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Attention Deficit/Hyperactivity Disorder in Children and Adolescents With Autism Spectrum Disorder

Symptom or Syndrome?

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Objective: This study aims to evaluate ADHD-like symptoms in children with autism spectrum disorder (ASD) based on single-item analysis, as well as the comparison of two ASD subsamples of children with ADHD (ASD+) and without ADHD (ASD-). **Methods:** Participants are 83 children with ASD. Dimensional and categorical aspects of ADHD are evaluated using a diagnostic symptom checklist according to *DSM-IV*. **Results:** Of the sample, 53% fulfill *DSM-IV* criteria for ADHD. The comparison of the ASD+ and the ASD- samples reveals differences in age and IQ. Correlations of ADHD and PDD show significant results for symptoms of hyperactivity with impairment in communication and for inattention with stereotyped behavior. Item profiles of ADHD symptoms in the ASD+ sample are similar to those in a pure ADHD sample. **Conclusion:** The results of our study reveal a high phenotypical overlap between ASD and ADHD. The two identified subtypes, *inattentive-stereotyped* and *hyperactive-communication impaired*, reflect the *DSM* classification and may theoretically be a sign of two different neurochemical pathways, a dopaminergic and a serotonergic. (*J. of Att. Dis. 2009; 13(2) 117-126)*

Keywords: *ADHD; Asperger syndrome; autism; comorbidity; diagnosis*

Although autism spectrum disorders (ASD) can be accompanied by increased inattention, hyperactivity, and impulsivity, the diagnosis of ADHD continues to remain in the exclusionary criteria for pervasive developmental disorder (PDD) (APA, 2000). Currently, shared candidate regions as well as overlaps in neuroimaging studies, in particular with regard to cerebellar and frontostriatal structures, are being discussed for ADHD and for ASD (Bakker et al., 2003; Brieber et al., 2007; Ogdie et al., 2003). Neuropsychological examinations comparing both groups show similar results especially with regard to performance in inhibition tasks (Geurts, Verte, Oosterlaan, Roeyers, & Sergeant, 2004; Goldberg et al., 2005; Happé, Booth, Charlton, & Hughes, 2006; Ozonoff & Jensen, 1999; Sinzig, Morsch, Bruning, Schmidt, & Lehmkuhl, 2008).

The coexistence of ADHD symptoms and ASD was described as early as the 70s and 80s (Campbell et al., 1972; Geller et al., 1981). In an early investigation by Gillberg (1989), 21% of the children and adolescents with ASD were found to meet both the diagnostic criteria for an ADHD and an Asperger syndrome, and autistic traits were apparent in 36%. In 1997, Wozniak and Biederman reported that 74% of an ASD sample showed ADHD symptoms. Ghaziuddin, Weidmer-Mikhail, and Ghaziuddin (1998) described that children with Asperger syndrome most likely suffer from ADHD whereas depression was the most common diagnosis in adolescents and adults. Frazier et al. (2001) suggested in a comparative analysis that the two syndromes be considered independent of each other. They further demonstrated that the comorbid presentation of ADHD with ASD (83% in their study) led to higher rates of hospitalization,

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Table 1
Results of Recent Systematic Studies of ADHD Symptoms in Autistic Populations

	Goldstein et al. (2004) ($n = 27$)	Yoshida et al. (2004) ($n = 53$)	Gadow et al. (2006) ($n = 483$)	Lee et al. (2006) ($n = 83$)
No. (%)				
Gender				
– male	?	48	398	66
– female	?	5	85	17
ASD diagnosis				
– Autistic disorder	9 (24.3)	—	—	
– High-Functioning syndrome	—	33 (62.2)	170 (35.0)	58 (70.0)
– Asperger-Syndrome	—	3 (5.6)	104 (21.5)	12 (14.0)
– PDD-NOS	28 (75.6)	17 (32.0)	209 (43.2)	13 (16.0)
ADHD diagnosis	16 (59)	36 (68)	251 (52)	54 (65)
ASD Total sample/ ASD + sample (in%)				
– 0 Combined subtype	26/44	23/33	16/31	49/63
– 1 Inattentive only subtype	33/56	38/56	29/56	23/29
– 2 Hyperactive/Impulsive subtype	—	8/11	6/12	6/8
Mean				
Age at testing (years)	8.5	10.3	6.5	11.2
Min-Max	(?)	(7-15)	(3-12)	(4-20)
IQ	86.1	87.3	83.5	?
Min-Max	(?)	(>70)	(?)	

medication treatment, and combined psychotherapy. More recently, a study by Holtmann, Bolte, and Poustka (2007) found that 65% of children and adolescents with high functioning autism (HFA) or Asperger syndrome scored above the clinical cutoff on attention problems scale of the Child Behavior Checklist. ADHD subtypes in ASD were first specified by Yoshida and Uchiyama (2004). In their study, 68% of children with an autistic disorder, either Asperger syndrome or pervasive developmental disorder not otherwise specified (PDDNOS), met the diagnostic criteria for ADHD subtypes. These numbers are in line with results by Goldstein and Schwebach (2004) who found in a retrospective chart review that in a sample of children with autism or PDDNOS, 59% of the children suffered from ADHD. These results were recently confirmed by Gadow et al. (2006) who described almost equal ADHD subtypes for children with PDDNOS. Categorical aspects of ADHD diagnosis have also been reported in 2006 in a chart review of 83 children with ASD, where 78% fulfilled *DSM-IV* criteria for ADHD and exceeded the 93rd percentile norm for the ADHD rating scale (Lee & Ousley, 2006). Table 1 summarizes the results of recent systematic studies of ADHD symptoms in autistic populations.

In total, the reported studies show that children with ASD may display a significant degree of ADHD-like symptoms as well as ADHD subtypes. Because there is considerable controversy concerning the diagnosis of ADHD in children with ASD (Ghaziuddin, 1998; Perry, 1998; Tsai, 1996), especially ADHD symptoms being "true" ADHD or part of the ASD diathesis, we decided to look separately at both types of children, those with a categorical diagnosis of ADHD and those without.

As previous studies dealing with the prevalence of ADHD in ASD used rather heterogeneous samples concerning gender, age, ASD diagnosis, and IQ, we wanted to assess the association of these variables with the severity of ADHD symptomatology within the ASD sample affected by ADHD symptoms.

Associations of ADHD with PDD-symptoms had also never been investigated before. This is an important topic as one might assume that an autistic child is, for example, inattentive because that is a stereotypical behavior.

Until now, little attention has been given to investigate the detailed description of ADHD-like symptoms in ASD children based on single-item profiles. This was done only by Clark, Feehan, Tinline, and Vostanis (1999) the other way around in a sample of children with ADHD and comorbid autistic symptoms.

In summary, the objectives of our study were fourfold: (a) to compare an ASD sample with a categorical diagnosis of ADHD and one without such a diagnosis; (b) to assess the associations of gender, ASD diagnosis, age, and IQ with ADHD severity; (c) to investigate associations of ADHD with PDD symptoms; and (d) to perform a single-item analysis of ADHD symptoms in an ASD sample.

Because previous studies have described almost equal numbers for ADHD prevalence in ASD samples, we hypothesize that ADHD displays a genuine diagnosis in ASD. Therefore, we expected no differences between the two samples except for gender, as the ratio between males and females with ADHD diagnosis is approximately 3:1 (Szatmari, Offord, & Boyle, 1989). We also hypothesized that boys would be more severely impaired. Furthermore, we expected children with an autistic disorder and a lower IQ would show more hyperactivity symptoms whereas those with HFA or Asperger syndrome would be more inattentive. With regard to the 4th part of our study, we hypothesized that ASD children would have similar ADHD item profiles comprising the factors of hyperactivity, impulsivity, and inattention. Even though two factors describing inattention and hyperactivity-impulsivity according to *DSM-IV* classification were extracted in exploratory factor analysis of parent ratings of field samples of children with pure ADHD (Doepfner et al., 2006), we explicitly decided to use a 3-factor solution as we wanted to gain specific information about each subscale.

Methods

Child and Adolescent Psychiatric Assessments

All dependent measures are components of the Diagnostic System for Mental Disorders in Childhood and Adolescence (DISYPS-2) based on ICD-10 and *DSM-IV* components.

Diagnostic Checklist for Attention Deficit/ Hyperactivity Disorder (Diagnostik Checkliste für Aufmerksamkeitsdefizit-/Hyperaktivitätsstörung, DCL-ADHD); ADHD rating scale for teachers and for parents (Fremdbeurteilungsbogen für Aufmerksamkeitsdefizit-/Hyperaktivitätsstörung, FBB-ADHD). The DCL-ADHD and the FBB-ADHD provide the number of *DSM-IV* and ICD-10 criteria. The severity score for each item ranges from 0 to 3 (see also Herpertz et al., 2001; Konrad, Gunther, Hanisch, & Herpertz-Dahlman, 2004). It consists of 20 items describing the symptom criteria of ICD-10 and *DSM-IV*. The internal consistencies (Cronbach's alpha) for the parent rating versions are from á=.78 to á=.93. Similar rating scales have been developed in the United States, based solely on *DSM-IV* criteria for ADHD (DuPaul, Ervin, Hook, & McGoey, 1998).

Diagnostic Checklist for Pervasive Developmental Disorders (Diagnostik Checkliste fr Tiefgreifende Entwicklungsstörungen, DCL-TES); PDD-rating scale for teachers and for parents (Fremdbeurteilungsbogen für Tiefgreifende Entwicklungsstörungen, FBB-TES). The DCL-PDD and the FBB-PDD are also part of the Diagnostic System for Mental Disorders in Childhood and Adolescence (DISYPS-2). Both rating scales cover all *DSM-IV* criteria for autistic disorders. The 14 items are scored on a 4-point scale. The checklist was mainly used to exclude PDD in the ADHD children and to differentiate between HFA and Asperger syndrome within the ASD group.

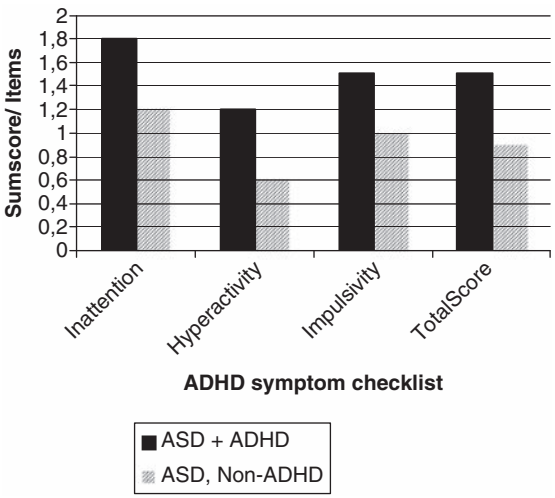
Diagnostic Checklist for Oppositional Defiant or Conduct Disorders (Diagnostik Checkliste für Störungen des Sozialverhaltens, DCL-SSV); ODD/CD rating scale for teachers and parents (Fremdbeurteilungsbogen für Störungen des Sozialverhaltens, FBB-SSV). These rating scales are also part of the Diagnostic System for Mental Disorders in Childhood and Adolescence (DISYPS-2). They contain the ODD and CD scales composed of the *DSM-IV* items. The rating scale has been proven to be reliable and valid in several psychometric studies (Doepfner et al., 2007). For the present study, only the first two parts of the checklist were used in assessing the symptoms of ODD (9 items, part A) as well as aggression toward people and animals, and deceitfulness and theft (6 items, part B).

All three checklists/questionnaires allow the assessment of a dimensional score and a categorical diagnosis. The scores for ASD+ and ASD- are illustrated separately in Figure 1.

Selection and Sample Description

From all outpatients presented at the Department for Child and Adolescent Psychiatry of the University of Cologne, we consecutively selected individuals with known ASD. Parents were asked to complete rating scales. Rating scales included ADHD, PDD, and ODD/CD rating scales for parents. In addition, ADHD symptoms within each child were observed and reported on by a child and adolescent psychiatrist during exploration of the parents and the child. The presence or absence of an ADHD diagnosis according to *DSM-IV* criteria was determined by the Diagnostic Checklist for ADHD, which is part of the Diagnostic System for Mental Disorders in Childhood and Adolescence (DISYPS-2, Doepfner et al., 2007).The checklist was used in a diagnostic interview with parents and teachers. The diagnosis of autistic disorder was clarified using the

Figure 1
Mean Subscale and Total Score of ADHD-Symptoms (FBB-ADHD, DISYPS-2) for the two Different Clinical Groups



Note: *FBB-ADHD = Fremdbeurteilungsbogen Aufmerksamkeitsdefizit-/ Hyperaktivitätsstörung, DISYPS-2 = Diagnostik System für Psychische Störungen-2*

Autism Diagnostic Interview-Revised (ADI-R, German translation: Boelte et al., 2006) and the *Autism Diagnostic Observation Scale* (ADOS, German translation: Ruehl, Boelte, Feineis-Matthews, & Poustka, 2004).

In total, 83 patients with ASD were selected. The sample comprised boys and girls with a diagnosis of either an autistic disorder (n=9; 10.8%), HFA (n=30; 36.1%) or an Asperger syndrome (n=44; 53.1%).

Of the autistic participants, 44 (53%) demonstrated a sufficient number of ADHD symptoms to warrant a comorbid diagnosis of ADHD according to the *DSM-IV*. In the following, the ASD group with ADHD is referred to as ASD+ and the group without ADHD as ASD-. Overall, 25 (30.1%) of the total sample had a comorbid diagnosis of oppositional defiant disorder (ODD), and 26 participants (31.3%) were treated with medication (methylphenidate, 50%; risperidone, 35.7%; SSRI, 7.2%; anticonvulsants, 7.2%). Parents and teachers were asked to make their ratings on an off-medication basis. Additionally, age, IQ, and gender were recorded based on the patients' charts. Table 2 summarizes the clinical and demographic features of the total sample of the ASD children divided into ADHD and non-ADHD participants.

Statistical Analysis

Chi-square tests (categorical variables) and ANOVAs (continuous variables) were used for group comparisons between the ASD+ and the ASD-.

Based on the ASD+ sample, the following analyses were conducted:

- Descriptive statistics (means and standard deviations) for the subscales inattention, hyperactivity, and impulsivity of the symptom checklists separated for gender, type of ASD diagnosis, age, and IQ were calculated. To evaluate the impact of these four variables on ADHD scores, a MANOVA was applied.
- For precise examination of the relationship between PDD and ADHD symptoms, additional Pearson product-moment correlations were applied for mean scores of impairment of social interaction/ communication, mean stereotype behavior; mean PDD total score from the PDD symptom checklist, and mean ADHD total score; mean hyperactivity score, mean inattention score as well as mean impulsivity score from the ADHD symptom checklist (DISYPS-2). Additionally, Pearson correlations were applied for mean scores of ADHD and PDD single items and vice versa.
- An explorative factor analysis (varimax rotation) with three factors, comprising the items of the ADHD symptom scale for the ASD + sample were applied.

All tests are based on a significance level of p<0.05.

Results

Comparison: ASD+ Versus ASD- Samples

The comparison of the ASD+ and the ASD- samples applying a MANOVA with group as the between-subject factor revealed significant group differences for age (F=21.73, p<.000), IQ (F=5.97, p=.01), medication (F=15.17, p<.000) and, as expected, for all scores of the ADHD symptom scale (inattention: F=19.72, p<.000; hyperactivity: F=11.36, p=.001; impulsivity: F=7.65, p=.007, total score: F=25.12, p<.000). Children in the ASD+ sample had a lower mean age and IQ and took medication more often. There were no significant differences for gender: F=0.28, p=.59; type of ASD diagnosis: F=2.65, p=.11. These results are also seen as part of Table 2. Table 3 summarizes the group comparison of the ADHD total score for gender, type of ASD diagnosis, age-groups, and IQ-groups separated for the two samples ASD+ and ASD-.

Impact of Gender, Type of ASD Diagnosis, Age, and IQ on ADHD-Symptoms in the ASD+ Sample

Neither the variable gender (F=0.02; p=.88), type of ASD diagnosis (F=1.97; p=.15), age (F=0.94; p=.54),

Table 2
Clinical and Demographic Features of the Total, the ADHD, and the Non-ADHD Sample

	Total (n = 83)	ADHD (n = 44)	Non-ADHD (n = 39)	Effect	Group	Effect
No (%)				$\Pi\div^2$	p	
Gender				0.59	0.76[a]	n.s.
– male	70 (84.4)	38 (86.4)	32 (82.1)			
– female	13 (15.6)	6 (13.4)	7 (17.9)			
ASD diagnosis						
– Autistic disorder	9 (10.8)	8 (18.2)	1 (2.6)	0.07	0.05[b]	n.s.
– High-Functioning autism	30 (36.1)	15 (34.1)	15 (38.5)			
– Asperger-Syndrome	44 (33.7)	21 (47.7)	23 (59.0)			
ADHD diagnosis	53%	100%	–			
– Combined subtype	14 (16.8)	14 (31.8)	–	–	–	–
– Predominantly Inattentive subtype	20 (24.1)	20 (45.5)				
– Hyperactive/Impulsive subtype	10 (12.1)	10 (22.7)				
Comorbid ODD yes	25 (30.1)	15 (34.1)	10 (25.6)	0.41	4.76[a]	n.s.
Mean (SD)						
Age at testing (years)	11.7 (3.3)	10.2 (2.8)	13.3 (3.1)	21.73	<.000	NA>A
Min-Max	(5.0 -17.9)	(5.0-17.9)	(7.0-17.9)			
IQ	96.1 (19.1)	91.3 (17.2)	101.3 (19.9)	5.97	.01	NA>A
Min-Max	(60-146)	(60-123)	(60-146)			

Note: n.s. = Not significant; a Fisher's exact test, b. Likelihood quotient; ADHD = attention-deficit/hyperactivity disorder; A= ADHD-sample, NA=non-ADHD sample, ODD = oppositional defiant disorder.

Table 3
Total Score of ADHD Symptoms (FBB-ADHD; DISYPS-2) Displayed for Total and for Different Sample Characteristics in the ASD+ and ASD- Group

Group	ASD+	ASD-
Total	1.5 (0.6)	0.9 (0.5)
Gender		
– male	1.5 (0.6)	0.9 (0.5)
– female	1.6 (0.5)	0.9 (0.6)
ASD diagnosis		
– Autistic disorder	1.7 (0.5)	0.7 (0.6)
– High-functioning autism	1.3 (0.5)	0.8 (0.5)
– Asperger syndrome	1.6 (0.6)	1.0 (0.6)
Comorbid Oppositional Defiant Disorder		
– yes	1.6 (0.7)	0.8 (0.5)
– no	1.5 (0.5)	1.0 (0.5)
Age-groups		
– 5-8 years	1.4 (0.5)	1.2 (0.5)
– 9-12 years	1.6 (0.4)	0.9 (0.7)
– 13-18 years	1.4 (0.9)	0.9 (0.5)

Note: FBB-ADHD = Fremdbeurteilungsbogen Aufmerksamkeitsdefizit-/Hyperaktivittsstörung , DISYPS-2 = Diagnostik System für Psychische Störungen-2.

nor IQ (F=10.86; p=.63) had an impact on the severity of ADHD total score. However, with regard to ADHD subscales, an ANOVA with post hoc Scheffé tests revealed a significant result for hyperactivity with type of ASD diagnosis (F=5.53; p=.007), with differences between the variable "autistic disorder" and "HFA" (p=.02) as well as Asperger syndrome (p=.01).

Association of PDD and ADHD Symptom Scores in the ASD + Sample

Results revealed only one significant correlation for mean hyperactivity and mean impairment of communication (r=0.4; p=.01).

The correlation of mean PDD scores and single ADHD symptoms showed significant results for "qualitative impairments in communication" and single hyperactivity items as "*often fidgets with hands or feet or squirms in seat"* (r=0.4; p=005), *"often gets up from seat when remaining in seat is expected"* (r=0.4; p=01), *"often runs about or climbs when and where it is not appropriate"* (r=0.5; p<000). Significant results were also seen for mean stereotyped behavior and inattention items such as *"often does not seem to listen when spoken to directly"* (r=0.3; p=.02) *and "often loses things needed for tasks and activities"* (r=0.3; p=.03); and for mean total score PDD and items of all three ADHD subscales.

Item Profiles of ADHD Symptoms in the ASD+ Sample

To identify potential item profiles of ADHD symptoms within the autistic children having an ADHD diagnosis,

Table 4
Factor Analysis for Items of ADHD Symptom Checklist (ASD+ Sample)

Factors with variables	1	2	3
(Eigenvalues and percentages)	6.449	2.628	2.004
	32.25 %	13.13 %	10.02 %
Factor 1 – Hyperactivity			
Fidgeting with hands or squirming in seat	0.801		
Gets up when remaining is expected	0.716		
Trouble playing quietly	0.767		
Often runs or climbs	0.780		
Often "on the go"	0.799		
Factor 2 – Impulsivity/Inattention			
Blurts out answers		0.752	
Interrupts others		0.802	
Often talks excessively		0.656	
Often loses things		0.739	
Easily distracted		0.370	
Often forgetful	0.388	0.588	
Factor 3 - Inattention			
No close attention to details			0.435
Trouble keeping attention			0.752
Does not follow instructions		0.298	0.325
Trouble organizing activities			0.596
Avoids things that take a lot of mental effort			0.806

an explorative factor analysis with three factors was performed. Within an analysis of the ADHD symptom checklist, all three extracted factors had eigenvalues greater than 2 and explained almost 55% of the variance (Factor scores>.32-.86). Factor 1 (32.25%) comprises symptoms of hyperactivity; Factor 2 (13.13%) includes symptoms of impulsivity and inattention; and Factor 3 (10.02%) symptoms of inattention.

Table 4 lists all items of the different factors extracted in the factor analyses.

Discussion

Of the autistic participants in our study, 53% demonstrated a sufficient number of ADHD symptoms to warrant a comorbid diagnosis of ADHD according to the *DSM-IV*. Of these children, 46% met the diagnostic criteria for the inattentive type of ADHD, 32% met the criteria for the combined subtype, and 22% for the hyperactive/impulsive subtype. Therefore, our results are in line with previous studies describing rates between 54% and 68% for comorbid ADHD diagnosis and between 30% and 44% for the combined type in children with ASD. However, the rate of the inattentive type is lower, whereas the rate of the hyperactive/impulsive type is higher. A reason for that might be that in our sample, the ASD + group comprises almost 25% of children younger than 8 years. Higher rates of the hyperactive/impulsive subtype in younger children were also found by Gadow et al. (2006), Lee and Ousley (2006), and Yoshida and Uchiyama (2004).

Systematic studies investigating ADHD symptoms in samples with PDD (Gadow, DeVincent, Pmoeroy, & Azizian, 2004; Goldstein & Schwebach, 2004; Yoshida & Uchiyama, 2004) did not compare sample characteristics and the severity of ADHD symptoms between children with and without ASD and a categorical ADHD diagnosis. Our results show that these two groups differ in the severity of either total and subscale ADHD scores.

Interestingly, the children in the ASD group with an ADHD diagnosis were significantly younger, with children between 5 and 7 years presenting more symptoms of hyperactivity. Whereas 30% in the ASD+ group were younger than 8 years, almost 60% in the ASD- group were older than 13 years. However, inattention symptom scores did not change with age. Lee and Ousley (2006) also found, in a large study, significantly higher scores of hyperactivity in younger children of their sample and only a slight decrease of inattention symptoms with age. The phenomenon of decreasing hyperactivity and persistence of inattention problems with growing age is furthermore consistent with the broader ADHD literature involving clinical populations (Biedermann et al., 2000) and cross-sectional assessment (DuPaul et al., 1998). To replicate these consistencies, it is necessary to incorporate

adolescents in studies assessing ADHD symptoms in ASD. Previous studies mostly included children not older than 12 years.

The comparison of the affected and non-affected subsamples also revealed that ASD participants with ADHD had lower mean IQ. Nevertheless, IQ was not statistically associated with the severity of ADHD symptoms within these children. However, in the ASD+ sample, lower-functioning ASD children, in comparison with higher-functioning ASD children, had more hyperactivity problems. These findings are in line with a study by Lee et al. (2006) but are in contrast to previous studies dealing with the same topic. Incorporating cognitive assessment is highly important as ADHD symptoms can vary inversely with IQ (Rapport et al., 1999). Furthermore, when applying the ICD-10, the differential diagnosis *"overactive disorder associated with mental retardation and stereotyped movements"* (F 84.4) for a child with moderate to severe mental retardation (IQ below 50) who exhibits major problems in hyperactivity, inattention, and stereotyped behaviors, has to be considered. As in previous studies as well as in our study, the assessed samples were very heterogeneous concerning the ASD diagnosis. Therefore, it seems very favorable to refer to the full range of IQ when interpreting ADHD-like symptoms in ASD children.

A study by Dietz et al. (2007) found indications of both stability and change of IQ scores in preschool children with ASD and a catch-up of intellectual development in at least one third of the assessed sample. Interestingly, in our study, age was not correlated with IQ in the ASD+ sample but in the ASD- sample, which could mean that ADHD symptoms are neither an effect of the higher proportion of young nor the involvement of mentally disabled children in the ASD+ group. This was additionally emphasized by the result that age and IQ had no effect in an applied MANOVA.

The occurrence of ADHD symptoms in ASD children was not associated with gender or comorbid ODD. In contrast to that, Holtmann et al. (2007) found more delinquent symptoms for girls with ASD. Furthermore, girls have been described to be more severely impaired with regard to executive functioning (Nydén, Gillberg, Hjelmquist, & Heimann, 2000).

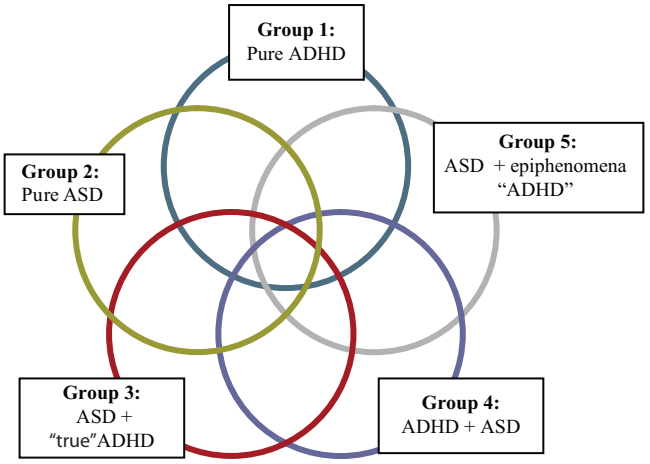
Interestingly, comorbid ODD/CD was not significantly higher in the ASD+ group compared with the ASD- group. Within this group, the severity of inattention and impulsivity was only slightly increased. However, Leyfer et al. (2006) did not report such a high number (7%) of comorbid ODD. These inconsistent findings underscore the necessity of systematically studying comorbid ODD and CD symptoms to get a broader understanding of overlapping symptoms in ODD/CD and ADHD in ASD, as previously done by Leyfer et al. (2006) either under a dimensional or a categorical aspect. However, evaluations in a larger sample would be helpful to draw any conclusion that ODD/CD is a relevant factor when comparing autistic children with and without ADHD.

The question as to whether PDD symptoms are associated with ADHD symptoms and vice versa in autistic children with a categorical ADHD diagnosis revealed that PDD is more associated with ADHD than the other way around and reflects the fact that ADHD is more common in ASD (Clark et al., 1999; Santosh et al., 2004). Items of inattention are highly associated with stereotyped behavior. This might be because autistic children displaying high degrees of stereotypes cannot be attentive to other things. Pliszka, Carlson, and Swanson (2003), for example, state that it is not adequate to give an autistic child the diagnosis *ADHD inattentive type*. Furthermore, items of hyperactivity were associated with mean scores of communication impairment. This finding is in line with results by Clark et al. (1999) who assessed autistic symptoms in children with ADHD. This underscores that hyperactive behavior seems to be predominant in children with language delay. However, hyperactive behavior is often difficult to differentiate from stereotyped movements.

The fact that within an ASD sample with comorbid ADHD symptoms the two subtypes (inattentive/stereotyped versus hyperactive/communication impaired) can be described leads to the hypothesis that these two subtypes may reflect two different neurochemical systems: (a) serotonergic + inattentive/stereotyped versus (b) dopaminergic + hyperactive/communication. Inattention and stereotypes are reported to be frequently associated with the serotonergic system (Cook et al., 1997; McDougle et al., 1997). The association of hyperactivity and the dopaminergic system was, for example, described by Gainetdinov et al. (1999). Pharmacological studies have shown that psychostimulants, elevating dopamine in the presynaptic cleft, and medications targeting the serotonergic system (i.e., serotonin-reuptake inhibitors and selective noradrenergic reuptake inhibitors; i.e., atomoxetine), are expected to afford some benefit to children with ASD (Hazell, 2007). However, response rates may be lower than those seen in children with pure ADHD, although the occurrence of adverse events seems to be higher in some children. Thus, it might be more important in ASD children to understand the type of predominant ADHD sub-symptomatology to achieve better first-line treatments.

Basically, the findings also underline that the categorical *DSM*-diagnosis of ADHD inattentive and hyperactive/impulsive type can be well described in ASD children.

Figure 2
Five-Group-Model on the Integration of the Disorders ADHD and ASD



Thus, a categorical approach in the controversy about ADHD in ASD is adequate.

The applied factor analysis clearly extracted three factors describing the subscales inattention, hyperactivity, and impulsivity. This is in line with results of factor analysis performed with the same German rating scale in an ADHD sample (Görtz et al., 2007). This underlines the phenotypical overlap between the two disorders.

Limitations

One limitation of the study is the unequal sample size with less participants with a lower-functioning autism and a higher rate of high-functioning children and adolescents. Furthermore, it should be noted that teacher ratings are not presented, which are, however, part of an ongoing study. A third problem is that more participants must be assessed to finally get reliable data of the correlations between PDD and ADHD symptoms and to be able to statistically integrate ODD and CD symptoms in the factorial analysis.

Summary

ASD and ADHD show a high phenotypical overlap. The results of our study reveal two subtypes, the *inattentive-stereotyped* and the *hyperactive-communication impaired*. These two subtypes reflect well the *DSM* classification for ADHD and may theoretically hint at two different neurochemical pathways, a dopaminergic and a serotonergic, as also described for pure ADHD. The fact that children with ASD show lower response rates to typical psychopharmacological treatments might be explained by five different groups that must be considered in the discussion about ADHD and ASD, as shown in Figure 2. This five-group-model integrates ADHD and ASD as pure disorders without any comorbid symptoms; ASD with a categorical diagnosis of ADHD; ADHD with ASD symptoms that do not reach the threshold for a categorical diagnosis; and an ASD group with symptoms as part of the autistic disorder itself, as an epiphenomena, for example, with increased stereotyped movements or behavior.

A very detailed examination of the child with ASD would help determine whether the reported ADHD-like symptoms support the notion of an ADHD behavioral syndrome or an increased rate of single behavior as stereotyped movements or excessive talking, to select appropriate treatment.

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