), found that even among the children who achieved the 'best outcome,' at least one third were noted as having mild delays in adaptive social functioning skills according to the Vineland Adaptive Behavior Scales (Sparrow, Balla, & Cicchetti, 1985), but did not have difficulties related to autism social symptoms. Thus, examining communication and socialization in terms of both autism symptomatology and adaptive functioning skills is important in assessing outcome in adolescents and young adults with ASD.

There is considerable evidence that, generally, social and communication symptoms of ASD, as well as adaptive functioning deficits, persist into adolescence and adulthood. However, some research studies over the past few decades have noted the phenomenon of "recovery," in which individuals lose their ASD diagnosis. Still largely unknown is what factors influence or predict prognosis, resulting in an optimal outcome or a persistent ASD, or whether these individuals who achieve optimal outcomes have any residual deficits.

The first published study noting "recovery" in autism was conducted by Lovaas over two decades ago (1987). He reported that after receiving extensive behavioral intervention, 47% of children (9 out of 19) in the study "recovered," as indicated by successful completion of first grade in a regular classroom in a public school and by achieving an average or above score on an IQ test. However, this study did not indicate whether autism symptomatology had been completely resolved. Since then, studies have found somewhat lower rates of "recovery," generally between 3% and 25%, of children

with ASDs who eventually lose their ASD diagnosis (Helt, et al., 2008). These studies used varied criteria to define "recovery." Therefore, recently, stricter criteria have been used to define recovery, or "optimal outcome." Specifically, most current definitions of optimal outcome mandate that the child no longer meets criteria for any pervasive developmental disorder (autism spectrum disorder) and that both IQ and adaptive functioning scores are within the average range (Helt et al., 2008). Using such criteria, one study found that children 48% of children (11 out of 23) who received intensive early behavioral intervention reached an 'best outcome' status according to the authors, scoring in the normal range on tests of IQ, language, adaptive functioning, school placement, and personality, with very mild elevations in diagnostic symptoms (Sallows & Graupner, 2005). Three of the children needed classroom aides for attention problems, and one probably still met criteria for ASD, but the remaining 7 children (30%) would likely have met these more stringent criteria for optimal outcome.

A few recent studies have examined in greater depth the current behavioral presentation of children who have achieved optimal outcomes. One study found that, in a small number of children, an ASD in early childhood evolved into clear-cut cases of Attention Deficit Hyperactivity Disorder by age eight (Fein, Dixon, Paul, & Levin, 2005). Another study examined language functioning in a group of children who had achieved an optimal outcome (Kelley, Paul, Fein, & Naigles, 2006). Their results suggested that the grammatical abilities of these optimal outcome children were mostly comparable to typically developing peers, but that they were still experiencing difficulties in both pragmatic and semantic language. The most recent study of children who have achieved optimal outcome included a comprehensive battery that assessed autism

symptomatology, adaptive functioning, problem behaviors, and language (Kelley, Naigles, & Fein, 2010). The authors found that the children who had achieved optimal outcome had adaptive and problem behavior scores that fell within the average range. They showed average language and communication scores on all language measures. Importantly, the optimal outcome children were no different than the children with high-functioning autism on early autism symptomatology, but the optimal outcome children no longer exhibited behaviors indicative of any autism spectrum disorder at the time of assessment (Kelley, et al., 2010). Despite the interesting findings of these past studies, no research to date has examined whether adolescents who achieve an optimal outcome retain any subtle residual communication or social impairments implicated in ASDs.

The current study is designed to address the following aims: (1) to replicate with a new sample the finding that adolescents who have achieved optimal outcomes no longer exhibit clinically significant deficits in the communication or social domains, (2) to determine whether adolescents who have achieved optimal outcomes exhibit subtle residual deficits in communication and social autistic symptomatology (disabilities), and (3) to determine whether adolescents who have achieved optimal outcomes exhibit subtle residual deficits in adaptive communication and social functioning skills (abilities). The hypotheses are that the optimal outcome adolescents will no longer meet diagnostic criteria for any ASD, that they will display some minor impairment in autism symptomatology in both the communication and social domains, particularly of symptoms that are more resistant to change over time, and that they will display some minor impairment in adaptive functioning skills in both the communication and social domains.

Methods

Participants

Participants included 32 adolescents with a history of ASD who achieved optimal outcomes (OO), 33 high-functioning adolescents with a current ASD diagnosis (HFA), and 25 typically developing peers (TD). The participants in the study ranged from 8 years, 5 months to 21 years, 8 months. The three groups were matched on age, *M*(age)=12.9, 13.4, 13.9, for OO, HFA, and TD, respectively, p=.473. The groups were also matched on gender, χ^2 (2, 90) = 2.97, p=.23, with 7 females in the OO group (21.9%), 3 females in the HFA group (9.1%), and 4 females in the TD group (16.0%). Groups did not differ on nonverbal IQ (p=.573) but were significantly different on verbal IQ, *M*(VIQ)= 112.7, 103.0, 112.1, for OO, HFA, and TD, respectively, p=.003. See Table 1 for participant characteristics. The participants were predominantly Caucasian, with only three individuals in the OO group, one individual in the HFA, and three individuals in the TD group reporting other races or ethnicities. All participants were part of a larger study at the University of Connecticut entitled Language Functioning in Optimal Outcome Children with a History of Autism. Participants were recruited through flyers and information distributed to New England autism associations, advertisements posted in newspapers and online forums, and presentations at conferences. Participants were also referred from the principal investigators' private practices, the Psychological Services Clinic at the University of Connecticut, and from other ongoing studies at the University of Connecticut. TD participants were additionally recruited through advertisements posted at local public schools and at the University of

Connecticut. The study was approved by the Institutional Review Board of the University of Connecticut.

Enrollment Criteria

To be included in the study, all participants had to perform within the average range or above on standardized measures of cognitive functioning. Participants were required to have verbal, nonverbal, and full-scale IQ scores greater than 77 (within one-and-a-half standard deviations of the mean IQ of 100). The *Wechsler Abbreviated Scale of Intelligence (WASI)* was administered during testing in order to confirm IQ for all participants. Other eligibility requirements applied specifically to the separate participant groups, as described below.

To be included in the OO group:

(1) Participants had to have a documented history of an ASD diagnosis made by a specialist in the field of autism. Parents of participants needed to provide a written report that described an ASD diagnosis made before the age of 5. To confirm the participant's early diagnosis, the written report was edited to remove all references to the child's early diagnosis and was reviewed by an expert in the field of ASDs who was blind to group membership. This specialist was given a total of 35 reports of possible participants for the OO group deemed appropriate after phone screening, as well as 18 reports for children without ASD diagnosis (foils). Four potential participants for the OO group were rejected and all of the 18 foils were rejected.

(2) Participants could not currently meet criteria for any Pervasive Developmental Disorder according to the Autism Diagnostic Observation Schedule (ADOS) or clinical judgment.

(3) Participants had to perform in the average range or above on a standardized measure of adaptive functioning. Specifically, participants' scores on the communication and socialization domains of the Vineland Adaptive Behavior Scales had to be greater than 77 (within one-and-a-half standard deviations of the mean IQ of 100).

(4) Participants had to be included in regular education classrooms without the support of special education services to address deficits specific to ASDs. However, participants in this group could be receiving limited special education services to address impairments not specific to ASDs, including language deficits, learning disorders, and psychiatric disorders.

To be included in the HFA group:

(1) Participants' behavioral presentation and parent report of ASD symptomatology had to be consistent with a diagnosis of ASD at the time of assessment. Specifically, participants had to meet criteria for ASD on the ADOS and according to clinical judgment.

(2) Participants had to be able to speak in full sentences and participate fully in testing procedures in order to be included.

To be included in the TD group:

(1) Participants could not meet criteria for any ASD at any point in their development, by parent report. Specifically, participants could not meet current

diagnostic criteria for any ASD according to the ADOS or clinical judgment, nor could participants exhibit clinical features of ASD according to an interview with the parent.

(2) As with the OO group, participants had to perform in the average range or above on a standardized measure of adaptive functioning. Specifically, participants' scores on the communication and socialization domains of the Vineland Adaptive Behavior Scales had to be greater than 77 (within one-and-a-half standard deviations of the mean IQ of 100).

Exclusion criteria. Three participants were rejected from the OO group because clinical judgment detected the presence of clinically significant ASD symptoms. An additional two participants were excluded from the OO group because cognitive functioning or adaptive skills did not fall in the average range. Two potential participants in the HFA group were excluded because their scores did not clearly meet criteria for ASD. An additional four potential HFA participants were excluded because their cognitive functioning did not fall in the average range. Two potential participants for the TD group were excluded because they exhibited symptoms of ASD. An additional two TD participants were excluded because their adaptive skills did not fall in the average range. Additionally, potential participants were excluded from the study if (1) at the time of the telephone screening they exhibited symptoms of major psychopathology (e.g., active psychotic disorder) that would impede their full participation in the study, (2) they had severe visual or hearing impairments, or (3) they had a history of seizure disorder, Fragile X syndrome, or significant head trauma that involved loss of consciousness. Two

potential participants, one for the TD group and one for the HFA group, were excluded because of a history of a seizure disorder.

Procedure

Phone screenings were conducted with the parents of each participant to ensure that the participants met the enrollment criteria of the study. Those who met enrollment criteria were scheduled for an assessment. The evaluation was administered over the course of two or three testing sessions at the University of Connecticut, the Institute of Living of Hartford Hospital, or in the participant's home. Testing was conducted in a quiet room with one examiner and lasted approximately six hours. In most cases, parent interviews were conducted concurrently by a second examiner and lasted approximately three hours for the OO and HFA groups and one-and-a-half hours for the TD group. At the end of each testing session, the participant received a monetary incentive for participation. Measures were administered to the participants and parents to gather data in the areas of cognitive functioning, adaptive behavior, autism symptomatology, and language abilities.

Measures

Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) is a brief measure of intelligence that consists of two subtests that measure verbal ability (Vocabulary and Similarities) and two subtests that measure nonverbal reasoning (Block Design and Matrix Reasoning). The T-scores from each subtest are combined to yield Full Scale, Verbal and Performance (non-verbal) IQs that have a mean of 100 and a standard deviation of 15. As per the WASI manual, internal consistency as measured by corrected split-half reliability, ranged from .81 to .98 for the subtests, and .92 to .98 for

the IQ scores. Test-retest coefficients ranged from .83 to .95, depending on age, for the IQ composite scores, and were in the high .70s to high .80s for the subtests. Criterion validity was demonstrated by evaluating the correlation between the WASI and other measures of cognitive ability. Correlations between scores on the WASI and on the Wechsler Scale of Adult Intelligence, Third Edition (Wechsler, 1997) ranged between .76 and .92 for the IQ scores and .66 and .88 for the subtests. The WASI was also capable of predicting achievement, as measured by the Wechsler Individual Achievement Test (Wechsler, 1992). In the present study, the WASI was used to ensure participants met inclusion criteria, to match the groups on IQ, and to assess cognitive abilities of the participants.

Vineland Adaptive Behavior Scales (VABS; Sparrow, et al., 1985) assesses an individual's functioning in daily life through an interview with the primary caregiver. The VABS measures adaptive behavior in three domains: Communication, Daily Living Skills, and Socialization. Each domain consists of several sub-domains that address more specific areas of development. The interview evaluates developmental milestones in adaptive behavior by asking for concrete examples of observable behavior. The raw scores are converted into standard scores with a mean of 100 and a standard deviation of 15. As per the manual, internal consistency was measured by split-half reliability and ranged from .69 to .84 for all subdomains and from .80 to .90 for domain scores. For the current study, the VABS was used to ensure the OO and TD participants met inclusion criteria and to examine adaptive communication and socialization functioning (communication and social abilities) across the three groups.

Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000) is a play and interview based direct assessment with specific presses designed to examine ASD symptoms as defined by the DSM-IV-TR. The instrument consists of a series of activities designed to interest children and young adults and to encourage communication, social interaction, and imaginative use of materials. The instrument has four modules which can be used, based on the language level of the individual, ranging from non-verbal to fluent phrase speech. For this study, either Module 3 or 4 of the ADOS was used, depending on the age and developmental level of each participant. The participant's behavior was then coded on items in the domains of Communication, Reciprocal Social Interaction, Imagination/Creativity, and Stereotyped Behaviors and Restricted Interests. Scores for each item range from 0 to 3, with higher scores indicating more severe behaviors. Inter-rater reliability of this instrument is 0.82 or above on all domains, and test-retest reliability is 0.73 or above, except for restricted interests (0.59). According to the manual, Cronbach's alpha was .71 for the communication items, .87 for the social functioning items, and .43 for the restricted and repetitive behaviors items. For the current study, the ADOS was used to place participants into diagnostic groups, as well as to assess whether the participants with a history of autism retained any autistic features in the Communication and Reciprocal Social Interaction domains. The ADOS served as a measures of social and communication disabilities. ADOS administrations were videotaped and five administrations per group were coded by a rater blind to group status. Inter-rater reliability was coded based on the method determined by the test authors and was high for both the algorithm and total items, at 86.7% and 85.7% respectively.

Test of Language Competence (TLC; Wiig & Secord, 1989) assesses semantic, syntactic, and pragmatic language skills. There are four subtests, including Ambiguous Sentences, Listening Comprehension: Making Inferences, Oral Expression: Recreating Speech Acts, and Figurative Language. According to the manual, the TLC has high correlations with the Wechsler Intelligence Scale for Children-Revised (WISC-R) verbal scale, the Clinical Evaluation of Language Functions-Revised (CELF-R), and the Test of Adolescent Language (TOAL). The current study utilized the Listening Comprehension: Making Inferences and Figurative Language subtests to assess pragmatic language ability. The Making Inferences subtest assessed the participant's ability to listen and understand description of situations presented orally in order to generate two plausible inferences. The Figurative Language subtest assessed the participant's ability to comprehend and interpret metaphors.

Results

The scores on most of the measures examined in the current study did not meet the assumptions of normality of data or homogeneity of variances necessary to conduct parametric statistical tests. However, most parametric techniques are robust enough to deal with distributions that are not normal and have heterogeneous variances. Nonetheless, non-parametric test equivalents were also conducted when possible to increase confidence in the results.

Communication Domain

Communication Disabilities

There are nine communication items that are included on both Modules 3 and 4 of the Autism Diagnostic Observation Schedule (ADOS). A one-way between-groups

analysis of variance (ANOVA) was conducted to explore the impact of group (OO, HFA, or TD) on a sum of these communication items (see Figure 1). There was a statistically significant difference between the groups on the ADOS communication sum, $F(2, 87) = 98.5$, $p < .001$. Effect size calculations resulted in a large effect with Cohen's $d = 2.13$.Levene's test for homogeneity of variances was found to be violated, $F(2, 87) = 6.12$, $p = .003$. Therefore, post-hoc comparisons used the Games-Howell test, which is a modified Tukey HSD test that is appropriate when the homogeneity of variances assumption is violated. The Games-Howell post-hoc comparisons indicated that the mean ADOS communication sum for the HFA group ($M = 7.03$, $SD = 2.39$) was significantly different from the OO group ($M = 1.50$, $SD = 1.29$) and the TD group ($M = 1.68$, $SD = 1.31$). The mean ADOS communication sums for the OO and TD groups were not significantly different from each other (see Figure 1).

One ADOS communication item (emphatic gestures) is on Module 4 but not Module 3. Therefore, an average ADOS communication score was calculated by dividing the ADOS communication total score by nine items for Module 3 and ten items for Module 4. A one-way between-groups ANOVA was conducted to explore the impact of group (OO, HFA, or TD) on the average of all communication items. There was a statistically significant difference between the groups on the ADOS communication average, $F(2, 87) = 92.0$, $p < .001$. Effect size calculations resulted in a large effect with Cohen's $d = 2.06$.Levene's test for homogeneity of variances was found to be violated, $F(2, 87) = 7.87$, $p = .001$. Games-Howell post-hoc comparisons indicated that the ADOS communication average for the HFA group ($M = 0.79$, $SD = 0.28$) was significantly different from the OO group ($M = 0.17$, $SD = 0.15$) and the TD group ($M = 0.19$, $SD =$

0.14). The mean ADOS communication averages for the OO and TD groups were not significantly different from each other (see Figure 2).

Finally, a one-way between-groups ANOVA was conducted to explore the impact of group (OO, HFA, or TD) on ADOS communication algorithm total. The algorithm total includes four communication items, but the specific items differ between Modules 3 and 4. The autism spectrum cutoff is a score of 2 or higher. There was a statistically significant difference between the groups on the ADOS communication algorithm total, $F(2, 87) = 92.3$, $p < .001$. Effect size calculations resulted in a large effect with Cohen's $d = 2.06$.Levene's test for homogeneity of variances was found to be violated, $F(2, 87) = 14.2$, $p < .001$. Games-Howell post-hoc comparisons indicated that the mean ADOS communication algorithm for the HFA group ($M = 3.51$, $SD = 1.48$) was significantly different from the OO group ($M = 0.50$, $SD = 0.67$) and the TD group ($M = 0.40$, $SD = 0.58$). The mean ADOS communication algorithm total for the OO and TD groups were not significantly different from each other, and both means were well below the ADOS communication autism spectrum cutoff of 2 (see Figure 3). Because these three methods of examining the ADOS communication totals led to similar results, the communication sum was considered the most useful since this score included the same items across all participants.

A Kruskal-Wallis Test, the non-parametric alternative to the one-way between-groups ANOVA, compares group medians instead of means and was used to confirm the findings for the ADOS communication sum. A Kruskal-Wallis test revealed a statistically significant difference in the ADOS communication sum across groups, χ^2 (2,

n = 90) = 60.5, p< .001. The HFA group recorded a higher median score (Md = 7) than the other two groups (OO and TD), which both recorded median values of 1.

Since verbal IQ varied between the groups, and verbal IQ has been linked to communication skills, a one-way between-groups analysis of covariance (ANCOVA) was conducted to control for the effect of verbal IQ on the ADOS communication sum. Due to the nature of the groups in this study, covarying for verbal IQ is controversial (see discussion). However, even after adjusting for verbal IQ, there were still significant differences between the groups on the ADOS communication sum, F(2, 86) = 80.1, p< .001, d = 1.92, with the same pattern of differences as in the uncovaried analysis. Only 5.6 percent of the variance in the ADOS communication sum was accounted for by verbal IQ.

A one-way between-groups multivariate analysis of variance (MANOVA) was performed to investigate group differences in ADOS communication scores to determine whether an item-by-item analysis was warranted. Nine ADOS communication items that were common across Modules 3 and 4 were used as dependent variables. The independent variable was group: OO, HFA, or TD. There was a statistically significant difference between groups on the combined dependent variables, F (18, 156) = 12.5, p< .001, Wilks' λ = .17; d = 0.57. When the results for the dependent variables were considered separately, two variables did not show significant differences between groups. The first was overall language level, F (2, 86) = 0.89, p = .41, d = 0.20. The other non-significant item was echolalia, F (2, 86) = 2.85, p = .063, d = 0.36. The remaining items showed significant group difference, so further analyses were conducted to determine which groups differed.

The objective of this study was to discover subtle residual deficits; therefore, exploratory independent sample *t* tests were conducted to ascertain whether or not the OO and TD groups differed on the remaining ADOS communication items. Higher mean scores indicated more abnormal behavior. The OO and TD groups did not differ on the presence of speech abnormalities or the incidence of stereotyped or idiosyncratic language (see Table 2). No group differences were found for the OO and TD participants for offering information, the frequency of information asked, or on how they reported events, although the OO group had non-significantly lower mean scores on these three items (see Table 2). Conversation ability and the use gestures did not differ between the OO and TD participants (see Table 2). Finally, the use of emphatic gestures was compared for participants given ADOS Module 4, with no significant difference found between the OO and TD groups. These results suggest that there are no residual deficits in autism communication symptoms for the OO participants; however, the power in the present study was too low to detect significance in small effect sizes. Mann-Whitney U non-parametric tests comparing the OO and TD groups on these ADOS communication items confirmed the above findings demonstrated with *t* tests (see Table 2).

Communication Abilities

A one-way between-groups ANOVA was conducted to compare the three groups (OO, HFA, and TD) on the communication domain score of the Vineland Adaptive Behavior Scales (VABS). There was a statistically significant difference between the groups on the VABS communication domain score, $F(2, 86) = 9.40$, $p < .001$. Effect size calculations resulted in a medium effect with Cohen's $d = 0.66$. Levene's test for homogeneity of variances was not violated, $F(2, 86) = 2.47$, $p = .091$. Therefore, post-

hoc comparisons used the Tukey HSD test which indicated that the mean VABS communication domain score for the HFA group (M = 85.1, SD = 13.9) was significantly different from the OO group (M = 97.9, SD = 11.9) and the TD group (M = 93.5, SD = 8.80), which did not differ significantly from each other (see Figure 4).

Since verbal IQ varied between the groups, and verbal IQ has been linked to communication skills, a one-way between-groups ANCOVA was conducted to control for the effect of verbal IQ on the VABS communication domain score. Even after adjusting for verbal IQ, there were still significant differences between the groups on the VABS communication domain score, $F(2, 85) = 6.21$, $p = .003$, $d = 0.54$. Only 3.8 percent of the variance in the VABS communication domain score was accounted for by verbal IQ.

Two one-way between-groups ANOVAs were conducted to compare the three groups (OO, HFA, and TD) on the pragmatic language subtests of the Test of Language Competence (TLC). There was a statistically significant difference between the groups on the Making Inferences subtest of the TLC, $F(2, 85) = 10.4$, $p < .001$. Effect size calculations resulted in a medium to large effect with Cohen's $d = 0.70$.Levene's test for homogeneity of variances was not violated, $F(2, 85) = 0.58$, $p = .56$. Therefore, post-hoc comparisons used the Tukey HSD test which indicated that the mean TLC Making Inferences scaled score for the HFA group (M = 8.03, SD = 2.71) was significantly different from the OO group (M = 10.0, SD = 2.80) and the TD group (M = 11.4, SD = 2.78).The mean TLC Making Inferences scaled scores for the OO and TD groups were not significantly different from each other (see Figure 5). However, it is important to note that all three groups scored within the average range, despite the group differences.

A one-way between-groups ANCOVA was again conducted to control for the effect of verbal IQ on the Making Inferences scaled score on the TLC. Even after adjusting for verbal IQ, there were still significant differences between the groups on the Making Inferences scaled score, $F(2, 84) = 6.19$, $p = .003$, $d = 0.54$. Only 7.9 percent of the variance in the TLC Making Inferences scaled score was accounted for by verbal IQ.

There was also a statistically significant difference between the groups on the Figurative Language subtest of the TLC, $F(2, 85) = 20.1$, $p < .001$. Effect size calculations resulted in a large effect with Cohen's $d = 0.97$.Levene's test for homogeneity of variances was not violated, $F(2, 85) = 2.34$, $p = .10$. Therefore, post-hoc comparisons used the Tukey HSD test which indicated that the mean TLC Figurative Language scaled score for the HFA group ($M = 7.31$, $SD = 2.59$) was significantly different from the OO group ($M = 9.66$, $SD = 2.88$) and the TD group ($M = 11.7$, $SD = 2.01$).The mean TLC Figurative Language scaled scores for the OO and TD groups were also significantly different from each other (see Figure 6). However, it is important to note that all three groups again scored within the average range, despite the group differences, although the HFA average was at the bottom of the average range.

A one-way between-groups ANCOVA was conducted to control for the effect of verbal IQ on the Figurative Language scaled score on the TLC. Even after adjusting for verbal IQ, there were still significant differences between the groups on the Figurative Language scaled score, $F(2, 84) = 13.2$, $p < .001$, $d = 0.79$. About 18.1 percent of the variance in the TLC Figurative Language scaled score was accounted for by verbal IQ.

Social Domain

Social Disabilities

There are ten social items that are included on both Modules 3 and 4 of the Autism Diagnostic Observation Schedule (ADOS). A one-way between-groups analysis of variance was conducted to explore the impact of group (OO, HFA, or TD) on a sum of these social items. There was a statistically significant difference between the groups on the ADOS social sum, $F(2, 87) = 112$, $p < .001$. Effect size calculations resulted in a large effect with Cohen's $d = 2.27$. Levene's test for homogeneity of variances was found to be violated, $F(2, 87) = 6.12$, $p < .001$. Games-Howell post-hoc comparisons indicated that the mean ADOS social sum for the HFA group ($M = 8.94$, $SD = 3.14$) was significantly different from the OO group ($M = 1.88$, $SD = 2.09$) and the TD group ($M = 0.68$, $SD = 1.03$). The mean ADOS social sums for the OO and TD groups were also significantly different from each other (see Figure 7).

Two ADOS social items (communication of own affect and responsibility) are on Module 4 but not Module 3. Therefore, an average ADOS social score was calculated using ten items for Module 3 and twelve items for Module 4. A one-way between-groups ANOVA was conducted to explore the impact of group (OO, HFA, or TD) on the average of all appropriate social items. There was a statistically significant difference between the groups on the ADOS social average, $F(2, 87) = 115$, $p < .001$. Effect size calculations resulted in a large effect with Cohen's $d = 2.30$. Levene's test for homogeneity of variances was found to be violated, $F(2, 87) = 8.51$, $p < .001$. Games-Howell post-hoc comparisons indicated that the mean ADOS social average for the HFA group ($M = 0.88$, $SD = 0.30$) was significantly different from the OO group ($M = 0.19$, $SD = 0.20$) and the TD group ($M = 0.070$, $SD = 0.11$). The mean ADOS social averages

for the OO and TD groups were also significantly different from each other (see Figure 8).

Finally, a one-way between-groups ANOVA was conducted to explore the impact of group (OO, HFA, or TD) on ADOS social algorithm total. The algorithm total includes seven social items, but the specific items differ between Modules 3 and 4. The autism spectrum cutoff is a score of 4 or higher. There was a statistically significant difference between the groups on the ADOS social algorithm total, $F(2, 87) = 127$, $p < .001$. Effect size calculations resulted in a large effect with Cohen's $d = 2.42$. Levene's test for homogeneity of variances was found to be violated, $F(2, 87) = 14.1$, $p < .001$. Games-Howell post-hoc comparisons indicated that the mean ADOS social algorithm for the HFA group ($M = 7.00$, $SD = 2.36$) was significantly different from the OO group ($M = 1.41$, $SD = 1.62$) and the TD group ($M = 0.32$, $SD = 0.63$). The mean ADOS social algorithm totals for the OO and TD groups were also significantly different from each other; however the OO group mean of 1.41 is still well below the ADOS autism spectrum cutoff of 4 (see Figure 9). Because these three methods of examining the ADOS Social totals led to similar results, the social sum was considered the most useful since this score included the same items across all participants.

A Kruskal-Wallis Test, the non-parametric alternative to the one-way between-groups ANOVA, compares group medians instead of means and was used to confirm the findings for the ADOS social sum. A Kruskal-Wallis test revealed a statistically significant difference in the ADOS social sum across groups, $\chi^2 (2, n = 90) = 63.3$, $p < .001$. The HFA group had a median score of 9, the OO group had a median score of 1 and the TD group had a median score of 0. Mann-Whitney U Tests were conducted to

determine which of the groups differed significantly. There was a significant difference between the ADOS social sum of participants with HFA and TD participants, $U = 0.000$, $z = -6.55$, $p < .001$. This equates to a large effect size, $r = .86$. The HFA group was also significantly different from the OO group on the ADOS social sum, $U = 20.5$, $z = -6.71$, $p < .001$. This also equates to a large effect size, $r = .83$. Finally, the OO and TD groups were significantly different on the ADOS social sum, $U = 282$, $z = -2.05$, $p = .041$. This equates to $r = .27$, which is a small to medium effect size.

A one-way between-groups multivariate analysis of variance (MANOVA) was performed to investigate group differences in ADOS social scores to determine whether an item-by-item analysis was warranted. Ten ADOS social items that were common across Modules 3 and 4 were used as dependent variables. The independent variable was group: OO, HFA, or TD. There was a statistically significant difference between groups on the combined dependent variables, F (20, 156) = 12.2, $p < .001$, Wilks' $\lambda = .15$; $d = 0.56$. When the results for the dependent variables were considered separately, all of the social variables did show significant differences between groups; however, further analyses were needed to determine which groups differed.

Again, because the objective of this study was to determine subtle residual deficits, exploratory independent sample *t* tests were conducted to ascertain whether or not the OO and TD groups differed on the ADOS social items. For items with that differed significantly between the OO and TD groups, the OO group was then compared to the HFA group. Higher mean scores indicated more abnormal behavior. The OO and TD groups did not differ on their language production and linked nonverbal communication, their shared enjoyment with the examiner, or on empathy or comment on

others' emotions (see Table 3). The quality of their social response and the amount of reciprocal social communication were not different between the OO and TD groups (see Table 3). Communication of their own affect and perception of responsibility of his/her own actions in daily living situations were compared for participants given ADOS Module 4. The OO and TD groups were not significantly different on either of these items (see Table 3). Mann-Whitney U non-parametric tests comparing the OO and TD groups on these items confirmed the above findings demonstrated with *t* tests (see Table 3). The difference in scores for the OO and TD groups approached significance for appropriateness of their eye contact and the quality of their social overtures (see Table 3). These data suggest that there was not enough power to detect small effect sizes for the entire sample and small or medium effect sizes for the ADOS Module 4 sample.

There was a significant difference in scores for facial expressions directed to others between the OO and TD groups (see Table 3). Exploring this difference further, the OO group was then compared to the HFA group on this item to see if the OO group was similar to the HFA group or was in between the HFA and TD groups. The OO group scored significantly lower than the HFA group ($M = 0.79$, $SD = 0.48$), $t\ (55) = -4.69$, $p < .001$. This corresponds to a Cohen's $d = -1.16$, which is a large effect size. A Mann-Whitney U non-parametric test produced similar findings, $U = 256$, $z = -4.09$, $p < .001$. This equates to a large effect size, $r = .51$. Thus, in terms of facial expressions directed to others, the OO group engaged in this behavior more than the HFA group, but less than the TD group (see Figure 10). Eight participants in the OO group scored a 1 on this item (some direction of facial expressions to examiner) compared to only one participant in the TD group, which is a statistically significant difference in frequency, $\chi^2\ (1, 57) =$

4.65, $p = .031$. Phi coefficient, which is a correlation coefficient, was used to estimate effect size, with $\Phi = .29$, representing a small to medium effect. Conversely, 25 participants in the HFA group scored a 1 on this item, and one participant scored a 2 (rarely or never directs facial expressions). The frequency of abnormality in the HFA group was significantly greater than the OO group, χ^2 (1, 65) = 17.0, $p < .001$. Effect size was large, with $\Phi = .51$. Figure 11 compares all three groups.

The OO and TD groups differed significantly on their insight into the nature of social relationships (see Table 3). Exploring this difference further, the OO group was then compared to the HFA group on this item. The OO group scored significantly lower than the HFA group ($M = 1.18$, $SD = 0.73$), t (55) = -4.64, $p < .001$. This corresponds to a Cohen's $d = -1.15$, which is a large effect size. A Mann-Whitney U non-parametric test produced similar findings, $U = 238$, $z = -4.08$, $p < .001$. This equates to a large effect size, $r = .50$. Thus, the OO group had more insight into social relationships than the HFA group, but less than the TD group (see Figure 12). Nine participants in the OO group scored a 1 on this item (insight into several typical social relationships but not own role OR into only one relationship including own role) and two scored a 2 on this item (some insight into one typical social relationship but not own role), compared to only two participants in the TD group scoring a 1 and none scoring a 2, which approaches a statistically significant difference in frequency, χ^2 (1, 57) = 5.77, $p = .056$. However, the Phi coefficient, $\Phi = .32$, indicates a medium effect size. Conversely, 15 participants in the HFA group scored a 1 on this item, and 12 participants scored a 2. The frequency of abnormality in the HFA group was significantly greater than the OO group, χ^2 (1, 65) = 16.96, $p < .001$. Effect size was large, with $\Phi = .51$. Figure 13 compares all three groups.

Quality of rapport was also significantly different between the OO and TD groups (see Table 3). Exploring this difference further, the OO group was then compared to the HFA group on this item. The OO group scored significantly lower than the HFA group (M = 0.89, SD = 0.54), $t(55) = -4.47$, $p < .001$. This corresponds to a Cohen's $d = -1.11$, which is a large effect size. A Mann-Whitney U non-parametric test produced similar findings, $U = 262$, $z = -3.95$, $p < .001$. This equates to a medium to large effect size, $r = .49$. Thus, the OO group had a better quality of rapport with the examiner than the HFA group, but worse than the TD group (see Figure 14). Ten participants in the OO group scored a 1 on this item (interaction sometimes comfortable but not sustained) compared to only two participants in the TD group, which is a statistically significant difference in frequency, $\chi^2 (1, 57) = 4.56$, $p = .033$. The Phi coefficient, $\Phi = .28$, represents a small to medium effect size. Twenty-three participants in the HFA group scored a 1 on this item, and three participants scored a 2 (one-sided or unusual interaction). The frequency of abnormality in the HFA group is significantly greater than the OO group, $\chi^2 (1, 65) = 15.87$, $p < .001$. Effect size was medium to large, with $\Phi = .49$. Figure 15 compares all three groups.

Social Abilities

A one-way between-groups ANOVA was conducted to compare the three groups (OO, HFA, and TD) on the socialization domain score of the Vineland Adaptive Behavior Scales (VABS). There was a statistically significant difference between the groups on the VABS socialization domain score, $F(2, 86) = 47.4$, $p < .001$. Effect size calculations resulted in a large effect with Cohen's $d = 1.48$. Levene's test for homogeneity of variances was violated, $F(2, 86) = 10.8$, $p < .001$. Games-Howell post-

hoc comparisons indicated that the mean VABS socialization domain score for the HFA group (M = 77.6, SD = 15.6) was significantly different from the OO group (M = 102, SD = 7.94) and the TD group (M = 102, SD = 8.25). The mean VABS socialization domain score for the OO and TD groups were not significantly different from each other (see Figure 16).

Discussion

The first aim of the present study was to replicate with a new sample the finding that adolescents who have achieved optimal outcomes no longer exhibit clinically significant deficits in the communication or social domains. As hypothesized, none of the participants in the OO group met criteria for an ASD on the ADOS for either the communication or social domain. In fact, the mean score for the OO group for the ADOS communication algorithm was not different from the TD group at 0.50, and was well below the autism spectrum cutoff of 2. The ADOS communication sum across nine items was also quite low, with a mean of only 1.50. While the mean score for the OO group for the ADOS social algorithm was different from the TD group, the OO mean score of 1.41 was well below the autism spectrum cutoff of 4. The ADOS social sum across ten items was also low, with a mean of only 1.88. Additionally, parent report of communication and socialization adaptive abilities indicated that the OO adolescents were performing well within the average range. Thus, there are individuals with a history of ASDs who truly achieve an optimal outcome and no longer exhibit impairing communication and social symptoms.

The second aim of the present study was to determine whether adolescents who have achieved optimal outcomes exhibit subtle residual deficits in autism communication

and social symptomatology (disabilities). Contrary to our hypothesis, individuals in the OO group did not exhibit subtle residual deficits, relative to TD peers, on any ADOS communication item. However, the power of the study was too low to detect small to medium effect sizes. With a larger sample, there were several ADOS communication items that may have become statistically significant. These include presence of speech abnormalities and stereotyped or idiosyncratic language. This would be unsurprising as prosody and language abnormalities are among the least likely communication symptoms to improve over time in individuals with high functioning autism (Gilchrist, et al., 2001; Rumsey, et al., 1985; Rutter, et al., 1967; Seltzer, et al., 2003), suggesting that these autism features may be the most resistant to change regardless of outcome. Additionally, there were several communication items with small effect sizes on which the OO participants actually had a lower mean than the TD participants. These items were offering information, asking for information and reporting events. The OO participants tended to be more likely to spontaneously offer information about thoughts, feelings or experiences, ask the examiner about his/her thoughts, feelings or experiences, and provide a detailed accounted of a non-routine event. Individuals with high functioning autism have a tendency to offer and ask too much information (Seltzer, et al., 2003), which suggests that behaviors that are present in excess are easier to remediate than skills that are not present in their repertoire. Additionally, this also may fit with the research that individuals with high functioning autism persist in asking inappropriate questions into adolescence and adulthood (Seltzer, et al., 2003), in that there may be an inappropriate quality that was not captured in the coding. Overall, however, it is important to note that the OO group performed substantially better on all of these

communication items when compared to the HFA group, so any residual deficits were quite subtle.

As hypothesized, on the social domain of the ADOS, there were several items on which the OO participants exhibited subtle deficits relative to the TD participants. The OO group directed a more limited range of facial expressions than the TD group. Relatedly, more individuals in the OO group had abnormal directing of a range of facial expressions than the TD group. Range and directedness of facial expressions often remain abnormal as individuals with high functioning autism age (Rumsey, et al., 1985; Seltzer, et al., 2003), suggesting that learning and implementing this subtle social gesture is difficult for individuals with an autism history. Additionally, the OO group demonstrated an interactive quality that was less well sustained and was sometimes mildly awkward or inappropriate. Similarly, more individuals in the OO group had a poorer quality of rapport than did individuals in the TD group. Again, adolescents and young adults with high functioning autism typically continue to struggle with rapport (Howlin, et al., 2000), indicating that individuals with an autism history are overall less successful at incorporating social rules and demands in order to form a completely appropriate interaction. Finally, the OO group differed from the TD group on their insight into the nature of typical social relationships. There was a trend toward a difference in frequency of individuals with poorer insight between the OO and TD groups. This is not unexpected as understanding social relationships requires integration of intricate and complex social expectations and guidelines. Unfortunately, the present study was unable to examine in detail whether this lack of insight translated into poorer social relationships for the OO participants.

In particular, friendships occur in less quantity and with poorer quality for adolescents and young adults with autism, including even the most high functioning (DeMyer, et al., 1973; Howlin, 2003; Howlin, et al., 2000; Orsmond, et al., 2004; Seltzer, et al., 2003; Shattuck, et al., 2007; Whitehouse, et al., 2009). Friendships for individuals with ASD may differ from typically developing peers by how long they last, activities involved, and the frequency of get-togethers (Bauminger & Shulman, 2003; Bauminger, Solomon, Aviezer, Heung, Gazit, et al., 2008). Additionally, individuals with ASDs tend to have friends with disabilities more frequently than do typically developing peers (Bauminger & Shulman, 2003; Bauminger, Solomon, Aviezer, Heung, Brown, et al., 2008; Bauminger, Solomon, Aviezer, Heung, Gazit, et al., 2008). Friendships for individuals with ASD often are characterized by less companionship, security and help (Bauminger & Kasari, 2000). Observations of friendship dyads including individuals with ASD have noted less goal-directed behaviors, sharing and positive affect (Bauminger, Solomon, Aviezer, Heung, Gazit, et al., 2008) than dyads of typically developing peers. Additionally, mothers of adolescents with ASD commonly report that considerable support is necessary in order for their children with high functioning autism to develop and maintain friendships (Bauminger & Shulman, 2003). Given the considerable trouble individuals with high functioning autism have in regards to friendship, close examination of friendship quantity and quality in the OO group is warranted. In order to be included in the present study, parents of OO participants had to report that their child had a best friend or a group of friends. However, there was no clear measure of friendship quality. Therefore, observation of friendship dyads would be ideal, in addition to parent report and self-report. Additionally, intimate, romantic relationships

have been under studied in autism in general, and should also be evaluated in OO individuals, particularly adolescents and young adults, as dating is an important milestone for typically developing individuals during these periods. Until we have a better and more thorough understanding of how the OO group performs in typical social relationships, we cannot rule out that they are experiencing some finer level of social impairment.

There were two additional ADOS social items that approached a significant difference between the OO and TD groups, both with a small to medium effect size. These items were unusual eye contact and quality of social overtures. The difficulty with eye contact likely relates to the difficulty with direction of a range of facial expressions, as both skills involve subtle social sharing. Poorer quality of social overtures likely relates to the poorer quality of overall rapport, as less well implemented social overtures would have contributed to the inability to sustain the interaction well. There were three additional non-significant social items with small to medium effect sizes. Subtle differences between the OO and TD groups on these items may have been detected with a larger sample size. One of these items was poorer quality of social response, which again likely relates and contributes to the overall quality of rapport found deficient in the OO group. The other two items were empathy and communication of their own affect, which both likely relate to and result in the OO group's more limited insight into social relationships, as empathy and the ability to communicate one's affect are important in social relationships, including both friendships and romantic relationships. Again important to note, however, is that on all ADOS social items, the OO group performed substantially better when compared to the HFA group, (see Figures 10 through 15) so

residual deficits are quite subtle and might be expected within the less skilled end of the normal range of social functioning.

The third aim of the present study was to determine whether adolescents who have achieved optimal outcomes exhibit subtle residual deficits in communication and social functioning skills (abilities), including adaptive skills and pragmatic language skills. Contrary to our hypotheses, the OO group did not exhibit mean differences on either the communication or socialization domain of the VABS. Importantly, the HFA group had substantially worse adaptive skills than both the OO and TD groups.

When examining pragmatic language, the OO group was not different from the TD group on the Making Inferences subtest, but was different on the Figurative Language subtest. However, even on the Figurative Language subtest, the OO group was still performing solidly in the average range, with a mean of almost 10. The difference from the TD group suggests that the OO group has not reached the high average level commensurate with their verbal IQ, but that this difference should not be seen as a deficit for the OO participants. Similarly, on both pragmatic language subtests, the HFA group performed worse than the OO and TD groups. Despite scoring in the average range, the HFA group was at the lowest end of average, which is not commensurate with what would be expected based on their IQ.

All of the findings described above for the communication domain remained even when controlling for verbal IQ, which was lower in the HFA group than the OO and TD groups in this study. However, using verbal IQ as a covariate in this type of study is controversial and potentially problematic (Dennis et al., 2009). An analysis of covariance (ANCOVA) is designed to be used when group differences in a variable, such

as IQ, are due to chance resulting from random assignment. However, if the covariate is considered to be intrinsic to the experimental group or groups, ANCOVAs cannot be used to adjust the differences between the groups on that factor (Dennis, et al., 2009). Verbal IQ has been shown to be diminished in individuals with autism, relative to performance or nonverbal IQ (Happe, 1994; Joseph, Tager-Flusberg, & Lord, 2002). Therefore, verbal IQ differences for the HFA group were expected, and not simply due to chance. Additionally, the ANCOVA works by using the grand mean; therefore the verbal IQ adjustment would be too little for the OO and TD groups and too great for the HFA (Dennis, et al., 2009). Thus, controlling for verbal IQ for the analyses in the communication domain may be inappropriate and may be removing too much variance.

There are several limitations to the present study. The sample size was relatively small, and as mentioned above, only medium to medium large effect sizes could be detected. The participants were predominantly Caucasian, with less than 8% of the participants belonging to other racial or ethnic groups. Additionally, all three groups were very high functioning, with mean nonverbal IQs in the high average range. Thus, these findings may not generalize well to other racial or ethnic groups, or to a broader spectrum of intellectual functioning. Additionally, the cross-sectional nature of the study does not provide for the opportunity to observe how communication and social skills change over time. Specifically, the current study could not fully assess how intervention played a role in improvement over time. Intervention history was collected and will be presented in another paper; however, this was based solely on parent report, interventions varied based on the geographic region of the participant, and we could not account for the quality of each intervention. Thus, the conclusions we can draw from this data will be

limited. A more integral limitation to the current results is the situation in which autism symptomatology was assessed. The ADOS was conducted by adult examiners experienced in working with children and adolescents with autism and in a one-on-one setting with minimal distractions. The participants may have performed differently in a more natural environment or with less experienced adults. Also important, as discussed, the ADOS does not indicate how the participant would interact with peers, nor did the study include any other direct measure of peer interaction. The participants were also aware that the ADOS administration was being videotaped, which could have positively or negatively affected their performance. Additionally, there were limits to the measures used in the current study. The ADOS was designed to help clinicians and researchers detect the symptoms and diagnose ASDs. The ADOS was never intended to be utilized as a measure of subtle symptomatology. Furthermore, a score of 0 on the ADOS items does not necessarily indicate truly typical performance. Rather, a score of 0 on the ADOS suggests lack of prototypically autistic behaviors. Thus, subtle residual deficits may not be detected with the current coding system of the ADOS. Assessment of adaptive functioning was based entirely on parent report. Confirmatory reports, such as by teachers, would increase confidence in the adaptive results. Finally, the measures of pragmatic language utilized in the present study were restricted to a contrived, standardized measure. However, the average pragmatic abilities demonstrated on this test by all groups may not be translated to appropriate use in a more realistic social context or interaction.

Future studies could address some of the above limitations by including a larger and more diverse sample to enable detection of small effects and increase

generalizability. A longitudinal study would be ideal; however, since at this point we cannot easily predict which children with ASD will go on to achieve an optimal outcome, a study of this kind would have to be extremely large and would be expensive and time-consuming. Additionally, since failure to develop peer relationships appropriate to developmental level is one of the diagnostic criteria for an ASD, a necessary future direction is to examine the friendships and romantic relationships of individuals who achieve optimal outcomes through direct observation, in addition to parent and self-report. Including teacher report of adaptive skills in future studies would also help address how these optimal outcome adolescents are functioning in their daily life with peers. Finally, future studies should include more fine-tuned and complex measures of pragmatic language to truly determine if the optimal outcome individuals have mastered these skills.

In conclusion, the optimal outcome participants clearly have lost their ASD diagnosis and are functioning quite well in the communication and social domains. Nonetheless, these individuals still exhibit some subtle difficulties in a few areas within the social domain, including direction of a range of facial expression, quality of rapport, and insight into typical social relationships. Future research will need to examine these domains in further detail to determine whether or not there are still areas in which optimal outcome individuals may benefit from further intervention.

Table 1

Participant Characteristics

	HFA	OO	TD	F/χ^2	*p*	Tukey Post-hoc
N	33	32	25			
Gender	30 M, 3 F	25 M, 7 F	21 M, 4 F	2.97	.23	
Age	13.39 (2.68)	12.90 (3.31)	13.88 (2.94)	0.77	.47	
	8.63-20.04	8.48-21.24	9.71-21.72			
VIQ	102.8 (12.33)	112.7 (13.82)	112.2 (11.48)	6.12	.003	HFA < OO, TD
	81-133	80-137	93-136			
PIQ	110.0 (14.13)	112.8 (14.41)	112.0 (12.44)	0.56	.57	
	87-142	87-148	89-139			

Note: M = males, F = females; VIQ = Verbal IQ from the Wechsler Abbreviated Achievement Scales (WASI); PIQ = Performance IQ from the WASI

Table 2

ADOS Communication Items

	OO		**TD**		***t* tests**			**Mann-Whitney U tests**			
Item	Mean	SD	Mean	SD	*t*	*p*	Cohen's *d*	*U*	*Z*	*p*	*R*
Presence of speech abnormalities	0.25	0.51	0.12	0.33	1.16	.24	0.30	359	-1.00	.32	-.13
Stereotyped or idiosyncratic language	0.13	0.34	0.040	0.20	1.19	.24	0.31	366	-1.12	.26	-.15
Offering information	0.062	0.24	0.16	0.37	-1.13	.27	-0.31	361	-1.18	.24	-.16
Asks for information	0.75	0.67	1.04	0.73	-1.55	.13	-0.41	314	-1.51	.13	-.20
Reporting of events	0.031	0.18	0.12	0.33	-1.21	.23	-0.31	364	-1.29	.20	-.17
Conversation	0.16	0.37	0.12	0.33	0.38	.70	0.10	385	-0.39	.70	-.051
Use of gestures	0.12	0.34	0.080	0.28	0.54	.59	0.15	382	-0.54	.59	-.072
Use of emphatic gestures (Module 4)	0.20	0.41	0.23	0.44	-0.23	.82	-0.082	123	-0.24	.81	-.042

Note: For all items except use of emphatic gestures, there were 32 participants in the OO group and 25 participants in the TD group. Use of emphatic gestures is only one ADOS Module 4 and therefore contained a smaller sample of 15 OO participants and 17 TD participants.

Table 3

ADOS Social Items

	OO		**TD**		***t* tests**			**Mann-Whitney U tests**			
Item	Mean	SD	Mean	SD	*t*	*p*	Cohen's *d*	*U*	*Z*	*p*	*R*
Language production and linked nonverbal communication	0.000	0.000	0.080	0.28	-1.44	.16	-0.40	368	-1.61	.11	-.21
Shared enjoyment	0.062	0.25	0.080	0.28	-0.25	.80	-0.067	393	-.25	.80	-.034
Empathy or comment on others' emotions	0.28	0.46	0.16	0.37	1.10	.27	0.29	351	-1.07	.28	-.14
Quality of social response	0.12	0.34	0.040	0.20	1.19	.24	0.31	366	-1.12	.26	-.15
Amount of reciprocal social communication	0.16	0.37	0.12	0.33	0.38	.70	0.10	385	-.39	.70	-.051
Communication of own affect (Module 4)	0.33	0.49	0.12	0.33	1.44	.16	0.52	100	-1.45	.15	-.26
Responsibility for own actions (Module 4)	0.067	0.26	0.000	0.000	1.00	.33	0.37	119	-1.06	.29	-.19
Appropriateness of eye contact	0.19	0.59	0.000	0.000	1.79	.083	0.45	362	-1.56	.12	.21
Quality of social overtures	0.094	0.30	0.000	0.000	1.79	.083	0.45	362	-1.56	.12	.21
Facial expressions directed to others	0.25	0.44	0.040	0.20	2.40	.020	0.61	316	-2.14	.032	.28
Insight into social relationships	0.41	0.61	0.080	0.28	2.67	.010	0.68	292	-2.37	.018	.31
Quality of rapport with examiner	0.31	0.47	0.080	0.28	2.32	.024	0.60	307	-2.12	.034	.28

Note: For all items except communication of own affect and responsibility for own actions, there were 32 participants in the OO group and 25 participants in the TD group. Communication of own affect and responsibility for own actions are only one ADOS Module 4 and therefore contained a smaller sample of 15 OO participants and 17 TD participants.

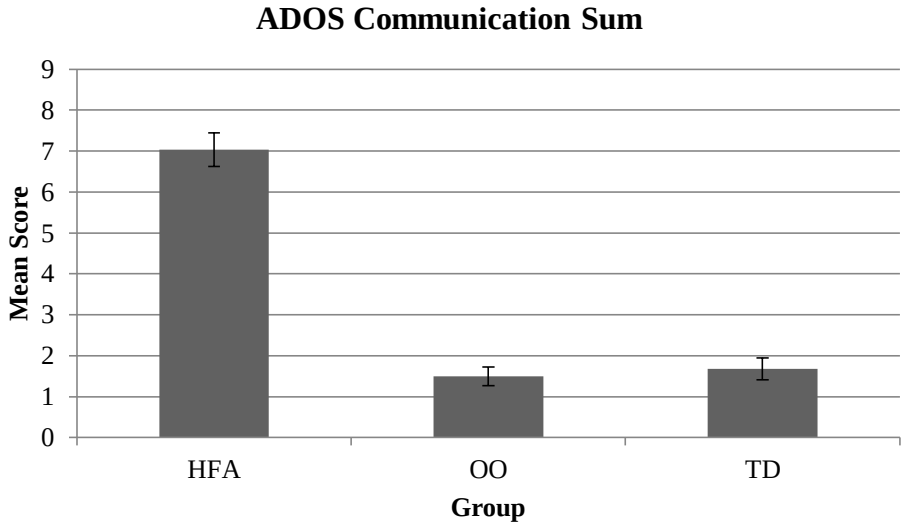

Figure 1. Mean Communication sum on the Autism Diagnostic Observation Schedule (ADOS) across the three groups.

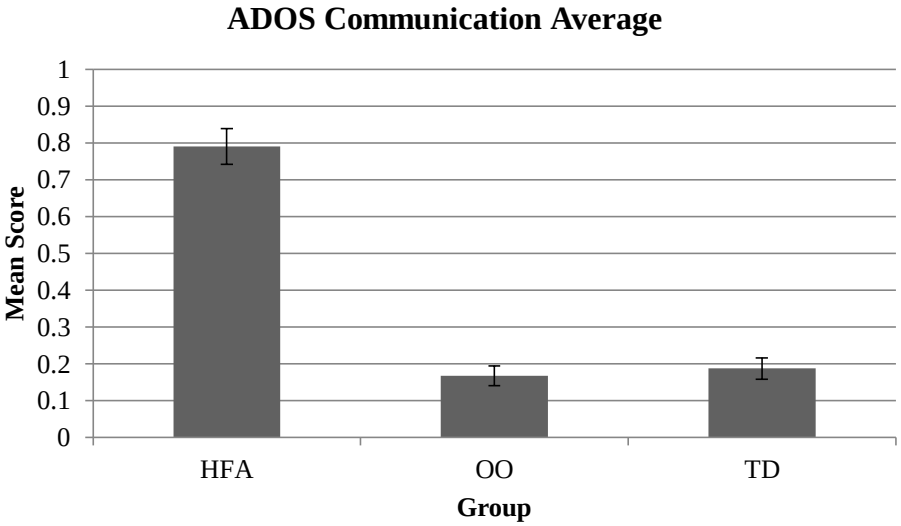

Figure 2. Mean Communication average on the Autism Diagnostic Observation Schedule (ADOS) across the three groups, using the nine communication items from Module 3 and the ten communication items from Module 4.

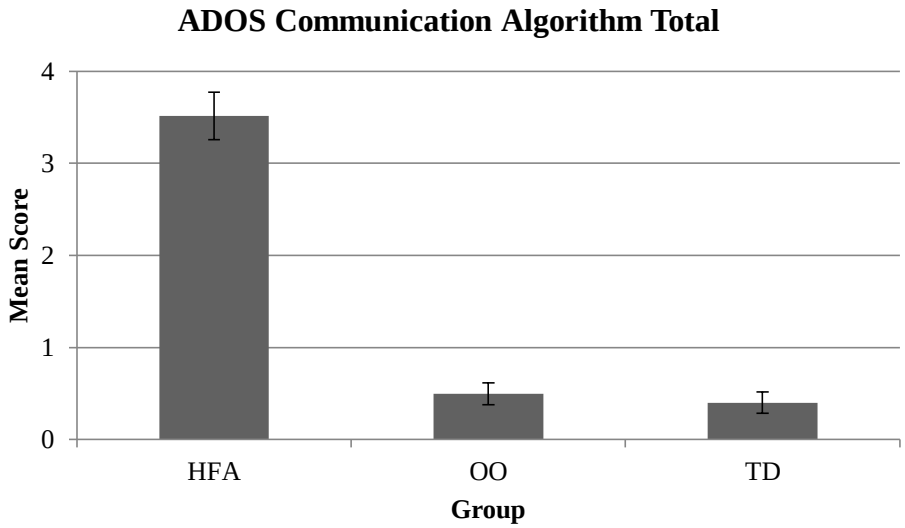

Figure 3. Mean Communication algorithm total on the Autism Diagnostic Observation Schedule (ADOS) across the three groups.

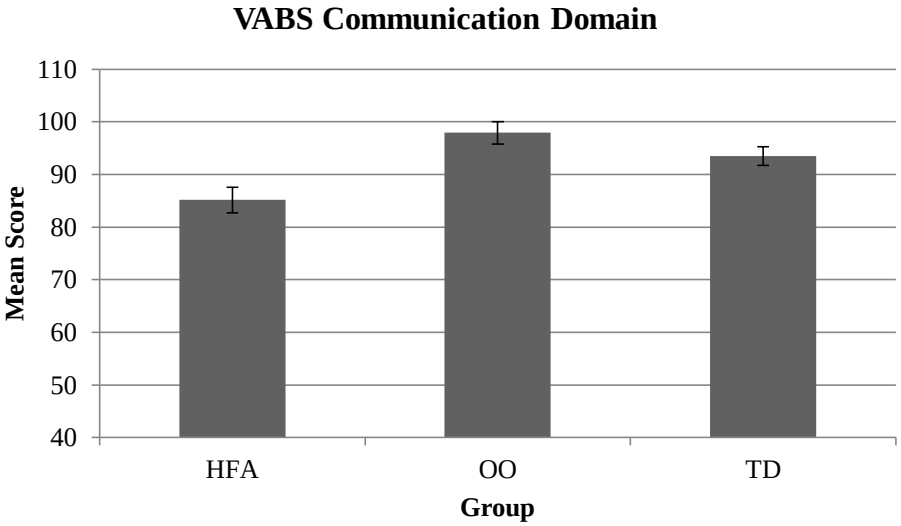

Figure 4. Mean Communication domain score on the Vineland Adaptive Behavior Scale (VABS) across the three groups. Mean on the VABS is 100, with a standard deviation of 15.

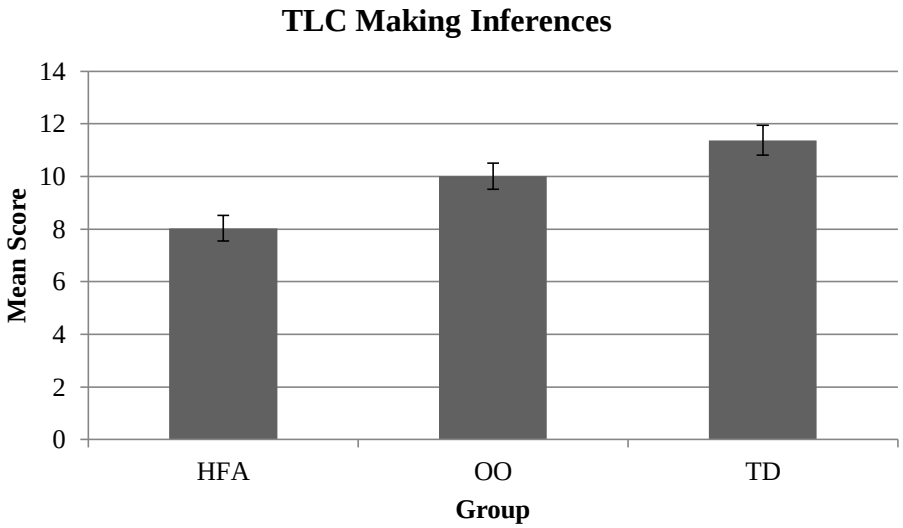

Figure 5. Mean Making Inferences scaled score on the Test of Language Competence (TLC) across the three groups. Mean on the TLC is 10, with a standard deviation of 3.

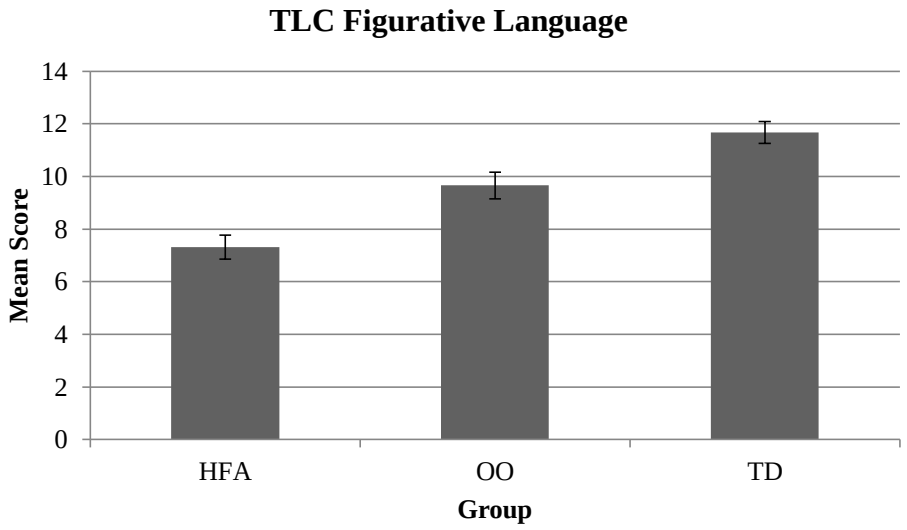

Figure 6. Mean Figurative Language scaled score on the Test of Language Competence (TLC) across the three groups. Mean on the TLC is 10, with a standard deviation of 3.

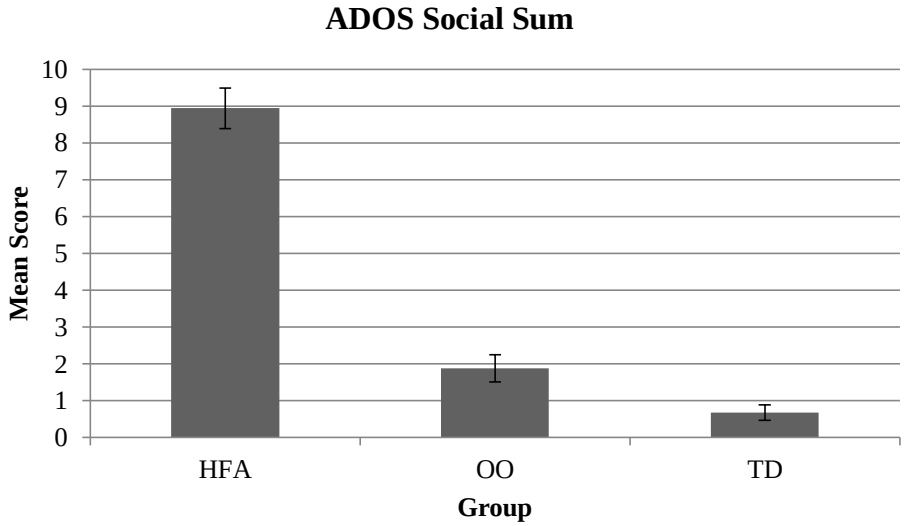

Figure 7. Mean Social sum on the Autism Diagnostic Observation Schedule (ADOS) across the three groups.

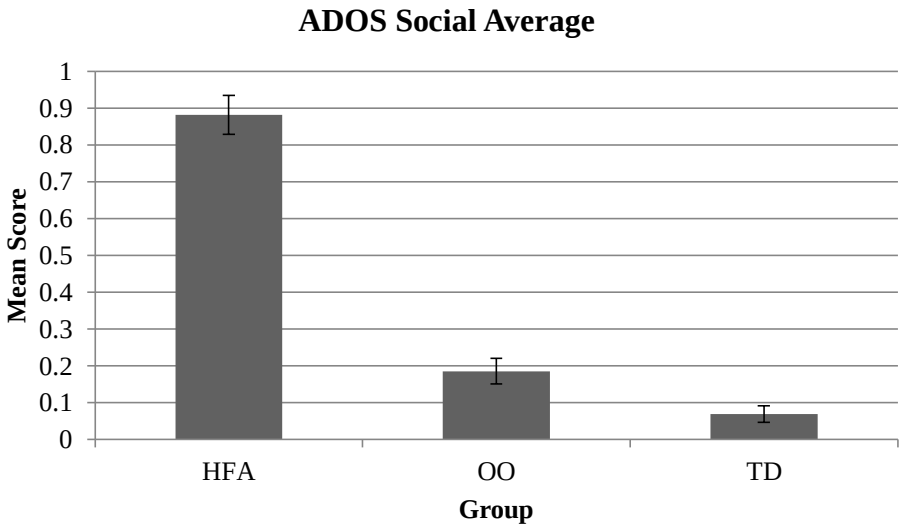

Figure 8. Mean Social average on the Autism Diagnostic Observation Schedule (ADOS) across the three groups, using the ten communication items from Module 3 and the twelve communication items from Module 4.

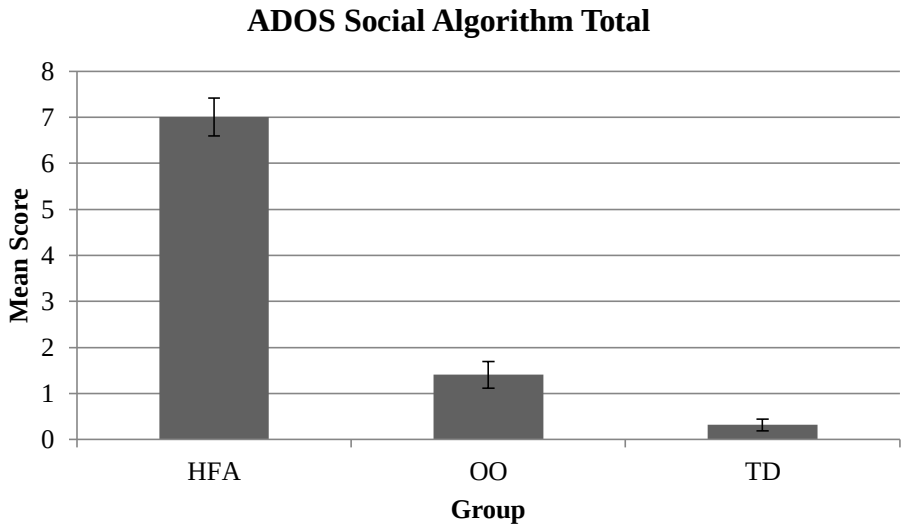

Figure 9. Mean Social algorithm total on the Autism Diagnostic Observation Schedule (ADOS) across the three groups.

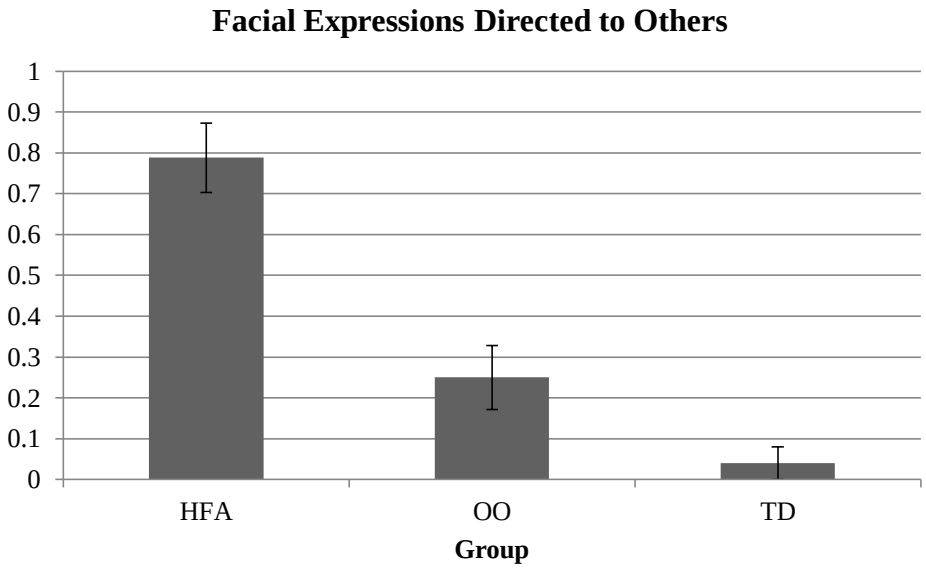

Figure 10. Mean scores by group on the ADOS social item Facial Expressions Directed to Others.

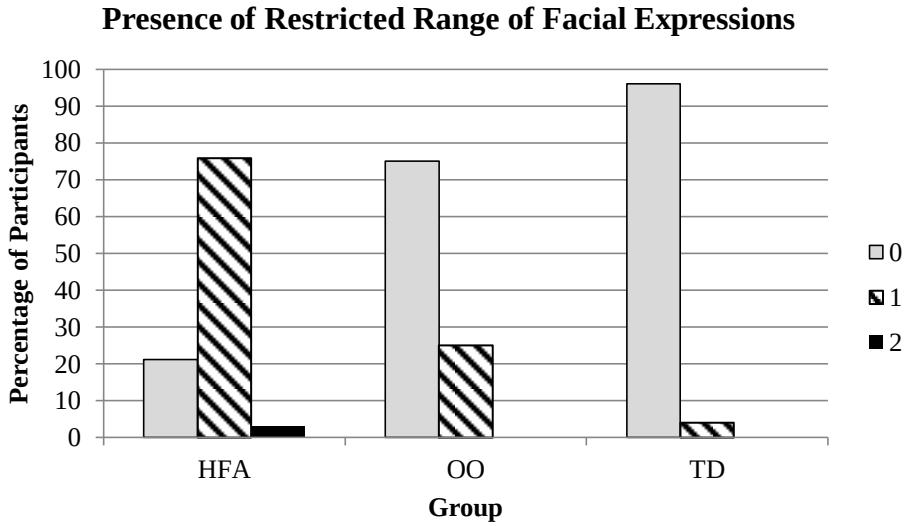

Figure 11. Frequency of abnormalities in direction of facial expression across the three groups. 0 = Directs a range of facial expressions; 1 = Some direction of facial expressions; 2 = Rarely or never directs facial expressions.

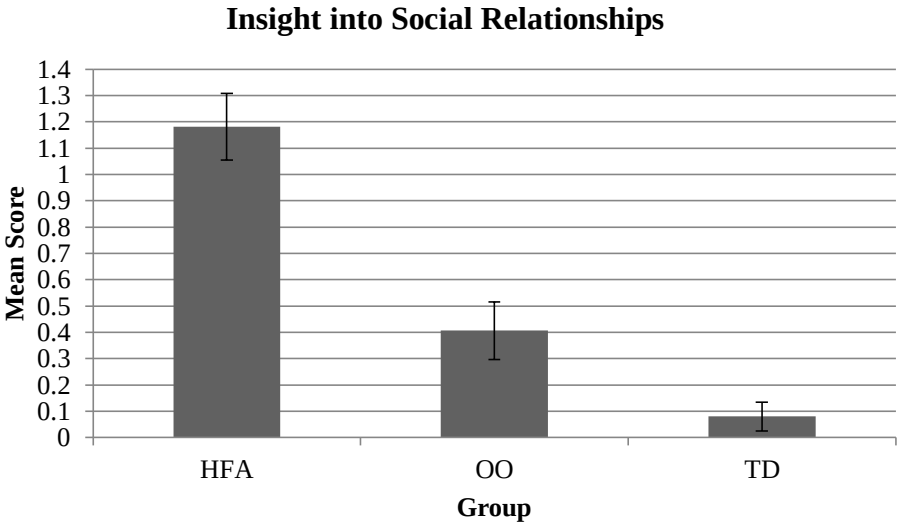

Figure 12. Mean scores by group on the ADOS social item Insight into social relationships.

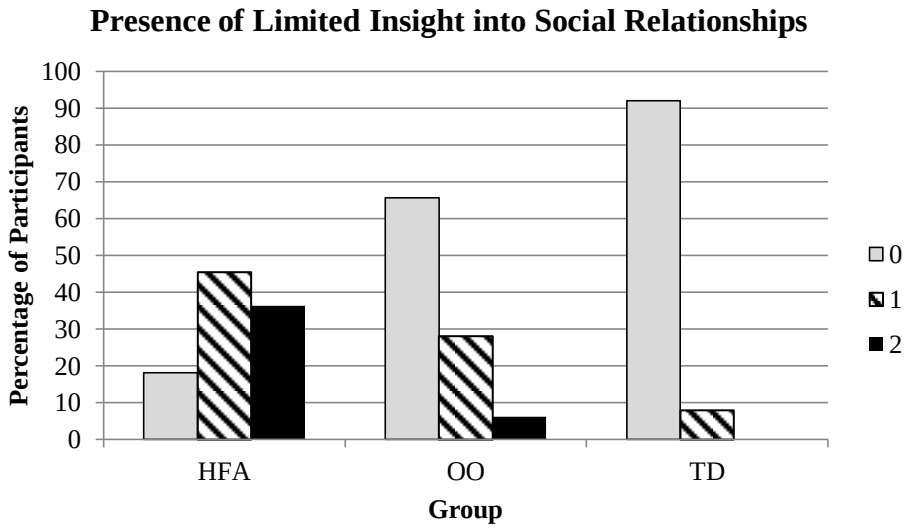

Figure 13. Frequency of abnormalities in insight into social relationships across the three groups. 0 = Shows several examples of insight into the nature of typical social roles, including own role in at least one; 1 = Shows examples into several typical social relationships but not own role OR into only one relationship into own role; 2 = Shows some insight into one typical social relationships but not own role.

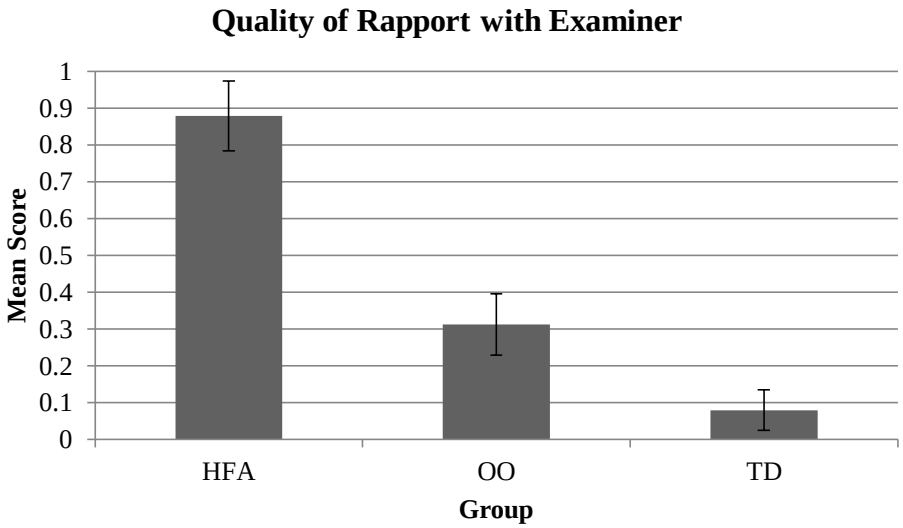

Figure 14. Mean scores by group on the ADOS social item Quality of Rapport.

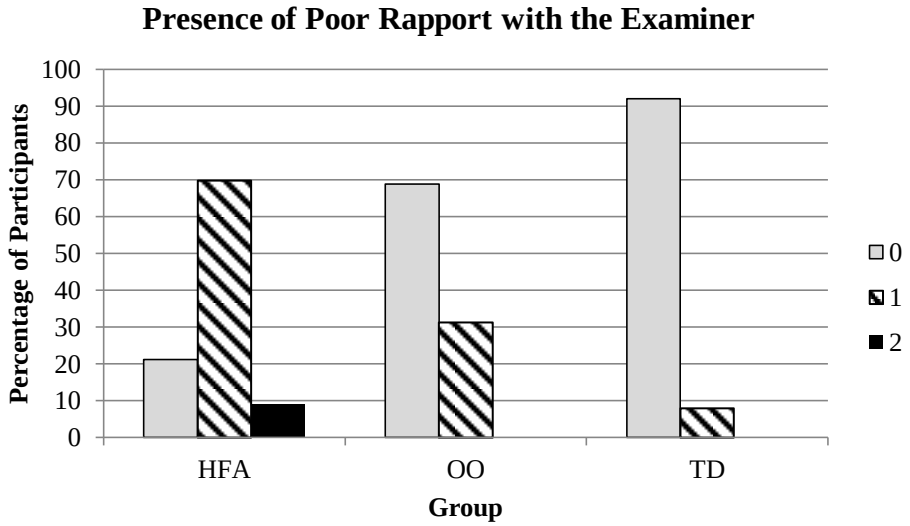

Figure 15. Frequency of abnormalities in quality of rapport across the three groups. 0 = Comfortable interaction that is appropriate to context; 1 = Interaction sometimes comfortable but not sustained; 2 = One-sided or unusual interaction.

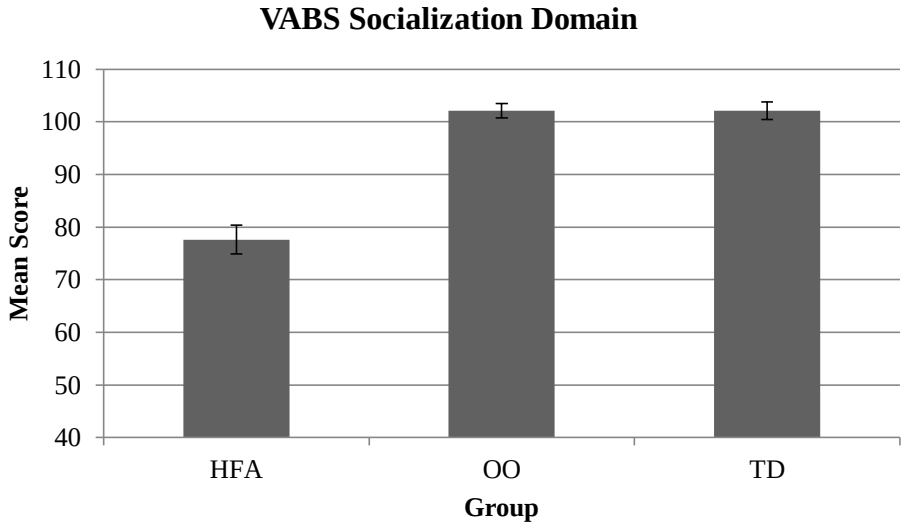

Figure 16. Mean Socialization domain score on the Vineland Adaptive Behavior Scale (VABS) across the three groups. Mean on the VABS is 100, with a standard deviation of 15.

References

American Psychiatric Anderson, D. K., Oti, R. S., Lord, C., & Welch, K. (2009). Patterns of growth in adaptive social abilities among children with autism spectrum disorders. *Journal of abnormal child psychology, 37*(7), 1019-1034. doi: 10.1007/s10802-009-9326-0

Association, A. P. (2000). *Diagnostic and statistical manual of mental disorders (4th ed., text revision)*. Washington, DC: American Psychiatric Association.

Ballaban-Gil, K., Rapin, I., Tuchman, R., & Shinnar, S. (1996). Longitudinal examination of the behavioral, language, and social changes in a population of adolescents and young adults with autistic disorder. [Research Support, U.S. Gov't, P.H.S.]. *Pediatric neurology, 15*(3), 217-223.

Bauminger, N., & Kasari, C. (2000). Loneliness and friendship in high-functioning children with autism. [Research Support, Non-U.S. Gov't]. *Child development, 71*(2), 447-456.

Bauminger, N., & Shulman, C. (2003). The development and maintenance of friendship in high-functioning children with autism: maternal perceptions. [Research Support, Non-U.S. Gov't]. *Autism : the international journal of research and practice, 7*(1), 81-97.

Bauminger, N., Solomon, M., Aviezer, A., Heung, K., Brown, J., & Rogers, S. J. (2008). Friendship in high-functioning children with autism spectrum disorder: mixed and non-mixed dyads. [Research Support, Non-U.S. Gov't]. *Journal of autism and developmental disorders, 38*(7), 1211-1229. doi: 10.1007/s10803-007-0501-2

Bauminger, N., Solomon, M., Aviezer, A., Heung, K., Gazit, L., Brown, J., & Rogers, S. J. (2008). Children with autism and their friends: a multidimensional study of friendship in high-functioning autism spectrum disorder. [Research Support, Non-U.S. Gov't]. *Journal of abnormal child psychology, 36*(2), 135-150. doi: 10.1007/s10802-007-9156-x

Boelte, S., & Poustka, F. (2000). Diagnosis of autism: the connection between current and historical information. *Autism : the international journal of research and practice, 4*(4), 382-390.

Burd, L., Kerbeshian, J., Westerland, A., Labine, J., Barth, A., Klug, M. G., & Wagner, K. (2002). Prospective long-term follow-up of patients with pervasive developmental disorders. [Comparative Study]. *Journal of child neurology, 17*(9), 681-688.

DeMyer, M. K., Barton, S., DeMyer, W. E., Norton, J. A., Allen, J., & Steele, R. (1973). Prognosis in autism: a follow-up study. *Journal of autism and childhood schizophrenia, 3*(3), 199-246.

Dennis, M., Francis, D. J., Cirino, P. T., Schachar, R., Barnes, M. A., & Fletcher, J. M. (2009). Why IQ is not a covariate in cognitive studies of neurodevelopmental disorders. [Research Support, N.I.H., Extramural

Review]. *Journal of the International Neuropsychological Society : JINS, 15*(3), 331-343. doi: 10.1017/S1355617709090481

Eaves, L. C., & Ho, H. H. (2008). Young adult outcome of autism spectrum disorders. *Journal of autism and developmental disorders, 38*(4), 739-747. doi: 10.1007/s10803-007-0441-x

Fecteau, S., Mottron, L., Berthiaume, C., & Burack, J. A. (2003). Developmental changes of autistic symptoms. *Autism : the international journal of research and practice, 7*(3), 255-268.

Fein, D., Dixon, P., Paul, J., & Levin, H. (2005). Brief report: pervasive developmental disorder can evolve into ADHD: case illustrations. *Journal of autism and developmental disorders, 35*(4), 525-534.

Freeman, B. J., Del'Homme, M., Guthrie, D., & Zhang, F. (1999). Vineland Adaptive Behavior Scale scores as a function of age and initial IQ in 210 autistic children. *Journal of autism and developmental disorders, 29*(5), 379-384.

Gilchrist, A., Green, J., Cox, A., Burton, D., Rutter, M., & Le Couteur, A. (2001). Development and current functioning in adolescents with Asperger syndrome: a comparative study. *Journal of child psychology and psychiatry, and allied disciplines, 42*(2), 227-240.

Happe, F. G. (1994). Wechsler IQ profile and theory of mind in autism: a research note. *Journal of child psychology and psychiatry, and allied disciplines, 35*(8), 1461-1471.

Helt, M., Kelley, E., Kinsbourne, M., Pandey, J., Boorstein, H., Herbert, M., & Fein, D. (2008). Can children with autism recover? If so, how? *Neuropsychology review, 18*(4), 339-366.

Howlin, P. (2003). Outcome in high-functioning adults with autism with and without early language delays: implications for the differentiation between autism and Asperger syndrome. *Journal of autism and developmental disorders, 33*(1), 3-13.

Howlin, P., Mawhood, L., & Rutter, M. (2000). Autism and developmental receptive language disorder--a follow-up comparison in early adult life. II: Social, behavioural, and psychiatric outcomes. *Journal of child psychology and psychiatry, and allied disciplines, 41*(5), 561-578.

Joseph, R. M., Tager-Flusberg, H., & Lord, C. (2002). Cognitive profiles and social-communicative functioning in children with autism spectrum disorder. [Research Support, U.S. Gov't, P.H.S.]. *Journal of child psychology and psychiatry, and allied disciplines, 43*(6), 807-821.

Kelley, E., Naigles, L. R., & Fein, D. (2010). An in-depth examination of optimal outcome children with a history of autism spectrum disorders. *Research in Autism Spectrum Disorders, 4*, 526-538.

Kelley, E., Paul, J. J., Fein, D., & Naigles, L. R. (2006). Residual language deficits in optimal outcome children with a history of autism. *Journal of autism and developmental disorders, 36*(6), 807-828.

Kenworthy, L., Case, L., Harms, M. B., Martin, A., & Wallace, G. L. (2010). Adaptive behavior ratings correlate with symptomatology and IQ among individuals with high-functioning autism spectrum disorders. [Research Support, N.I.H., Intramural]. *Journal of autism and developmental disorders, 40*(4), 416-423. doi: 10.1007/s10803-009-0911-4

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

Kobayashi, R., Murata, T., & Yoshinaga, K. (1992). A follow-up study of 201 children with autism in Kyushu and Yamaguchi areas, Japan. *Journal of autism and developmental disorders, 22*(3), 395-411.

Liss, M., Harel, B., Fein, D., Allen, D., Dunn, M., Feinstein, C., . . . Rapin, I. (2001). Predictors and correlates of adaptive functioning in children with developmental disorders. [Comparative Study

Research Support, U.S. Gov't, P.H.S.]. *Journal of autism and developmental disorders, 31*(2), 219-230.

Lord, C., Risi, S., Lambrecht, L., Cook, E. H., Jr., Leventhal, B. L., DiLavore, P. C., . . . Rutter, M. (2000). The autism diagnostic observation schedule-generic: a standard measure of social and communication deficits associated with the spectrum of autism. *Journal of autism and developmental disorders, 30*(3), 205-223.

Lovaas, O. I. (1987). Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of consulting and clinical psychology, 55*(1), 3-9.

Loveland, K. A., & Kelley, M. L. (1988). Development of adaptive behavior in adolescents and young adults with autism and Down syndrome. [Research Support, U.S. Gov't, P.H.S.]. *American journal of mental retardation : AJMR, 93*(1), 84-92.

McGovern, C. W., & Sigman, M. (2005). Continuity and change from early childhood to adolescence in autism. *Journal of child psychology and psychiatry, and allied disciplines, 46*(4), 401-408.

Mesibov, G. B., Schopler, E., Schaffer, B., & Michal, N. (1989). Use of the childhood autism rating scale with autistic adolescents and adults. *Journal of the American Academy of Child and Adolescent Psychiatry, 28*(4), 538-541.

Orsmond, G. I., Krauss, M. W., & Seltzer, M. M. (2004). Peer relationships and social and recreational activities among adolescents and adults with autism. *Journal of autism and developmental disorders, 34*(3), 245-256.

Perry, A., Flanagan, H. E., Dunn Geier, J., & Freeman, N. L. (2009). Brief report: the Vineland Adaptive Behavior Scales in young children with autism spectrum disorders at different cognitive levels. *Journal of autism and developmental disorders, 39*(7), 1066-1078.

Piven, J., Harper, J., Palmer, P., & Arndt, S. (1996). Course of behavioral change in autism: a retrospective study of high-IQ adolescents and adults. *Journal of the American Academy of Child and Adolescent Psychiatry, 35*(4), 523-529.

Rumsey, J. M., Rapoport, J. L., & Sceery, W. R. (1985). Autistic children as adults: psychiatric, social, and behavioral outcomes. *Journal of the American Academy of Child Psychiatry*, *24*(4), 465-473.

Rutter, M., Greenfeld, D., & Lockyer, L. (1967). A five to fifteen year follow-up study of infantile psychosis. II. Social and behavioural outcome. *The British journal of psychiatry : the journal of mental science, 113*(504), 1183-1199.

Sallows, G. O., & Graupner, T. D. (2005). Intensive behavioral treatment for children with autism: four-year outcome and predictors. *American journal of mental retardation : AJMR, 110*(6), 417-438.

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

Seltzer, M. M., Krauss, M. W., Shattuck, P. T., Orsmond, G., Swe, A., & Lord, C. (2003). The symptoms of autism spectrum disorders in adolescence and adulthood. *Journal of autism and developmental disorders, 33*(6), 565-581.

Shattuck, P. T., Seltzer, M. M., Greenberg, J. S., Orsmond, G. I., Bolt, D., Kring, S., . . . Lord, C. (2007). Change in autism symptoms and maladaptive behaviors in adolescents and adults with an autism spectrum disorder. *Journal of autism and developmental disorders, 37*(9), 1735-1747.

Sparrow, S. S., Balla, D. A., & Cicchetti, D. V. (1985). *Vineland Adaptive Behavior Scales (Interview Ed.)*. Circle Pines, MN: American Guidance Service.

Wechsler, D. (1992). *Wechsler Individual Achievement Test*. New York, NY: The Psychological Corporation.

Wechsler, D. (1997). *Wechsler adult intelligence scale-Third edition*. New York, NY: The Psychological Corporation.

Wechsler, D. (1999). *Wechsler abbreviated scale of intelligence (WASI)*. New York, NY: The Psychological Corporation.

Whitehouse, A. J., Watt, H. J., Line, E. A., & Bishop, D. V. (2009). Adult psychosocial outcomes of children with specific language impairment, pragmatic language impairment and autism. *International journal of language & communication disorders / Royal College of Speech & Language Therapists, 44*(4), 511-528.

Wiig, E. H., & Secord, W. A. (1989). *Test of Language Competence-Expanded Edition*. San Antonio, TX: The Psychological Corporation.