Overlap Between Autism Spectrum Disorders and Attention Deficit Hyperactivity Disorder: Searching for Distinctive/Common Clinical Features

Francesco Craig, Anna Linda Lamanna, Francesco Margari, Emilia Matera, Marta Simone, and Lucia Margari

Recent studies support several overlapping traits between autism spectrum disorders (ASD) and attention-deficit/hyperactivity disorder (ADHD), assuming the existence of a combined phenotype. The aim of our study was to evaluate the common or distinctive clinical features between ASD and ADHD in order to identify possible different phenotypes that could have a clinical value. We enrolled 181 subjects divided into four diagnostic groups: ADHD group, ASD group, ASD + ADHD group (that met diagnostic criteria for both ASD and ADHD), and control group. Intelligent quotient (IQ), emotional and behavior problems, ADHD symptoms, ASD symptoms, and adaptive behaviors were investigated through the following test: Wechsler Intelligence Scale for Children, Wechsler Preschool and Primary Scale of Intelligence or Leiter International Performance Scale Revised, Child Behavior Checklist, Conners’ Rating Scales-Revised, SNAP-IV Rating Scale, the Social Communication Questionnaire, Vineland Adaptive Behavior Scales. The ASD + ADHD group differs from ADHD or ASD in some domains such as lower IQ mean level and a higher autistic symptoms severity. However, the ASD + ADHD group shares inattention and hyperactivity deficit and some emotional and behavior problems with the ADHD group, while it shares adaptive behavior impairment with ASD group. These findings provide a new understanding of clinical manifestation of ASD + ADHD phenotype, they may also inform a novel treatment target. Autism Res 2015, 8: 328–337. © 2015 International Society for Autism Research, Wiley Periodicals, Inc.

Keywords: autism spectrum disorders; attention deficit hyperactivity disorder; overlapping; intelligent quotient; emotional and behavior problems; ADHD symptoms; ASD symptoms; adaptive behaviors

Introduction

Autism spectrum disorders (ASD) and attention-deficit/hyperactivity disorder (ADHD) are childhood-onset neurodevelopmental disorders, with prevalence, respectively, of 1% and 5% in the pediatric population [American Psychiatric Association, 2013]. According to the Diagnostic and Statistical Manual of Mental Disorders—4th edition—Text Revision (DSM-IV-TR) criteria, a diagnosis of ADHD cannot be made if the symptoms of inattention and hyperactivity occur exclusively during the course of a pervasive developmental disorder (PDD). However, epidemiological, clinical and neuroimaging findings have led a revision of the ADHD exclusion criteria in the recent publication of the DSM-5 [American Psychiatric Association, 2013]. In fact, autism is no longer an exclusion criteria and both ASD and ADHD can be diagnosed together [DSM-5, 2013]. Although there are some important differences (e.g., core symptom definition and recommended treatment), ASD and ADHD share many similar impairments in different domains that could complicate a differential diagnosis. Researchers have shown an increased interest in the overlapping features between these disorders, including attention deficit [Mayes et al., 2011; Sturm, Fernell, & Gillberg, 2004], behavior problems [Mayes et al., 2011], and difficulty in social skills [de Boo & Prins, 2007]. Moreover, several studies have shown high rates of ADHD comorbidity in children with ASD [Gadow et al., 2006; Holtmann, et al., 2007; Lee & Ousley, 2006; Simonoff et al., 2008; Wozniak & Biederman, 2012; Yoshida & Uchiyama, 2004]. On the other hand, several studies observed elevated rates of autistic symptoms in children with ADHD [Grzadzinski et al., 2011; Kotte et al., 2013; Reiersen et al., 2007;
Recent studies on biological risk factors, neuropsychological domains, and brain imaging support several overlapping traits between ASD and ADHD. In a review study, Taurines et al. (2012) suggest that comorbidity is caused by overlapping genetic or non-genetic biological risk factors [Taurines et al., 2012]. Family and twin studies provide support for the hypothesis that ADHD and ASD originate partly from similar familial/genetic factors [Reiersen, Constantino, Volk, & Todd, 2007; Ronald, Simonoff, Kuntsi, Asherson, & Plomin, 2008]. Only a few candidate gene studies, linkage studies, and Genome-Wide Association (GWA) studies have specifically addressed this co-occurrence, pointing to some promising pleiotropic genes, loci, and single-nucleotide polymorphisms (SNPs) [Freitag et al., 2012; Rommelse, Franke, Geurts, Hartman, & Buitelaar, 2010; Taurines et al., 2012]. The specific nongenetic biological risk factors associated with overlapping between ASD and ADHD seem to include maternal psychotropic medications, preterm birth, maternal pre-eclampsia, maternal autoimmune disease, and maternal infection disease [Cohen et al., 2011; Croen et al., 2011; Kroger et al., 2011; Lyall et al., 2012; Taurines et al., 2012].

Moreover, neuropsychological impairments, as attention and executive function (EF), were frequently reported in individuals with ASD and ADHD. A meta-analysis study of the EF in ADHD children found that response inhibition, vigilance, working memory, and planning were the strongest and most consistent deficits found across studies [Willcutt et al., 2005]. However, executive functions deficits are also detected in children with ASD who reported deficits in the areas of planning and cognitive flexibility [Hill, Berthoz, & Frith, 2004; Kenworthy et al., 2005; Ozonoff et al., 2004], response selection/monitoring [Happé et al., 2006], and task initiation/task shifting [Hill & Bird, 2006]. These impairments are due to the fact that ASD and ADHD are neurodevelopmental disorders affecting key fronto-striatal and fronto-parietal circuits that are important for executive functions. Neuroimaging findings describe common gray matter reductions in the left medial temporal lobe and increased gray matter volumes in the left inferior parietal cortex in both disorders [Briber et al., 2007]. Recently, Christakou et al. (2013) compared ASD children and ADHD children using functional magnetic resonance imaging (fMRI) during a parametrically modulated vigilance task with a progressively increasing load of sustained attention demonstrating that ADHD and ASD boys had significantly reduced activation relative to controls in bilateral striato-thalamic regions, left dorsolateral prefrontal cortex (DLPFC), and superior parietal cortex [Christakou et al., 2013]. Despite the fact that there have been an increasing amount of molecular genetic and imaging studies about the overlapping of ASD and ADHD, there are no definitive findings.

These literature data highlight the need for further studies on the overlap between ASD and ADHD, assuming the existence of a combined phenotype. For this reason, the aim of our study was to evaluate the common or distinctive clinical features between ASD and ADHD in order to identify possible different phenotypes that could have a clinical value.

**Method**

The sample consisted of 181 subjects referred to University Hospital of Bari. Participants were divided into four groups: ADHD group, ASD group, ASD+ADHD group, and a control group. The ADHD group comprised 51 children/adolescents, the ASD group comprised 43 children/adolescents, and the ASD+ADHD group comprised 31 children/adolescents. These patients were enrolled at the Child Neuropsychiatry Unit and clinical diagnoses were made by clinical experts according to DSM-IV-TR. The diagnoses were based on the developmental histories of the children, taken from clinical interviews with the parents, observations and extended neuropsychological testing of the children themselves. To be eligible for the current study, ASD patients had to present the typical triad of symptoms of autism: social deficits, communication impairment, and rigid ritualistic interests. The clinical diagnosis of ASD was supported by the Autism-Diagnostic Interview-Revised [Rutter et al., 2003b] and the Autism Diagnostic Observation Scale [Lord et al., 1999]. ADHD patients had to present the typical core symptoms of inattention, hyperactivity, and impulsivity. ADHD children that were included in our sample had received the DSM subtype diagnosis. The ASD+ADHD patients met DSM-IV-TR diagnostic criteria for both ASD and ADHD.

Exclusion criteria were the presence of any genetic or medical condition underlying ADHD or ASD symptoms. Considering the difficulty in recruiting healthy children, the control group comprised 56 children/adolescents enrolled at the Pediatric Surgery Unit, admitted for mild surgical diseases (hernia, ingrown nails, appendicitis, hemorrhoids, syndactylia, phimosis), in which neurological and psychiatric disorders were excluded. All participants were consecutively examined in the period between September 2010 and February 2014.

Parental informed consent was obtained for all participants and the study was approved by the local ethical committee of the “Azienda Ospedaliero-Universitaria Consorziale Policlinico di Bari.”

**Assessment**

In order to evaluate the common or distinctive clinical features in ASD, ADHD, ASD+ADHD, and the control groups we investigated intelligent quotient (IQ),...
emotional and behavior problems, ADHD symptoms, ASD symptoms, and adaptive behaviors.

In ASD, ADHD, ASD+ADHD patients, the IQ was assessed according to the age through Wechsler Intelligence Scale for Children (WISC-III) [Wechsler, 1991], Wechsler Preschool and Primary, Scale of Intelligence (WPPSI) [Wechsler, 2002], and Leiter International Performance Scale Revised (Leiter-R) [Roid & Miller, 1997] alternatively to WISC-III, in nonverbal subjects. The control group was not assessed for IQ.

Emotional and behavioral problems, ADHD symptoms, ASD symptoms, and adaptive behaviors were investigated through the following scales: Child Behavior Checklist (CBCL), Conners' Rating Scales-Revised (CRS-R), SNAP-IV Rating Scale, the Social Communication Questionnaire (SCQ), Vineland Adaptive Behavior Scales (VABS).

The CBCL [Achenbach & Rescorla, 2001] is a common tool used to assess emotional and behavioral problems in children. The first section of the scale includes 20 items related to the child's social competency, as rated by parents. These items address the child’s participation in sports, hobbies, games, activities, organizations, jobs, chores, friendships, social interactions during play, independent work, and school functioning. The second section consists of 120 items on behavior or emotional problems during the past 6 months as rated on a three-point scale. The main areas of this construct are aggression, hyperactivity, bullying, conduct problems, defiance, and violence. The following behavioral and emotional problems are also measured: aggressive behavior, anxious/depressed, attention problems, delinquent rule-breaking behavior, social problems, somatic complaints, thought problems, withdrawal, externalizing, internalizing, and total problems. Lower scores indicate lower functioning on the academic performance and adaptive functioning scales [Achenbach & Rescorla, 1991]. Higher scores indicate higher levels of maladaptive behavior on the syndrome, total problems, externalizing and internalizing scales. The instrument has an internal validity of 0.90-0.91 for the scales of internalizing disorders and of 0.95-0.96 for externalizing disorders. Cronbach's coefficient alpha was 0.95 and 0.96, respectively.

CRS [Conners, 1997] is used as part of a comprehensive examination and is designed to be easily administered and scored. Conners' Rating Scales-Revised (CRS-R) is an assessment for children aged 3 through 17 years designed to measure cognitive, behavioral, and emotional problems from teacher and parent perspectives. CRS-R are available in long and short versions for both parents and teachers. We used the long version for parents [Conners et al., 1998] that consisted of 80 items in the following subscales: oppositional, social problems, cognitive problems/inattention, psychosomatic, hyperactivity, DSM-IV symptom subscales, anxious-shy, ADHD Index, perfectionism, Conners’ Global Index. Conners' Global Index includes 10 items related to problem behavior critically associated with the severity of childhood problems. Each of the column scores can then be converted to a T-score. T-scores are standardized scores with a mean of 50 and a standard deviation of 10. These can be further converted to percentile scores, when needed. As a rule, T-scores above 60 are cause for concern and have interpretive value. Interpretable scores range from a low T-score of 61 (mildly atypical) to above 70 (markedly atypical).

The SNAP-IV Rating Scale [Swanson et al., 2001] is a revision of the Swanson, Nolan, and Pelham (SNAP) Questionnaire (Swanson, 1983). The 26 items of the SNAP-IV include the 18 ADHD symptoms (nine for inattentive, nine for hyperactive/impulsive) and eight ODD symptoms specified in the DSM-IV. The SNAP-IV is based on a 0 to 3 rating scale: Not at All = 0, Just A Little = 1, Quite A Bit = 2, and Very Much = 3. Subscale scores on the SNAP-IV are calculated by summing the scores on the items in the subset and dividing by the number of items in the subset.

The SCQ [Rutter, et al., 2003a] is a 40-item, parent completed, screening questionnaire, based on the initial mandatory probes from the original Autism Diagnostic Interview [Le Couteur et al., 1989]. It includes the areas of communication, reciprocal social interactions, and restricted and repetitive behaviors and interests. Each item is checked as “yes” or “no,” and is assigned a rating point of “1” (presence of abnormal behavior) or “0” (absence of abnormal behavior). Total scores are compared to a cut off of ≥15 for ASD. A lower cut-off score of ≥12 has been suggested for children under the age of 5 years. There are two different versions of the SCQ: 1) a “current” version designed for children under the age of 5 years and 2) a “lifetime” version designed for children of 5 years of age or older, with all questions based on lifetime or past behavior.

The VABS [Sparrow et al., 1984] is a semistructured parental interview that evaluates adaptive functioning in four domains: communication, daily living skills, socialization, and motor skills. Age-equivalent scores and standard scores are provided for each domain. Scores across domains can be combined to create an overall adaptive behavior composite standard score.

**Statistical Analysis**

All demographic and clinical variables were subjected to statistical analysis. Descriptive analysis was conducted for sociodemographics featuring of the four samples. Raw scores obtained from each subscale of the CSR, CBCL, SNAP-IV, SCQ, and VABS were transformed into t-scores to allow for consideration of how an individual’s response compares with that of the population.
norms. For CBCL, the borderline (t-score > 65) and clinical (t-score > 70) scores were put together. In line with the interpretive guidelines from CRS-R, participants with a t-score of 66 on a subscale represent individuals who score much above the average and were categorized as symptomatic for that trait. Analysis of variance (ANOVA) test was used to evaluate the differences of the means of the CBCL, CRS-R, SNAP-IV, SCQ, and VABS scales among overlap, ASD, ADHD and control groups. Additionally, Bonferroni correction was used to conduct the post hoc analysis. A P-value of less than .05 was considered as statistically significant. For statistical processing, we used the data processing program the Statistical Package for Social Science version 20.0.

Results

Socio-demographic characteristics of ASD, ADHD, ASD+ADHD and Control groups are summarized in Table 1. No statistical differences among the four groups in age (P = .26) and gender (P = .323) were found. Among the ASD participants in our study, 72% met the DSM-IV-TR diagnostic criteria for pervasive developmental disorder not otherwise specified (PDD-NOS), 14% for Autistic Disorder, and 14% for Asperger’s Syndrome. Among the ADHD patients, 8% met the DSM-IV-TR diagnostic criteria for the inattentive subtype of ADHD and 92% met the criteria for the combined subtype. Among the ASD+ADHD patients, 68% met the DSM-IV-TR diagnostic criteria for PDD-NOS+ADHD combined subtype, 19% for Autistic Disorder + ADHD combined subtype, and 13% for Asperger’s disorder + ADHD combined subtype.

Intelligent Quotient

A statistically significant difference was found between the groups in IQ mean score (F = 7.27; P < .001). The post-hoc analysis showed that ASD+ADHD groups had lower IQ mean score, compared with ASD (P = .023) and ADHD (P = .001) groups. No statistical difference was found between the ADHD and the ASD group. Results about IQ are summarized in Table 1.

Emotional and Behaviors Problems

Emotional and behaviors problems assessed with CBCL (Table 2) showed a statistically significant difference between the groups in internalizing (F = 8.32, P < .001), externalizing (F = 20.04, P < .001), and total problems (F = 19.9, P < .001). ADHD and ASD+ADHD groups showed higher Internalizing scores compared with the control group. ADHD and ASD+ADHD groups showed higher Externalizing and Total problems scores compared with the ASD and control groups.

Table 1. Sociodemographic Characteristics and IQ of ASD, ADHD, ASD+ADHD, and Control Groups

|                | ASD (N = 43) | ASD+ADHD (N=31) | ADHD (N = 51) | Control (N = 56) | P Value |
|----------------|-------------|-----------------|---------------|-----------------|---------|
| Gender (N)     |             |                 |               |                 |         |
| Male           | 36          | 26              | 46            | 43              | .323    |
| Female         | 7           | 5               | 5             | 13              |         |
| Age (years)    |             |                 |               |                 |         |
| Range          | 5.6–8.6     | 7.05–9.5        | 7.2–9.8       | 7.6–9.5         |         |
| Mean ± SD      | 7.11 ± 4.7  | 8.28 ± 3.3      | 8.54 ± 3.9    | 8.6 ± 3.46      | .26     |
| IQ (Mean ± SD) | 72.09 ± 36.7| 59.03 ± 34.5    | 85.17 ± 19.7  | —               |         |
| IQ level       |             |                 |               |                 |         |
| Borderline     | 27%         | 13%             | 19%           | —               |         |
| Mild           | 11%         | 22%             | 12%           | —               |         |
| Moderate       | 9%          | 16%             | 5%            | —               |         |
| IQ measures    |             |                 |               |                 |         |
| WISC-III       | 30%         | 3%              | 72%           | —               |         |
| WPPSI          | 16%         | 13%             | 20%           | —               |         |
| Leiter-R       | 54%         | 84%             | 8%            | —               |         |

Autism Spectrum Disorders (ASD), Attention-Deficit/Hyperactivity Disorder (ADHD), Intelligence Quotient (IQ), borderline (IQ 71-84), mild (IQ 50-70), moderate (IQ 35-49), Wechsler Intelligence Scale for Children (WISC-III), Wechsler Preschool and Primary Scale of Intelligence (WPPSI), Leitner International Performances Scale Revised (Leiter-R); *P < .005.
### Table 2. Significant Differences in CBCL Symptom Scores Between Groups

| Symptom                  | ASD (N = 43) | ASD + ADHD (N = 31) | ADHD (N = 51) | Control (N = 56) | F  | P Value | Bonferroni’s Test |
|--------------------------|--------------|---------------------|---------------|------------------|----|---------|-------------------|
| Internalizing problems   |              |                     |               |                  |    |         |                   |
| %> Cut-off               | 59.7%        | 60.4±8.8            | 76.8%         | 64.7±7.2         |    | <.001   | ASD+ADHD=ASD<ADHD |
| M ± SD                   | 59.7±8.2     | 80.6±13             | 84.9±9.3      | 66±10.3          |    |         |                   |
| Externatizing problems   |              |                     |               |                  |    |         |                   |
| %> Cut-off               | 32.7%        | 56.5±8.2            | 92.8%         | 69.8±1.1         |    | <.001   | ADHD=ASD<ADHD<ASD |
| M ± SD                   | 59.7±8.2     | 80.6±13             | 84.9±9.3      | 66±10.3          |    |         |                   |
| Total Problems           |              |                     |               |                  |    |         |                   |
| %> Cut-off               | 53.3%        | 59.7±8.2            | 72.4%         | 59.8±7.3         |    | <.001   | ASD=ADHD<ASD<ADHD |
| M ± SD                   | 59.7±8.2     | 80.6±13             | 84.9±9.3      | 66±10.3          |    |         |                   |
| Mood symptoms            |              |                     |               |                  |    |         |                   |
| %> Cut-off               | 25.2%        | 31.7±2               | 79.3%         | 71.7±10.3        |    | <.001   | ADHD=ADHD<ASD<ADHD |
| M ± SD                   | 59.7±8.2     | 80.6±13             | 84.9±9.3      | 66±10.3          |    |         |                   |
| Social Withdraw          |              |                     |               |                  |    |         |                   |
| %> Cut-off               | 75.6%        | 69.2±12.1           | 86.2%         | 68.4±9.8         |    | <.001   | ADHD=ADHD<ASD<ADHD |
| M ± SD                   | 59.7±8.2     | 80.6±13             | 84.9±9.3      | 66±10.3          |    |         |                   |
| Somatic Complain         |              |                     |               |                  |    |         |                   |
| %> Cut-off               | 9.4%         | 55.7                | 22.6%         | 57.3±6.9         |    | <.001   | ADHD=ADHD<ADHD<ADHD |
| M ± SD                   | 59.7±8.2     | 80.6±13             | 84.9±9.3      | 66±10.3          |    |         |                   |
| Attention deficit        |              |                     |               |                  |    |         |                   |
| %> Cut-off               | 37.2%        | 62.5±7.3            | 78.8%         | 73±7.9           |    | .001    | ADHD=ADHD<ADHD<ADHD |
| M ± SD                   | 59.7±8.2     | 80.6±13             | 84.9±9.3      | 66±10.3          |    |         |                   |
| Aggressive problem       |              |                     |               |                  |    |         |                   |
| %> Cut-off               | 28.1%        | 56.6±7.7            | 48.4%         | 64.4±8.7         |    | <.001   | ADHD=ADHD<ADHD<ADHD |
| M ± SD                   | 59.7±8.2     | 80.6±13             | 84.9±9.3      | 66±10.3          |    |         |                   |
| Depression               |              |                     |               |                  |    |         |                   |
| %> Cut-off               | 34.4%        | 60.6±9.7            | 48.4%         | 67.2±9.6         |    | <.001   | ASD=ADHD<ADHD<ADHD |
| M ± SD                   | 59.7±8.2     | 80.6±13             | 84.9±9.3      | 66±10.3          |    |         |                   |
| Anxiety                  |              |                     |               |                  |    |         |                   |
| %> Cut-off               | 25%          | 57.8±7.2            | 70%           | 66.1±8           |    | <.001   | ASD=ADHD<ADHD<ADHD |
| M ± SD                   | 59.7±8.2     | 80.6±13             | 84.9±9.3      | 66±10.3          |    |         |                   |
| ADHD                     |              |                     |               |                  |    |         |                   |
| %> Cut-off               | 18.3%        | 59.6±6.7            | 65.5%         | 67.8±7.3         |    | <.001   | ADHD=ADHD<ADHD<ADHD |
| M ± SD                   | 59.7±8.2     | 80.6±13             | 84.9±9.3      | 66±10.3          |    |         |                   |
| ODD                      |              |                     |               |                  |    |         |                   |
| %> Cut-off               | 6.2%         | 55.5±5.5            | 16.8%         | 61.1±7.7         |    | <.001   | ASD=ADHD<ADHD<ADHD |
| M ± SD                   | 59.7±8.2     | 80.6±13             | 84.9±9.3      | 66±10.3          |    |         |                   |

Autism Spectrum Disorders (ASD), Attention-Deficit/Hyperactivity Disorder (ADHD), Oppositional defiant disorder (ODD), Mean (M), standard deviation (SD), Child Behavior Checklist (CBCL); *P < .05.

### Table 3. Significant Differences in CRS-R Scores Between Groups

| Symptom                  | ASD (N = 43) | ASD + ADHD (N = 31) | ADHD (N = 51) | Control (N = 56) | F  | P Value | Bonferroni’s Test |
|--------------------------|--------------|---------------------|---------------|------------------|----|---------|-------------------|
| ODD                      | 9.8%         | 46±12.9             | 41.9%         | 60.7±13          |    | <.001   | ADHD=ADHD=ASD=ADHD |
| Cognitive problems       | 46.3%        | 60±13               | 80.6%         | 74.4±15          |    | <.001   | ADHD=ADHD=ASD=ADHD |
| Hyperactivity            | 19.5%        | 54.6±9.2            | 83.9%         | 73.7±12.6        |    | <.001   | ADHD=ADHD=ASD=ADHD |
| Anxiety                  | 19.5%        | 49.4±9.2            | 41.4%         | 60.2±13          |    | <.001   | ADHD=ADHD=ASD=ADHD |
| Perfectionism            | 12.2%        | 49.7±8.9            | 64.3%         | 64.6±15.1        |    | <.001   | ADHD=ADHD=ASD=ADHD |
| Social problems          | 41.5%        | 60.9±14.8           | 80.6%         | 77.4±18.9        |    | <.001   | ADHD=ADHD=ASD=ADHD |
| Psychosomatic            | 9.3%         | 49.8±9.5            | 51.4%         | 65±16.5          |    | <.001   | ADHD=ADHD=ASD=ADHD |
| ADHD INDEX               | 46.3%        | 60.4±10.3           | 90.3%         | 77±12            |    | <.001   | ADHD=ADHD=ASD=ADHD |
| CGI restlessness          | 29.3%        | 56.2±8.2            | 71%           | 68.4±12.4        |    | <.001   | ADHD=ADHD=ASD=ADHD |
| CGI emotional lability   | 22%          | 51±10.4             | 58.1%         | 66.6±16.4        |    | <.001   | ADHD=ADHD=ASD=ADHD |
| CGI total                | 19.5%        | 54.8±8              | 71%           | 70±13            |    | <.001   | ADHD=ADHD=ASD=ADHD |
| DSM-IV inattention       | 36.6%        | 59.8±11.3           | 83.9%         | 73.7±14.4        |    | <.001   | ADHD=ADHD=ASD=ADHD |
| DSM-IV hyperactivity     | 22%          | 54.4±10.8           | 83.9%         | 72.2±12.7        |    | <.001   | ADHD=ADHD=ASD=ADHD |
| DSM-IV ADHD              | 34.1%        | 57.6±9.7            | 96.8%         | 81.9±33.3        |    | <.001   | ADHD=ADHD=ASD=ADHD |

Autism Spectrum Disorders (ASD), Attention-Deficit/Hyperactivity Disorder (ADHD), Oppositional defiant disorder (ODD), Conners Global Impairment (CGI), Diagnostic and Statistical Manual of Mental Disorders (DSM), Mean (M), standard deviation (SD), Conners’ Rating Scales-Revised (CRS-R); *P < .05.
emotional lability, and CGI total scores, compared with the control group.

**ADHD Symptoms**

ADHD symptoms assessed with SNAP-IV (Table 4) showed a statistically significant difference among the groups in inattention scores ($F = 51.4$, $P < .001$) and hyperactivity scores ($F = 75.4$, $P < .001$). ADHD and ASD+ADHD groups had higher SNAP-IV inattention score compared with ASD and control groups; ASD groups had higher SNAP-IV inattention score compared with the Control group. ADHD and ASD+ADHD groups had higher SNAP-IV hyperactivity score compared with ASD and Control groups; ASD groups had higher SNAP-IV hyperactivity score compared with the control group.

ADHD symptoms assessed with CRS-R (Table 3) showed a statistically significant difference among the groups in Hyperactivity ($F = 49.3$, $P < .001$); ADHD Index ($F = 32$, $P < .001$); Restlessness-Impulsivity ($F = 31.4$, $P < .001$); DSM-IV inattention ($F = 22.1$, $P < .001$); DSM-IV Hyperactivity ($F = 43.3$, $P < .001$), DSM-IV ADHD Total ($F = 23.7$, $P < .001$). The Bonferroni test showed that ADHD and ASD+ADHD groups had higher hyperactivity, ADHD index, restlessness-impulsivity, DSM-IV inattention, DSM-IV hyperactivity, DSM-IV ADHD total scores, compared with ASD ($P < .001$ for every scales) and Control groups ($P < .001$ for every scales). No differences were found between ASD and control groups.

ADHD symptoms assessed with CBCL (Table 2) showed a statistically significant difference between the groups in ADHD scores ($F = 24.4$, $P < .001$) and attention deficit scores ($F = 18.5$, $P < .001$). The Bonferroni test showed that ASD+ADHD and ADHD groups had higher ADHD symptoms and attention deficit scores, compared with ASD and control groups. No differences were found between ASD and control groups.

**ASD Symptoms**

All four groups differed significantly from each other in SCQ total scores ($F = 47.7$, $P < .001$). The ASD+ADHD group had higher SCQ score (Table 4) compared with ASD ($P = .009$), ADHD ($P < .001$) and Control ($P < .001$) groups. The ASD group had higher score compared with ADHD ($P = .023$) and control ($P < .001$) groups. The ADHD group had higher score compared with the control ($P < .001$) group.

**Adaptive Behaviors**

Adaptive behaviors assessed with VABS (Table 4), showed a statistically significant difference among the groups in communication skills ($F = 13.6$, $P < .001$), daily living skills ($F = 15.4$, $P < .001$), social skills

---

**Table 4. Significant Differences in SNAP-IV, SCQ, VABS Scores Between Groups**

|       | ASD (N=43) | ASD+ADHD (N=31) | ADHD (N=51) | Control (N=56) |
|-------|------------|-----------------|-------------|----------------|
| SNAP-IV |            |                 |             |                |
| Inattention | 45% (1.5) | 67% (2.2)       | 57% (1.7)   | 35% (1.0)      |
| Hyperactivity | 23% (1.1) | 34% (2.2)       | 17% (1.0)   | 20% (1.2)      |
| Social skills | 63% (1.2) | 67% (1.5)       | 61% (1.0)   | 55% (1.2)      |

* Autism Spectrum Disorders (ASD), Attention-Deficit/Hyperactivity Disorder (ADHD), Oppositional defiant disorder (ODD), Mean (M), standard deviation (SD), Swanson, Nolan and Pelham (SNAP), Social Communication Questionnaire (SCQ), Vineland Adaptive Behavior Scales (VABS); * $P < .05$. 

---

**INSAR** Craig et al./Overlap Between ASD and ADHD 333
externalizing scores and ADHD symptoms compared ASD vs. ASD in our study, in comparison with previous research, was significantly higher ratings for externalizing problems, and attention problems, and hyperactivity than the ASD group. This finding is in accordance with Sprenger et al. (2013) who reported that patients with ASD and ADHD symptoms showed more strongly expressed autistic symptoms than children with ASD without ADHD. Therefore, in ASD+ADHD phenotype, the inattentive and hyperactive symptoms may exacerbate the severity of ASD. However, another possible explanation for the greater severity of autistic symptoms may be the fact that we found a lower IQ in the ASD+ADHD group, compared to the other groups. We also found that ADHD phenotype reported more ASD symptoms than healthy children. The presence of ASD symptoms in individuals with a primary diagnosis of ADHD has been increasingly noted [Hattori et al., 2006; Nijmeijer et al., 2008, 2009]. Several studies have shown social deficits, peer relationship and empathy problems are common in ADHD children [Gillberg et al., 2004; Kadesjö & Gillberg, 2001]. Recently, Cooper et al. (2014) investigated whether higher levels of autistic traits, indicated a more severe presentation in a large sample of children with ADHD symptoms, and suggested that ADHD children reported elevated ratings of core ASD traits not accounted for by ADHD or behavioral problems [Cooper et al., 2014].

Although studies have shown adaptive behavioral difficulties in children diagnosed with ASD and in children with ADHD, it remains poorly investigated whether ASD+ADHD children share similar adaptive functioning impairments. Studies comparing ASD and ADHD groups reported that adaptive functioning is generally impaired in both disorders, but individuals with ASD show more severe impairments [Happé, Booth, Charlton, & Hughes, 2006; Saulnier & Klin, 2008]. Yeyrs et al. (2009) detected that both ASD and ASD+ADHD groups received significantly lower adaptive functioning ratings on the communication, daily living skills, and socialization domains relative to the healthy children group, but the ASD+ADHD group exhibited a more severe impairment in daily living skills compared to the ASD group [Yeyrs et al., 2009]. Recently, Mattard-Labrecque, Ben Amor, & Couture (2013) investigated adaptive behaviors in children with ASD and control groups. These findings suggest that ADHD and ASD+ADHD phenotypes are characterized in equal measure by externalizing behavior problems and ADHD symptoms. Moreover, ASD phenotype reported more ADHD symptoms than the Control group confirming previous studies which found that inattentive and hyperactive symptoms are often reported in individuals with ASD [Lord et al., 2000; Levy et al., 2006]. Further study is needed to extend the analysis of differences between groups of patients on the clinical aspects.

Regarding the prevalence of ASD symptoms, we found that the ASD+ADHD group reported more ASD symptoms than ASD, ADHD, and control groups. These results are in accordance with Sprenger et al. (2013) who reported that patients with ASD and ADHD symptoms showed more strongly expressed autistic symptoms than children with ASD without additional ADHD symptoms. Therefore, in ASD+ADHD phenotype, the inattentive and hyperactive symptoms may exacerbate the severity of ASD. However, another possible explanation for the greater severity of autistic symptoms may be the fact that we found a lower IQ in the ASD+ADHD group, compared to the other groups. We also found that ADHD phenotype reported more ASD symptoms than healthy children. The presence of ASD symptoms in individuals with a primary diagnosis of ADHD has been increasingly noted [Hattori et al., 2006; Nijmeijer et al., 2008, 2009]. Several studies have shown social deficits, peer relationship and empathy problems are common in ADHD children [Gillberg et al., 2004; Kadesjö & Gillberg, 2001].

In literature data, studies regarding psychiatric comorbid disorders that compare children with ASD and ADHD are lacking. Recently, van Steensel et al. (2013) found that children with ASD did not differ from children with ADHD with respect to overall comorbidity rate, however, anxiety disorders were more often present in children with ASD compared to children with ADHD [van Steensel et al., 2013]. In our study, we found that the ASD+ADHD group (where the 68% met the DSM-IV-TR diagnostic criteria for PDD-NOS) was characterized by a statistically significant lower IQ mean score compared with ASD and ADHD groups. These findings suggest that the assessment of IQ could help to identify distinctive characteristics in ASD+ADHD phenotype. Further studies, which take these variables into account, will need to be undertaken.
a dual diagnosis of ASD+ADHD compared with children with ADHD or ASD alone. The authors found that children with ASD+ADHD had a lower performance in all of the adaptive functions except home/school living than children with ADHD [Mattard-Labrecque et al., 2013]. In the present study, no statistically significant difference in adaptive functions between ASD+ADHD and ASD group was found. However, ASD+ADHD and ASD groups reported more impairment in communication, daily living skills, and motor skills compared to ADHD and control groups. These findings suggest that the presence of ADHD does not lead to a greater impairment in adaptive functions, but impairments in these domains may result from increased neurocognitive deficits related to the autism phenotype characterized by difficulties in executive function, organization, and planning skills [Kenworthy et al., 2005]. However, ASD+ADHD, ASD, and ADHD children reported a lower score in social skills compared with the control group. These findings suggest that the Social skills deficit could be due to impairments in social perception and/or difficulties in emotion recognition, which characterize both ASD and ADHD disorders.

**Conclusion**

In conclusion, the ASD+ADHD phenotype differs from ADHD or ASD phenotypes in some domains such as IQ and autistic symptoms severity. However, the ASD+ADHD phenotype maintains some clinical aspects that characterize ASD or ADHD phenotypes. In fact, the ASD+ADHD phenotype shares inattention and hyperactivity deficit and emotional and behavior problems with the ADHD phenotype, while it shares the adaptive behavior impairment with the ASD phenotype.

The findings in this study provide some new understanding of the clinical manifestation of the ASD+ADHD phenotype, and it represents a starting point for future research that needs to investigate aspects such as treatment response, neuropsychological measures, etiopathogenesis, and developmental trajectories of the ASD+ADHD phenotype.

**Conflict of Interest**

All authors declare that they have no conflicts of interest.

**References**

Achenbach, T.M., & Rescorla, L.A. (2001). Manual for ASEBA school-age forms & profiles. Burlington, VT: Research Center of Children, Youth, & Families, University of Vermont. 

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

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Arlington, VA: American Psychiatric Publishing.

Briere, S., Neufang, S., Bruning, N., Kamp-Becker, I., Remschmidt, H., et al. (2007). Structural brain abnormalities in adolescents with autism spectrum disorder and patients with attention deficit/hyperactivity disorder. J Child Psychol Psychiatry, 48, 1251–1258.

Christakou, A., Murphy, C.M., Chantiluke, K., Cubillo, A.I., Smith, A.B., et al. (2013). Disorder-specific functional abnormalities during sustained attention in youth with attention deficit hyperactivity disorder (ADHD) and with autism. Molecular Psychiatry, 18, 236–244.

Cohen, M.J., Meador, K.J., Browning, N., Baker, G.A., Clayton-Smith, J., et al. (2011). Fetal antiepileptic drug exposure: motor, adaptive, and emotional/behavioral functioning at age 3 years. Epilepsy & Behavior, 22, 240–246.

Connors, C. (1997). Conner’s rating scales-revised technical manual. North Tonawand, NY: Multi-Health System.

Connors, C.K., Sitarenios, G., Parker, J.D., & Epstein, J.N. (1998). The revised Connors’s Parent Rating Scale (CPRS-R): factor structure, reliability, and criterion validity. Journal of Abnormal Child Psychology, 9, 257–268.

Cooper, M., Martin, J., Langley, K., Hamshere, M., & Thapar, A. (2014). Autistic traits in children with ADHD index clinical and cognitive problems. European Child & Adolescent Psychiatry, 23, 23–34.

Croen, L.A., Grether, J.K., Yoshida, C.K., Ondouli, R., & Hendrick, V. (2011). Antidepressant use during pregnancy and childhood autism spectrum disorders. Archives of General Psychiatry, 68, 1104–1112.

de Boo, G.M., & Prins, P.J. (2007). Social incompetence in children with ADHD: possible moderators and mediators in social-skills training. Clinical Psychology Review, 27, 78–97.

Freitag, C.M., Hanig, S., Schneider, A., Seitz, C., Palmason, H., et al. (2012). Biological and psychosocial environmental risk factors influence symptom severity and psychiatric comorbidity in children with ADHD. Journal of Neural Transmission, 119, 81–94.

Gadow, K.D., DeVincent, C.J., & Pomeroy, J. (2006). ADHD symptom subtypes in children with pervasive developmental disorder. Journal of Autism and Developmental Disorders, 36, 271–283.

Gillberg, C., Gillberg, I.C., Rasmussen, P., Kadesjö, B., Söderström, H., et al. (2004). Co-existing disorders in ADHD—implications for diagnosis and intervention. European Child & Adolescent Psychiatry, 13, 80–92.

Grzadzinski, R., Di Martini, A., Brady, E., Mairena, M. A., O’Neale, M., et al. (2011). Examining autistic traits in children with ADHD: does the autism spectrum extend to ADHD? Journal of Autism and Developmental Disorders, 41, 1178–1191.

Happé, F., Booth, R., Charlton, R., & Hughes, C. (2006). Executive function deficits in autism spectrum disorders and attention-deficit/hyperactivity disorder: examining profiles across domains and ages. Brain and Cognition, 61, 25–39.

Hattori, J., Ogino, T., Abiru, K., Nakano, K., Oka, M., et al. (2006). Are pervasive developmental disorders and
attention-deficit/hyperactivity disorder
distinctive disorders? Brain Development, 28, 371–374.
Hill, E., Berthoz, S., & Frith, U. (2004). Brief report: cognitive processing of own emotions in individuals with autistic spectrum disorder and in their relatives. Journal of Autism and Developmental Disorders, 34, 229–235.
Hill, E.J., & Bird, C.M. (2006). Executive processes in Asperger syndrome: patterns of performance in a multiple case series. Neuropsychologia, 44, 2822–2835.
Holtmann, M., Bolte, S., & Poustka, F. (2007). Attention deficit hyperactivity disorder symptoms in pervasive developmental disorders: association with autistic behavior domains and coexisting psychopathology. Psychopathology, 40, 172–177.
Kadesjo, B., & Gillberg, C. (2001). The comorbidity of ADHD in the general population of Swedish school-age children. Journal of Child Psychology and Psychiatry, 42, 487–492.
Kenworthy, L.E., Black, D.O., Wallace, G.L., Ahluvalia, T., Wagner, A.E., et al. (2005). Disorganization: the forgotten executive dysfunction in high-functioning autism (HFA) spectrum disorders. Developmental Neuropsychology, 28, 809–827.
Kotte, A., Joshi, G., Fried, R., Uchida, M., Spencer A., et al. (2013). Autistic traits in children with and without ADHD. Pediatrics, 132, 612–622.
Kroger, A., Hanig, S., Seitz, C., Palmason, H., Meyer, J., et al. (2011). Risk factors of autistic symptoms in children with ADHD. European Child & Adolescent Psychiatry, 20, 561–570.
Le Couteur, A., Rutter, M., Lord, C., Rios, P., Robertson, S., et al. (1989). Autism diagnostic interview: a standardized investigator-based instrument. Journal of Autism and Developmental Disorders, 19, 363–387.
Lee, D.O., & Ousley, O.Y. (2006). Attention-deficit hyperactivity disorder symptoms in a clinic sample of children and adolescents with pervasive developmental disorders. Journal of Child and Adolescent Psychopharmacology, 16, 737–746.
Leyfer, O.T., Folstein, S.E., Bacalman, S., Davis, N.O., Dinh, E., et al. (2006). Comorbid psychiatric disorders in children with autism: interview development and rates of disorders. Journal of Autism and Developmental Disorders, 36, 849–861.
Lord, C., Risi, S., Lambrecht, L., Cook, E.H., Jr., Leventhal, B.L., et al. (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, 205–223.
Lord, C., Rutter, M., DiLavore, P. S., & Risi, S. (1999). Autism diagnostic observation schedule: manual. Los Angeles, CA: Western Psychological Services.
Lyall, K., Pauls, D.L., Spiegelman D, Ascherio, A., & Santangelo, S.L. (2012). Pregnancy complications and obstetric suboptimality in association with autism spectrum disorders in children of the Nurses’ Health Study II. Autism Research, 5, 21–30.
Mattard-Labrecque, C., Ben Amor, L., & Couture, M.M. (2013). Children with autism and attention difficulties: a pilot study of the association between sensory, motor, and adaptive behaviors. Journal of the Canadian Academy of Child and Adolescent Psychiatry, 22, 139–146.
Mayes, S.D., Calhoun, S.L., Murray, M.J., Morrow, J.D., Yurch, K.K., et al. (2011). Use of Gilliam Asperger’s disorder scale in differentiating high and low functioning autism and ADHD. Psychological Reports, 108, 3–13.
Nijmeijer, J.S., Hoeckastra, P.J., Minderaa, R.B., Buitelaar, J.K., Altink, M.E., et al. (2009). PDD symptoms in ADHD, an independent familial trait? Journal of Abnormal Child Psychology, 37, 443–453.
Nijmeijer, J.S., Minderaa, R.B, Buitelaar, J.K., Mulligan, A., Hartman, C.A., et al. (2008). Attention-deficit/hyperactivity disorder and social dysfunctioning. Clinical Psychology Review, 28, 692–708.
Ozonoff, S, Cook, I., Coon, H., Dawson, G., Joseph, R.M., et al. (2004). Performance on Cambridge Neuropsychological Test Automated Battery subtests sensitive to frontal lobe function in people with autistic disorder: evidence from the Collaborative Programs of Excellence in Autism network. Journal of Autism and Developmental Disorders, 34, 139–150.
Reiersen, A.M., Constantino, J.N., Volk H.E., & Todd, R.D. (2007). Autistic traits in a population-based ADHD twin sample. The Journal of Child Psychology and Psychiatry, 48, 464–472.
Roid, G.H, & Miller, L.J. (1997). Leiter international performance scale—revised: examiner’s manual. Wood Dale. IL: Stoelting Co.
Rommelse, N.N, Franke, B., Geurts, H.M., Hartman, C.A., & Buitelaar, J.K. (2010). Shared heritability of attention-deficit/hyperactivity disorder and autism spectrum disorder. European Child & Adolescent Psychiatry, 19, 281–295.
Ronald, A., Simonoff, E., Kuntsi, J., Asherson, P., & Plomin, R. (2008). Evidence for overlapping genetic influences on autistic and ADHD behaviours in a community twin sample. The Journal of Child Psychology and Psychiatry, 49, 535–542.
Rutter, M., Bailey, A., & Lord, C. (2003a). The social communication questionnaire. Los Angeles, CA: Western Psychological Services.
Rutter, M., Le Couteur, A., & Lord, C. (2003b). Autism diagnostic interview, revised. Los Angeles, CA: Western Psychological Services.
Santosh, P.J., & Mijovic, A. (2004). Social impairment in hyperkinetic Disorder—relationship to psychopathology and environmental stressors. European Child & Adolescent Psychiatry, 13, 141–150.
Saulnier, C.A., & Klin, A. (2008). Brief report: social and communication abilities and disabilities in higher functioning individuals with autism and Asperger syndrome. Journal of Autism and Developmental Disorders, 37, 788–793.
Scheirs, J.G., & Timmers, E.A. (2009). Differentiating among children with PDD-NOS, ADHD, and those with a combined diagnosis on the basis of WISC-III profiles. Journal of Autism and Developmental Disorders, 39, 549–556.
Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., Baird, G. (2008) Psychiatric disorders in children with autism spectrum disorders: prevalence, comorbidity, and associated factors in a population-derived sample. Journal of the American Academy of Child & Adolescent Psychiatry, 47, 921–929.
Sparrow, S.S., Balla, D.A., & Cicchetti, D.V. (1984). Vineland adaptive behavior scales. Minnesota: American Guidance Service.
Sprenger, L., Bühler, E., Poustka, L., Bach, C., Heinzel-Gutenbrunner, M., et al. (2013). Impact of ADHD symptoms on autism spectrum disorder symptom severity. Research in Developmental Disabilities, 34, 3545–3552.

Sturm, H., Fernell, E., & Gillberg, C. (2004). Autism spectrum disorders in children with normal intellectual levels: associated impairments and subgroups. Developmental Medicine and Child Neurology, 46, 444–447.

Swanson, J.M. (1983). The SNAP-IV teacher and parent rating scale. Irvine, CA: University of California.

Swanson, J.M., Kraemer, H.C., Hinshaw, S.P., Arnold, L.E., Conners, C.K., et al. (2001). Clinical relevance of the primary findings of the MTA: success rates based on severity of ADHD and ODD symptoms at the end of treatment. Journal of the American Academy of Child & Adolescent Psychiatry, 40, 168–179.

Taurines, R., Schwenck, C., Westerwald, E., Sachse, M., Siniatchkin, M., et al. (2012). ADHD and autism: differential diagnosis or overlapping traits? A selective review. Attention Deficit and Hyperactivity Disorders, 4, 115–139.

van Steensel, F.J., Rögels, S.M., & de Bruin, E.I. (2013). Psychiatric comorbidity in children with autism spectrum disorders: a comparison with children with ADHD. Journal of Child and Family Studies, 22, 368–376.

Wechsler D. (1991). WISC-III: Wechsler intelligence scale for children. New York: The Psychological Corporation.

Wechsler, D. (2002). The Wechsler Preschool and Primary Scale of Intelligence, Third Edition (WPPSI-III). San Antonio, TX: The Psychological Corporation Canadian Journal of School Psychology, 19, 205–220.

Willcutt, E.G., Doyle, A.E., Nigg, J.T., Faraone, S.V., & Pennington, B.F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: a meta-analytic review. Biological Psychiatry, 57, 1336–1346.

Wozniak, J., Biederman, J., Faraone, S.V., Frazier J, Kim J, et al. (1997). Mania in children with pervasive developmental disorder revisited. Journal of the American Academy of Child and Adolescent Psychiatry, 36, 1552–1560.

Yerys, B.E., Wallace, G.L., Sokoloff, J.L., Shook, D.A., James, J.D., et al. (2009). Attention deficit/hyperactivity disorder symptoms moderate cognition and behavior in children with autism spectrum disorders. Autism Research, 2, 322–333.

Yoshida, Y., & Uchiyama, T. (2004). The clinical necessity for assessing attention deficit/hyperactivity disorder (AD/HD) symptoms in children with high functioning pervasive developmental disorder (PDD). European Child and Adolescent Psychiatry, 13, 307–314.