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Impact of ADHD symptoms on autism spectrum disorder symptom severity

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ABSTRACT

Despite the official exclusion criteria for autism spectrum disorder (ASD) and attention deficit/hyperactivity disorder (ADHD) in the DSM-IV and ICD-10, patients with ASD often show ADHD symptoms. We aimed to examine the potential influence of ADHD symptoms on autistic psychopathology in a large sample of patients with ASD. We tested the hypothesis that patients with ASD and an additional ADHD (ASD+) would show a higher severity of autistic symptoms than those with ASD only (ASD−). We measured autistic symptoms using the autism diagnostic observation schedule (ADOS-G), the autism diagnostic interview (ADI-R), and the social responsiveness scale (SRS). To measure overall psychopathology and ADHD symptoms, we used the child behavior checklist (CBCL) and the ADHD rating scale (FBB-ADHS), respectively. Group differences between the ASD+ and the ASD− group (group division was conducted according to the results of the FBB-ADHS) were calculated using a univariate analysis of variance (ANOVA). The ASD+ group showed a greater severity of autistic symptoms than the ASD− group, measured by the SRS and the ADI-R. Especially in the social interaction subscale (ADI-R), a significantly higher symptom severity was found in the ASD+ group. No significant group differences were found regarding autistic symptoms measured by the ADOS-G. Patients with ASD and an additional ADHD expressed a stronger severity of autistic symptoms than patients with ASD only. According to our results, the possibility of a co-diagnosis of ADS and ADHD, as is being planned in the DSM-5, is in line with earlier studies, is highly reasonable, will simplify research, and have therapeutic implications.

1. Introduction

Children with autism spectrum disorder (ASD) are frequently found to manifest symptoms of hyperactivity, inattention and impulsiveness, which are the cardinal symptoms of attention deficit/hyperactivity disorder (ADHD) (Frazier et al., 2001; Leyfer et al., 2006; Matson & Nebel-Schwalm, 2007; Sinzig, Bruning, Morsch, & Lehmkuhl, 2008; Smith & Matson, 2010).

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Despite the official exclusion criteria for the diagnoses ADHD and ASD in the DSM-IV and ICD-10, several studies have investigated the commonly co-occurring disorders. The rate of comorbidity of ADHD in ASD ranges from 16% to 50% (Gjevik, Eldevik, Fjaeran-Granum, & Sponheim, 2011; Hanson et al., 2012; Rommelse, Franke, Geurts, Hartman, & Buitelaar, 2010). In general, the presence of comorbidities is associated with more severe and impairing psychopathology and decreased quality of life (Banaschewski, Poustka, & Holtmann, 2011; Gadow, DeVincent, & Schneider, 2009; Holtmann, Bölte, & Poustka, 2007; Yerys et al., 2009).

Studies investigating the potential influence of ADHD symptoms on the pathology of ASD have reported heterogeneous results regarding the influence on the severity of the autistic symptoms. In any case, a number of studies highlight that children suffering from both disorders (termed in the following as ASD+) generally present a more severe psychopathology: In a study by Lutejin and colleagues (2000), children with a diagnosis of ASD+ showed similar levels of autistic psychopathology (as rated by the CSBQ) compared to children with no comorbid ADHD diagnosis (in the following: ASD−). Parents rated children with ASD− as more socially withdrawn. A population-based study found that children with ASD+ had more than five times greater odds of showing bullying behavior than the general population (Montes & Halterman, 2007). In this study, children with ASD− were as likely to bully as children in the general population. The authors further found that children with both ASD and ADHD (ASD+) were more likely to have conduct problems or anxiety or depression symptoms than ASD− children. A recent study by Jang et al. (2013) also indicated that children with ASD+ present higher rates of comorbid symptoms, with tantrum behaviors and conduct problems being exhibited more frequently in this group.

In a study by Gadow et al. (2009), a group of children who suffered from both ASD and ADHD (ASD+) exhibited more severe anxiety symptoms than children with ADHD or children with ADHD and tic disorders. A recent study described children with ASD+ who failed to improve following social skills training as opposed to children with ASD− and children with ASD and a comorbid anxiety disorder (Antshel et al., 2011). In a further study, children with ASD+ showed increased rates of externalizing behavior, aggression, delinquent behavior and thought problems compared to children with ASD− (Matsushima et al., 2008). Another recent study provided evidence that children with ASD+ show greater impairment in adaptive functioning and a poorer quality of life than children with ASD− (Sikora, Vora, Coury, & Rosenberg, 2012).

The results outlined above highlight the severity of the condition of simultaneous ASD and ADHD (ASD+) and the need to pay special attention to these children (Yoshida & Uchiyama, 2004).

Sinzig, Morsch and Lehmkuhl (2008) found that the presence of comorbid ADHD symptoms was associated with a reduced ability of facial emotion recognition, a central feature of psychopathology in ASD. Moreover, attention problems in the ASD+ group exceeded those of a group of children with ADHD only, indicating an additive negative effect of the ADHD pathology both on attention functioning and facial emotion recognition.

In a study by Holtmann et al. (2007), a group of lower functioning (mean IQ: 68.6) ASD children with a high level of attention problems was found to show a higher degree of general psychopathology and more profound impairments in social interaction, as measured by the ADI-R, than children without symptoms of ADHD. Yerys et al. (2009) also found higher autistic traits (SRS) in a group of children with ASD+ than in children with ASD−. However, the two groups did not differ regarding ADOS-G or ADI-R scores. Results of two further studies reported no worsening influence of additional ADHD symptoms on social behavior (Gomarus, Wijers, Minderaa, & Althaus, 2009; Luteijn et al., 2000).

A recent fMRI study provided evidence of shared underlying mechanisms at the large-scale network level for ASD and ADHD (Di Martino et al., 2013). It was also shown that the ASD+ group shared ADHD-specific abnormalities in basal ganglia in contrast to the ASD− group.

Overall, the question of a potential influence of ADHD symptoms on ASD remains controversial. The existing studies differ regarding their methodology and sample composition; an overview of recent studies investigating the influence of ADHD on ASD profiles is provided in Table 1.

While it seems clear that children suffering from both disorders are faced with a more severe condition and a higher degree of psychosocial problems, it remains unclear whether ADHD symptoms influence autistic psychopathology in particular. We therefore aimed to examine the potential impact of ADHD symptoms on ASD psychopathology in a large sample of ASD patients through the administration of the gold-standard instruments ADOS-G and ADI-R as well as specific questionnaires.

We hypothesized that comorbid symptoms of an ADHD (ASD+) would influence the intensity of the autistic pathology. Regarding the potential effect of development on ADHD symptoms, we hypothesized further that there would be a significant effect of age. Finally, we assumed a higher degree of clinically relevant symptoms (general psychopathology, as measured by the CBCL) in the group of children with ASD+. In order to investigate this, we compared ASD patients with a significant degree of ADHD symptoms (ASD+) to children with ASD−, corrected for age.

2. Methods

2.1. Participants

The participants were recruited at specialized diagnostic outpatient clinics for autistic disorders in three German child and adolescent psychiatry departments from 2009 to 2012. The autistic pathology was assessed by the German versions of the autism diagnostic observation schedule-Generic (ADOS-G) (Lord, Rutter, DiLavore, & Risi, 1999; Rühl, Bölte, Feineis-Matthews, & Poustka, 2004), the Autism Diagnostic Interview–Revised (ADI-R) (Bölte, Rühl, Schmötzer, & Poustka, 2006;

Table 1
Studies investigating samples with autism spectrum disorder and attention deficit/hyperactivity disorder.

Authors	Methods	Groups	Cognitive level *M* (SD)	Age *M* (SD)	Results regarding the co-morbid condition
Jang et al. (2013)	Autism spectrum disorders-comorbidity child version (ASD-CC)	ASD− (*n* = 207) ADHD (*n* = 33) ASD+ (*n* = 38)		7.77 (3.51) 9.94 (3.15) 9.74 (3.07)	*ASD-CC:* ASD+ > ASD− and ADHD
Sikora et al. (2012)	Child behavior checklist (CBCL 4–18) Vineland adaptive behavior scales (VABS-II) Pediatric quality of life inventory (PedsQl)	ASD− (*n* = 3066) ASD+ (*n* = 598)	<70 = 841 ≥70 = 1625	2–18	*PedsQl:* ASD+ < ASD− *VABS-II:* ASD+ < ASD−
Ames and White (2011)	3Di (interview parent) Theory of mind battery Inhibitory control (IC)	ASD− (*n* = 55)	VIQ 105 (19) PIQ 94 (14)	10.2	Sign. relation inhibitory control and ASD-symptoms (3Di)
Gadow et al. (2009)	Child Symptom Inventor-4 (CSI-4)	ASD+ (*n* = 88) ADHD (*n* = 66) ADHD + Tic (*n* = 66)	96.9 (17.0) 105.8 (13.4) 102.5 (12.8)	8.5 (1.9) 8.0 (1.4) 8.6 (1.8)	*CSI-4 subscales specific phobia* ± *social phobia:* ASD+ > ADHD
Gomarus et al. (2009)	CBCL 4–18 Children's social behavior questionnaire (CSBQ)	PDD− (*n* = 15) PDD+ (*n* = 15)	108.6 (17.5) 101.9 (14.0)	10.25(1.11) 10.13(1.33)	*CBCL & CSBQ*: PDD− = PDD+
Yerys et al. (2009)	Social responsiveness scale (SRS) Autism diagnostic interview (ADI-R) Autism diagnostic observation schedule (ADOS) VABS-II Behavior assessment system for children (BASC)	ASD− (*n* = 28) ASD+ (*n* = 21) TYP (*n* = 21)	116.24 (11.53) 111.24 (13.56) 117.39 (18.68)	10.3 (1.76) 9.65 (1.62) 9.70 (2.12)	*SRS*: ASD+ > ASD− *ADI-R & ADOS-G*: ASD+ = ASD− *VABS*: ASD+ > ASD *BASC externalizing problems*: ASD+ > ASD−
Sinzig et al. (2008b)Sinzig, Morsch et al. (2008)	Frankfurt test and training of social affect (FEFA)	ASD− (*n* = 19) ASD+ (*n* = 21) ADHD (*n* = 30)	111 (19.1) 102 (13.1) 100 (14.9)	13.6 (3.4) 11.6 (3.7) 12.7 (3.1)	*FEFA:* ASD+ > ASD−
Holtmann et al. (2007)	CBCL 4–18 ADI-R ADOS	PDD− (*n* = 93) PDD + (*n* = 89)	83.7 (29.2) 68.6 (29.0)	10.4 (4.7) 10.7 (4.7)	*CBCL:* PDD+ > PDD− *ADI-R social interaction*: PDD+ > PDD−
Luteijn et al. (2000)	CBCL Autism behavior checklist (ABC) CSBQ	PDD− (*n* = 190) PDD+ (*n* = 98) HFA (*n* = 64) ADHD (*n* = 152)	N/A	8.3 (2.2) 8.8 (2.6) 8.2 (2.3) 8.3 (2.1)	*CBCL total score*: PDD+ > ADHD *CBCL social problems*: PDD+ = PDD− *CBCL withdrawn*: PDD− > PDD+; ADHD *CBCL attention problems*: PDD+ > ADHD *ABC total score*: PDD+ = PDD− *ABC relating scale*: PDD+ = PDD− *ABC social and self help scale*: PDD+ = PDD− *CSBQ total score*: PDD+ = PDD− = HFA *CSBQ social interaction scale*: PDD+ = HFA; PDD− *CSBQ communication scale*: PDD+ = PDD− and >HFA and <ADHD

ADHD, attention deficit/hyperactivity disorder; ASD−, autism spectrum disorder without ADHD; ASD+, ASD+ ADHD; PDD−, Pervasive developmental disorder not otherwise specified without ADHD; PDD+, PDD+ ADHD; TYP, typically developing children; HFA, high functioning autism.

Table 2
Sample characteristics.

	Total	ASD−	ASD+
N	126	70	56
Diagnoses	32 HFA	14 HFA	18 HFA
	17 AA	10 AA	7 AA
	77 AS	46 AS	31 AS
Sex (m/f)	117/9	67/3	50/6
Age (M, SD)	13.9 (4.7)	15.1 (4.7)	12.68 (4.3)
IQ (M, SD)	98.5 (15.8)	99.33 (16.1)	97.55 (15.6)

Annotations: HFA, high functioning autism; AA, atypical autism; AS, asperger syndrome.

Lord, Rutter, & Le Couteur, 1994) and the German-language version of the social responsiveness scale (SRS) (Bölte, Poustka, & Constantino, 2008; Constantino et al., 2003). The parent rating scale for attention deficit hyperactivity disorders from the diagnostic system for mental disorders in childhood and adolescence (DISYPS-II) (Görtz-Dorten & Döpfner, 2009) was administered in order to assess symptoms of ADHD. To assess the level of cognitive functioning, one of the following standardized intelligence tests was used: culture fair test (Catell, Weiss, & Osterland, 1997), Kaufman assessment battery for children (Kaufman, Kaufman, Melchers, & Preuss, 2003), Snijders-oomen nonverbal intelligence test (SON-R, Tellegen & Laros, 2005), Hamburg Wechsler Intelligenztest für Kinder (Petermann & Petermann, 2007). The diagnoses were made by well-versed child and adolescent psychiatrists and psychologists strictly according to ICD-10 criteria. Patients with the diagnoses high-functioning autism (HFA), atypical autism (AA) or asperger's syndrome (AS) were included. The administration of the ADOS-G and the ADI-R was undertaken by experienced psychologists who had undergone intensive training in the administration of these procedures. All participants and their parents or authorized representatives gave their written consent for participation in the study. The study was approved by the ethics committee in charge and is in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

Table 2 summarizes the sample characteristics for the total group and for the two subgroups ASD− vs. ASD+.

2.2. Measures

ADOS-G and ADI-R.

The autism diagnostic observation schedule-generic (ADOS-G) and the autism diagnostic interview-revised (ADI-R) are diagnostic instruments that strictly operationalize the diagnostic criteria for ASDs according to the DSM-IV and ICD-10 (Bölte & Poustka, 2004). While the ADOS-G addresses the current psychopathology by the elicitation of a number of social stimuli, the ADI-R consists of an interview with the parents or principal caregivers and covers the lifetime perspective and especially the early childhood (Le Couteur et al., 1989). The items in both instruments are divided into (a) qualitative impairment in social interactions, (b) qualitative impairment in communication, and (c) restricted, repetitive and stereotypic patterns of behaviors, interests and activities.

SRS (Social responsiveness scale).

The SRS is a 65-item questionnaire measuring autistic traits. Five domains are assessed: social awareness, social information processing, capacity for reciprocal social communication, social anxiety/avoidance, and autistic preoccupations and mannerisms. Each item is scored on a Likert scale ranging from 1 (not true) to 4 (almost always true). Moderate associations have been found between the SRS and the ADI-R, with correlation coefficients > 0.52 across all subscales (Constantino et al., 2003).

FBB-ADHS.

The ADHD rating scale (FBB-ADHS; Erhart, Döpfner, Ravens-Sieberer, & Bella study group, 2008) consists of 20 items asking about the accuracy of the description of certain behaviors (0 'does not fit at all' to 4 = 'fits extremely well'), covering attention problems (items 1–9), hyperactivity (items 10–16), and impulsivity (items 17–20). In addition to the dimensional evaluation, cut-off scores are available for diagnostic purposes.

CBCL.

The "Child Behavior Checklist" (Achenbach, 1991) contains 120 items relating to behavior and emotions of children and adolescents. The items are rated from 'not true' (0), through 'somewhat or sometimes true' (1), to 'very often true' (2). A total score is calculated, as well the following eight subscale scores: 'withdrawn', 'somatic complaints', 'anxious-depressed', 'social problems', 'thought problems' (internalizing behavior scale), 'attention problems', 'delinquent behavior' and 'aggressive behavior' (externalizing behavior scale). The German version of the checklist shows good reliability and validity (Döpfner, Schmeck, Berner, Lehmkuhl, & Poustka, 1994; Schmeck et al., 2001).

2.3. Data analysis

Statistical analysis was performed using SPSS version 20.0 for Windows. We compared group differences using a univariate analysis of variance (ANOVA) corrected for age, using age as a metric covariate. We corrected for age since we expected significant effects of age on the autistic and ADHD symptoms.

Table 3
Results of the psychometric instruments.

	ASD+ ($N = 56$)	**ASD**− ($N = 70$)
ADOS	17.6 (6.2)	19.2 (6.6)
ADI-R	38.5 (10.9)	33.0 (11.0)
SRS	86.0 (10.2)	83.1 (9.9)
CBCL externalizing	62.2 (10.0)	58.5 (7.6)
CBCL internalizing	67.4 (9.2)	68.7 (7.6)

Annotations: ADOS, autism diagnostic observation schedule; ADI-R, autism diagnostic interview-revised; SRS, social responsiveness scale; CBCL, child behavior checklist.

Table 4
Results of the analysis of variance for the variable "age".

	Dependent variable	F (df = 1)	Significance level
Age	ADI-R	0.856	0.357
	SRS	0.171	0.680
	ADOS	4.035	0.047
	CBCL internalizing	0.325	0.570
	CBCL externalizing	3.420	0.068

3. Results

The results for the whole sample can be found in Table 3.

There was a significant effect of age concerning the results of the ADOS-G ($F(1) = 4.74$, $p = .03$) and the externalizing behavior scale of the CBCL ($F(1) = 4.6$, $p = .03$). Older participants were found to be significantly more strongly impaired than younger participants in terms of autistic symptoms measured by the ADOS-G. In the Externalizing Behavior Scale of the CBCL, the younger children in the ASD+ group were more strongly affected. For the other instruments, age did not have a significant effect (Table 4).

Significant differences between the two groups ASD− and ASD+ were found regarding the SRS ($F(1) = 5.25$, $p = .02$) and the ADI-R ($F(1) = 4.85$, $p = .03$). In both cases, the group with an additional ADHD showed a stronger impairment compared to the ASD− group. The ADOS-G revealed no significant difference between the groups ($F(1) = 0.55$, $p = .46$). Regarding the CBCL, neither the scale for internalized behavior nor the scale for externalized behavior showed a significant difference between the two groups (Figs. 1 and 2 and Table 5).

For ADI-R and SRS, we took an exploratory look at the subscales in order to examine whether one of the subscales had a greater impact on the significant result than the others. No such impact was found for the SRS. For the ADI-R, the scale "qualitative impairment in social interactions" did have an impact; a significant group difference as calculated by an ANOVA ($F(1) = 4.96$, $p = .03$) was found for this scale.

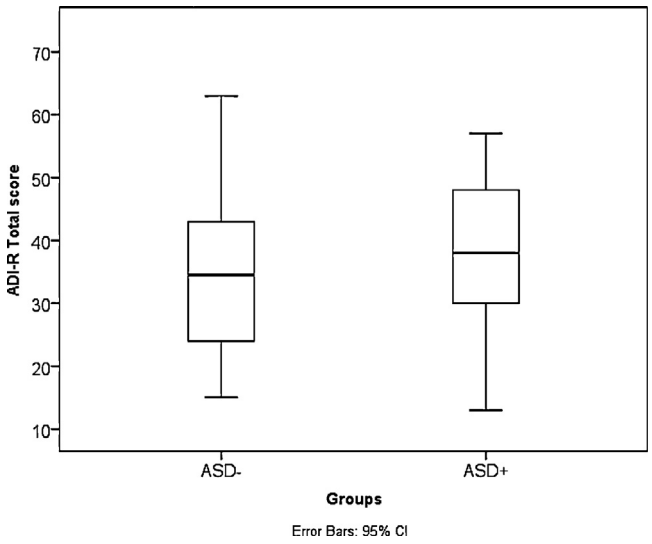

Fig. 1. Mean and standard deviation of the autism diagnostic interview (ADI-R) total score, according to diagnostic group.

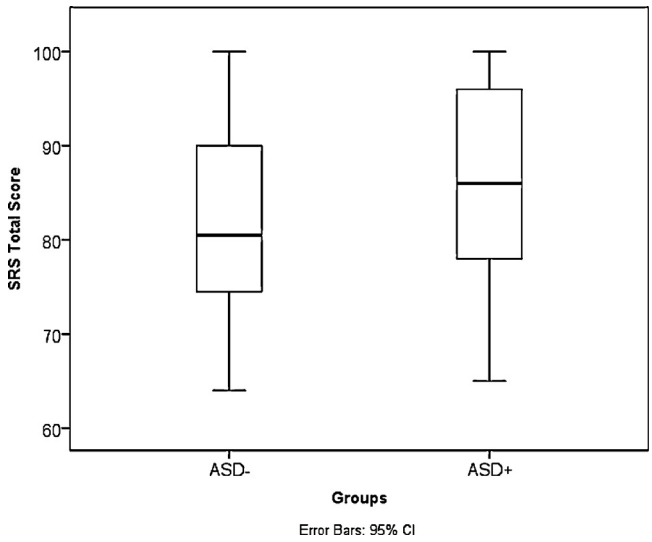

Fig. 2. Mean and standard deviation of the social responsiveness scale (SRS) total score according to diagnostic group.

Table 5
Results of the analysis of variance (ANOVA) for the variable "group differences".

	Dependent variable	*F* (df = 1)	Significance level
ASD+ vs. ASD−	ADI-R	4.851	0.030
	SRS	5.251	0.024
	ADOS	0.553	0.459
	T value CBCL internalizing	0.868	0.354
	T value CBCL externalizing	2.707	0.103

4. Discussion

In the present study, we aimed to investigate the potential influence of ADHD symptoms on ASD psychopathology. We divided our sample into two groups: those with ASD without clinically relevant ADHD symptoms (ASD−) and those with ASD plus clinically relevant symptoms of ADHD (ASD+).

In line with our hypothesis that ASD+ participants would exhibit more autistic symptoms than ASD− participants, the two groups showed a significant difference in two measures of autistic symptoms: Both in the ADI-R and the SRS, the group with ASD+ presented with significantly more autistic symptoms than the group with ASD−. These results are in accordance with Yerys et al. (2009), who also found children and adolescents with ASD+ to exhibit a higher severity of autistic symptoms as measured with the SRS. However, we did not find a significant difference between the two groups concerning the ADOS-G results. A reason for this finding could lie in the differing time points to which the psychometric instruments employed in our study refer. While the ADI-R is a retrospective interview asking parents predominantly about their children's behavior at the age of 4–5 years, the ADOS-G, by contrast, is a rating of autistic symptoms at the child's current age. In turn, the SRS is an instrument measuring the intensity of autistic symptoms, and might therefore be more sensitive to differences in the severity of autistic symptoms. A further reason might lie in a possible interviewer bias in conducting the ADOS-G, e.g. the examiner may rate symptoms as less high because he/she explains them through the comorbid ADHD symptoms and therefore discounts symptom severity.

To explore whether particular subscales of the ADI-R and SRS are responsible for the perceived group differences between ASD+ and ASD− patients, we examined the subscales by using a univariate ANOVA. Regarding the SRS, no subscale had a special relevant impact on the findings; on the contrary, all subscales seemed to have a fairly equal impact. On the other hand, the results of the ADI-R are mainly attributable to the subscale "Social Interaction". This result is in line with the findings of Holtmann et al. (2007), who showed that children and adolescents in the ASD+ group exhibited more problems in the domain of social interaction. It is quite reasonable to assume that participants suffering from additional ADHD symptoms are especially impaired in this domain, since this area is strongly affected in patients with ADHD (Kochhar et al., 2011).

We found a significant effect of age in the ADOS-G and the externalizing subscale of the CBCL, with older patients showing significantly higher autistic symptoms than younger participants. Younger children in the ASD+ group, on the other hand, showed more externalizing behavior than older children, as measured by the CBCL. We did not find a significant effect for the other psychometric instruments.

While Luteijn et al. (2000) as well as Holtmann et al. (2007) found children with ASD to be significantly more impaired on the CBCL total score and the social problems and attention problems subscales, we found no such difference. This is surprising, especially given that group division was performed depending on ADHD symptoms and even the subscale "externalizing behavior", which includes a scale measuring ADHD symptoms, did not show a significant difference. Only a trend for a slight difference was found, insofar as ASD+ patients seemed to be more impaired on this scale and less affected on the "internalizing behavior" scale.

A strength of our study is that we examined a large sample of participants with high-functioning ASD diagnosed by gold-standard instruments and trained professionals. The sample also comprised a wide age range, resulting in good external validity. The internal validity of our study was enhanced as we controlled for age. Limitations of the study are that both the FBB-ADHS and the SRS are based on parental rating and therefore prone to bias. Moreover, the different designs of psychometric instruments might influence the results and hamper comparison: The ADI-R and ADOS-G are not ideal for measuring the intensity of autistic symptoms (Gotham, Pickles, & Lord, 2009; Hus & Lord, 2013), but are rather more suitable for assessing the absence versus presence of the diagnosis, while the SRS, on the other hand, is a measure for severity of autistic symptoms (Hus, Bishop, Gotham, Huerta, & Lord, 2013). The ADI-R and ADOS-G consider different times of interest, with the ADI-R predominantly referring to age 4–5 years, and the ADOS-G referring to the child's current age. The finding that older participants were more strongly impaired than younger ones could be an artifact due to the different ADOS-G modules: For example, ratings in module 4 contain some fairly difficult items such "emotional gestures" and "personal responsibility", which may be problematic for many adolescents, and not only those with impairments.

5. Conclusion

In the current study, patients with ASD and additional ADHD symptoms showed more strongly expressed autistic symptoms than participants with ASD and no additional ADHD symptoms. Interestingly, the former group of patients did not show a concerning higher level of comorbid psychopathology as measured by the CBCL.

This suggests that there is a psychopathological difference between ASD patients with and without additional ADHD symptoms, which may be rooted in neurobiological underpinnings (Di Martino et al., 2013). Therefore, it is reasonable to reconsider the exclusion criteria of ASD and ADHD in diagnostic classification systems. This has already occurred in the DSM-5, while relevant plans are still underway for the ICD-11.

The option to diagnose comorbid ADHD and ASD will facilitate new research approaches and will also have therapeutic implications (Holtmann et al., 2007).

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