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ORIGINAL PAPER

Validation of DSM-IV Model of Psychiatric Syndromes in Children with Autism Spectrum Disorders

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Abstract The objective of this study was to assess the internal construct validity of the DSM-IV as a conceptual model for characterizing behavioral syndromes in children with ASD. Parent and teachers completed the Child Symptom Inventory-4, a DSM-IV-referenced rating scale, for 6-to-12 year old clinic referrals with an ASD ($N = 498$). Ratings were submitted to confirmatory factor analysis and models were assessed for fit. Results were also compared to those obtained for a sample of non-ASD psychiatric outpatient school-age children. Fit indices ranged from acceptable to good for the ASD samples and compared well to those obtained in typically developing children. Findings lend support to the notion that DSM-IV syndromes may be an appropriate conceptual model for characterizing psychopathology in ASD.

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Psychopathology (i.e., behavioral/emotional problems on the one hand and psychiatric disorders on the other) in youngsters with autism spectrum disorders (ASDs) has received increased attention in recent years. Research has shown that youngsters with ASDs present with high rates of behavior and emotional problems, including tantrums, mood swings, aggression, and self-injury (Lecavalier 2006; Tonge and Einfeld 2003). Psychiatric disorders also appear to be prevalent; the most commonly reported are disruptive, mood, and anxiety disorders (e.g., DeBruin et al. 2007; Gadow et al. 2005; Leyfer et al. 2006). The impact of psychopathology is significant. Behavior problems have been associated with significant caregiver stress (Lecavalier et al. 2006) and nearly half of youngsters with ASD are administered psychotropic medicines to stabilize their behavior (e.g., Witwer and Lecavalier 2005).

Despite the recent increased interest in psychopathology, its nosology in ASDs remains largely unstudied (Lecavalier and Gadow 2008). It is unclear if behaviors and symptoms of individuals with ASDs are features of psychiatric disorders as defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; APA 2000) or separate clusters of behavior that appear similar but are really part of the ASD diathesis (i.e., a phenocopy of psychiatric disorders). With regard to the latter, it is also possible that the psychobiogenic variables associated with ASD and conventional psychiatric disorders interact to produce unique behavioral syndromes peculiar to ASD. Equally important is the relation between theories of psychogenesis and the development of effective strategies for

intervention and prevention, all of which are linked to the characterization of clinical phenotypes.

There is a growing body of evidence suggesting that psychiatric syndromes in ASD are phenotypically similar to conventional DSM-IV-defined psychiatric syndromes (e.g., DeBruin et al. 2007; Gadow in press; Gadow et al. 2005; Gadow et al. 2004; Gadow et al. 2006; Leyfer et al. 2006; Sverd 2003). However, there continues to be a disparity between current nosology and clinical realities that hampers research in assessment, etiology, and treatment. Attention-deficit hyperactivity disorder (ADHD) illustrates this point well. ADHD symptoms clearly differentially impact a subset of children with ASDs, yet the DSM-IV-TR instructs that the syndrome is not to be diagnosed in those with ASDs, presumably because it is considered a phenocopy. Despite this, clinicians often diagnose ADHD in individuals with ASDs, and its behavioral symptoms have been the subject of several pharmacological trials (e.g., Posey et al. 2007).

A valid nosology is necessary to a greater understanding of psychopathogenesis in children with an ASD. Robins and Guze (1970) and Cantwell (1996) described a process for validating syndromes that begins with a reliable description of the hallmark and associated features. After the clinical picture is elucidated, differences in internal (e.g., brain structure and function, genetics) and external (e.g., treatment sought, adaptive functioning) factors, developmental trajectory, family history, and outcome can provide further support for the validity of the classification system.

In addition to the established nosologies such as the DSM-IV, several empirical approaches may be used alone or in concert to delineate meaningful syndromes for individuals with developmental disabilities. For example, Einfeld and Aman (1995) proposed the following: multivariate statistical procedures, family history approach, pharmacological probes, markers associated with specific disorders, and the use of neuroimaging techniques to test for structural correlates of disordered behavior. None of these techniques will be fully satisfactory when used alone.

Although prior research supports internal construct validity of the DSM in non-ASD samples (see Gadow and Sprafkin 2007), we are unaware of studies that have examined this in youngsters with ASD. Most studies consist of small samples and many used modified diagnostic criteria (see Sverd 2003; Lecavalier and Gadow 2008). Recent advances in multivariate statistics and access to large clinical samples represent a unique opportunity to contribute meaningfully to the nosology of psychiatric disorders in this clinical population. One such technique is confirmatory factor analysis (CFA), which is a statistical test of empirical relationships between items (symptoms) and latent factors (syndromes). In other words, CFA quantifies the extent to which the symptoms of DSM-IV-defined syndromes statistically coalesce. In contrast to exploratory factor analysis, the number of factors and the factor loading structure are specified in advance in the CFA framework. CFA also provides readily available fit statistics, which help gauge the extent to which the proposed model accounts for the observed data.

In this study, children with a diagnosed ASD were rated by parents and teachers using the Child Symptom Inventory-4 (CSI-4; Gadow and Sprafkin 2002), a DSM-IV-referenced rating scale, and obtained item scores for the most prevalent disorders were subjected to CFA. Based on previous studies, we expected to find evidence of symptom differentiation consistent with non-ASD samples. In addition, results were contrasted to those obtained in a non-ASD psychiatric outpatient sample with similar demographic characteristics. Similarities in models would further support the construct validity of the DSM in the ASD population. Because the models are not nested, there is no statistical test to determine if one model is "better" than the other. Rather, the objective of these additional analyses is to place findings in a context. Lastly, given well-documented differences in parent and teacher ratings of symptom severity and preliminary evidence supporting source-specific syndromes in non-ASD (e.g., Offord et al. 1996) and ASD (e.g., Gadow et al. 2004) samples, parent- and teacher-completed ratings were considered separately.

Method

Participants

The medical charts of consecutive child referrals of two university-hospital specialty clinics (developmental disabilities and child psychiatry outpatient) located on Long Island, New York, were reviewed. As part of their routine clinic evaluation, parents and teachers of all children in both clinics completed the CSI-4 for 6–12 year olds. The socio-demographic characteristics of both samples are presented in Table 1. This study was approved by the universities' Institutional Review Boards.

ASD Sample

The ASD sample consisted of 498 children aged 6 through 12 years (mean = 8.4; SD = 1.9) and was predominantly male (84%) and characterized by parents as Caucasian (92%). The number rated by parent and teachers was 463 and 430, respectively (thus, 68 children were rated by parents only and 35 children were rated by teachers only). There was no significant difference between children rated by one or two raters on any of the demographics variables listed in Table 1. All children in the ASD sample met

Table 1 Group characteristics

Variable	ASD ($n = 498$)	Non-ASD ($n = 191$)
Age (M/SD)	8.4 (1.9)	8.7 (2.0)
Gender (males) *n* (%)	$n = 418$ (84)	$n = 136$ (71)
IQ n (% above 70)	$n = 400$ (73)	$n = 82$ (98)
Ethnic status *n* (%)	$n = 492$	n = 185
Caucasian	451 (92)	159 (86)
African-American	12 (2)	17 (9)
Hispanic-American	14 (3)	6 (3)
Other	15 (3)	3 (2)
Special education *n* (%)	424 (85)	63 (33)
Current medication *n* (%)	185 (38)	27 (14)
SES *N* (%)	($n = 484$)	($n = 166$)
Level 1	16 (3)	18 (11)
Level 2	53 (11)	31 (19)
Level 3	108 (22)	41 (25)
Level 4	210 (43)	59 (36)
Level 5	97 (20)	17 (10)
Single parent *n* (%)	70 (14)	42 (24)
ASD subtype		
Autistic disorder	163 (33)	N/A
Asperger's disorder	124 (25)	N/A
PDD-NOS	211 (42)	N/A

Note: SES = socioeconomic status assessed with Hollingshead's (1975) index of occupational and educational social status, which includes five levels ranging from unskilled laborers (1) to major business and professionals (5)

DSM-IV criteria for autistic disorder (33%), Asperger's disorder (25%), or pervasive developmental disorder not otherwise specified (PDD-NOS) (42%). This distribution of ASD subtypes is fairly consistent with recent epidemiological findings (Fombonne 2005). The process for making these diagnoses is outlined below. Because the goal was to examine the validity of DSM-IV model of psychiatric syndromes in elementary school-aged children with ASD, we wanted not only a representative sample of clinic-referred children but one that also included the full range of relevant symptom severity.

Non-ASD Sample

The non-ASD outpatient sample consisted of 191 children aged 6 through 12 years (mean = 8.7; SD = 2.0), most of whom were male (71%) and characterized by their parents as Caucasian (86%). Ratings were obtained from both parents ($N = 185$) and teachers ($N = 172$).The most common Axis I clinical diagnoses in the non-ASD clinic sample were as follows: ADHD, any type (86%); mood disorder, any type (46%); oppositional defiant disorder (33%), and anxiety disorder, any type (30%). Communication disorders were present in 18%; however, no children were diagnosed with only a communication disorder. None of the children were diagnosed with ASD or early onset psychosis.

Procedure

Prior to scheduling their initial clinic evaluation, the parents of potential patients in both clinics were mailed a packet of materials including behavior rating scales for both parent and teacher, background information questionnaire, and permission for release of school reports, psycho-educational and special education evaluation records. Parents were required to complete and return their forms as well as distribute school materials prior to the first appointment. In most cases (92%), ratings were completed by the child's mother. Intake evaluations included interviews with the children and their caregivers; informal observation of parent-child interaction; and review of the aforementioned measures. The available documentation provided clinicians with information about specific DSM-IV symptoms of psychiatric disorders, academic and social impairment, age of onset and duration of symptoms, and exclusionary criteria.

ASD diagnoses were made by an expert clinician, who has more than 20 years of clinical and research experience with ASD, either directly or by a clinician under his supervision. These diagnoses were based on the aforementioned diagnostic procedures which included parent interviews and observation of the child, comprehensive developmental history social development, language, and repetitive behaviors, review of standardized parent- and teacher-completed rating scales that included ASD symptoms, and prior evaluations by educators and clinicians.

The interrater reliability of the expert diagnostician was reported in a related study that compared these diagnoses to those of an independent clinician for 45 randomly selected cases whose charts were "edited" to exclude mention of the initial diagnoses or rating scale findings (Sprafkin et al. 2002). The two sets of ASD diagnoses were compared, and agreement was excellent ($k = .90$), which is consistent with the findings for the DSM-IV Autism Field Trial (Klin et al. 2000). The most recently evaluated ASD children (38% of the total sample) were administered the *Autism Diagnostic Observation Schedule* (ADOS; Lord et al. 2000), as part of their clinical evaluation. Importantly, t-tests indicated that the ADOS- and expert-diagnosed groups did not differ in terms of (a) the severity of any of the CSI-4 DSM-IV psychiatric symptoms we investigated, (b) socio-demographic characteristics, or (c) the severity of the 12 DSM-IV ASD symptoms as measured by the CSI-4. The one exception was "*unable to pretend or make believe*" (Ms = .94 vs .55; $t = 23.3$, $p = <.001$), but the effect size was small ($d = .38$).

Measure

Child Symptom Inventory-4 (CSI-4)

The CSI-4 is a behavior rating scale based on the classification and symptoms of the DSM-IV-TR (APA 2000). The parent version contains 97 questions grouped into 10 categories, and the teacher version contains 87 items grouped into 9 categories. Items are evaluated on a four-point Likert scale ranging from 0 (Never) to 3 (very often) and can be scored in two different ways: symptom count (number of items rated 2 or 3) and symptom severity (weighted total score). Numerous studies indicate that the CSI-4 demonstrates satisfactory reliability and validity in community-based normative, clinic-referred non-ASD, and ASD samples (reviewed in Gadow and Sprafkin 2007). Items from the most common disorders in children with ASD were included in the analyses: ADHD, oppositional defiant disorder (ODD), conduct disorder (CD), generalized anxiety disorder (GAD), and major depressive episode (Depression).

Statistical Analyses

All CFA estimates were obtained using the LISREL software (Jöreskog and Sörbom 2004). The analyses were conducted separately for parent and teacher ratings, and for the ASD and non-ASD sample, using diagonally weighted least squares (DWLS) and polychoric correlations. DWLS was selected because it is can generate accurate estimates of the model parameters for categorical data, given a stable weight matrix, and has reduced sample size requirements compared to other estimation methods currently available (Wirth and Edwards 2007). In cases where variables (i.e., items) did not have sufficient variability to obtain stable estimates (i.e., very low endorsements), rating categories were collapsed. If a dichotomized version of the item did not provide enough information to obtain a stable estimate, it was removed from the analysis.

Figure 1 shows a simplified path diagram representing the model we tested to explain the observed data. The model consists of seven factors that are hypothesized to underline the observed responses. Factors four through seven (which represent ODD, CD, GAD, and Depression, respectively) have what is typically described as an independent clustering structure, where each item is related to one and only one factor. Factors one through three represent a different sort of structure called a bi-factor structure and consists of "general" and "specific" factors (see Gibbons and Hedeker 1992). As depicted in Figure 1, factors one and two are specific factors (inattentiveness and hyperactivity) and factor three is the general ADHD factor. These two specific factors account for variability in responses which is unique from that

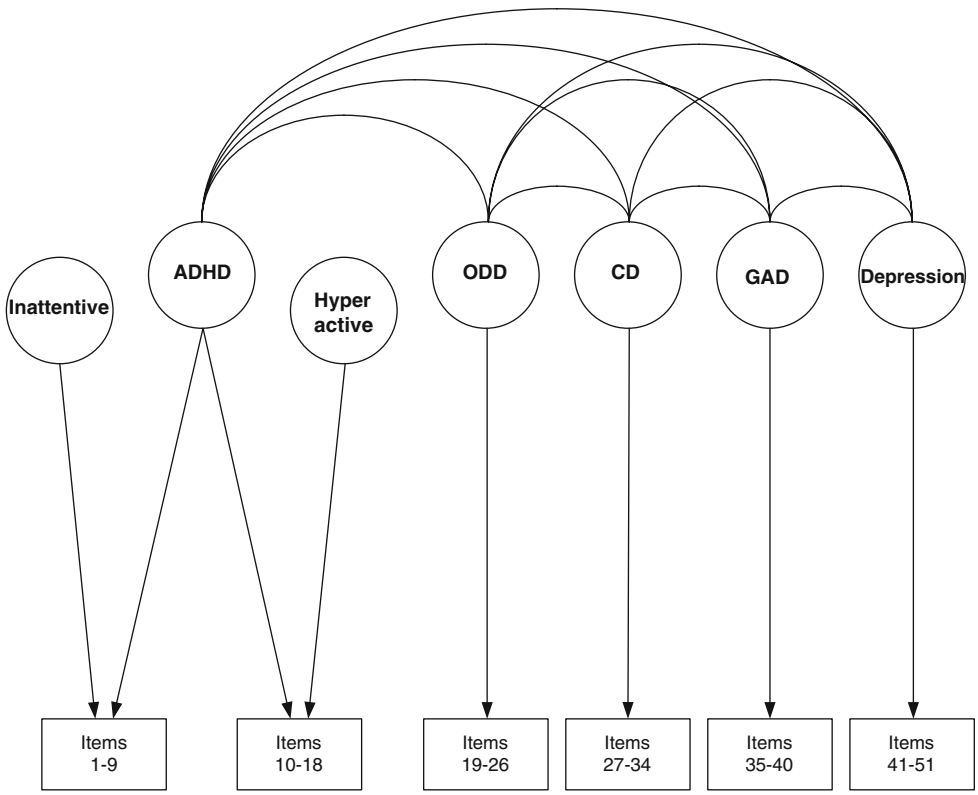

Fig. 1 Simplified path diagram for parent ratings of the child symptom inventory-4

accounted for by an individual's level on the ADHD latent variable.

Although this is not the standard model used with the CSI-4, one study in typically developing children suggested that five factors are not sufficient to adequately explain the data (Hartman et al. 2001). As such, we considered other possible models which would provide a better fit to the observed data. The model considered here includes two additional factors beyond the standard five factor model. These additional factors help to account for excess covariance among two distinct clusters within the ADHD items. In essence, the ADHD factor alone does not predict that the questions within each of these two clusters would be as strongly related to one another as they are. Other equivalent models could have been used in this situation. For example, the ADHD factor could have been conceived as a second-order factor that loaded on the two lower order factors (inattentiveness and hyperactivity in the present case). In order for this model to be identified, additional constraints would be required that we did not wish to impose. Although there are some subtle differences, the ADHD factor in this model will have a similar meaning to ADHD factors found in other approaches.

In terms of measures of fit, we report the root mean square error of approximation (RMSEA), root mean square residual (RMSR), comparative fit index (CFI), and goodness of fit index (GFI) (see Kline 2005). The RMSEA estimates the amount of error of approximation per degree of freedom in the model and takes sample size into account. Values below .08 are considered acceptable and values below .05 are considered good (Browne and Cudeck 1993). The CFI assesses the relative improvement of the specified model over a model where all parameters are assumed to be zero; values above .90 indicate acceptable fits. The GFI estimates the proportion of variability in the sample covariance matrix explained by the model; values above .90 indicate acceptable fits. Finally, the RMSR represents the average deviation between the observed model and implied correlation matrix. In continuous data, values less than 0.1 are generally considered acceptable. With categorical data, there is some evidence that the RMSR may not be a valid index of fit (Yu 2002). However, this is a commonly used statistic and we present it with the caveat that it must be interpreted more cautiously than the other fit indices.

Finally, we examined the association between CSI factor scores and gender, age, and IQ. Full Scale IQs were transformed into categorical scores for these analyses (1 = <24, 2 = 25–39, 3 = 40–54, 4 = 55–70, 5 = 71–85, 6 = 86–100, 7 = 101–115, 8 = >115). Such a transformation to ordinal variables increases reliability.

Results

Child and Family Characteristics

Comparisons between samples indicated some significant differences in socio-demographic characteristics (Table 1). Socioeconomic status (SES) was higher in the ASD sample (Ms = 3.7 vs. 3.2; $t = 5.26$, $p < .001$). There were more non-white families ($\chi^2 = 4.93$, $p = .03$) and single-parent households ($\chi^2 = 8.38$, $p < .001$) in the non-ASD clinic sample. The ASD sample had a larger percentage of males ($\chi^2 = 14.2$, $p < .001$), more children receiving special education services ($\chi^2 = 180.2$, $p < .001$), and a higher rate of psychotropic drug therapy ($\chi^2 = 36.8$, $p < .001$). IQ testing results (Full Scale IQ on Wechsler and Stanford-Binet scales only) indicated that the non-ASD children obtained higher scores than the ASD children ($n = 72$, $M = 98.8 \pm 15.6$ vs. $n = 346$, $M = 90.1 \pm 23.6$; $t = 3.90$, $p < .001$). IQs were not available for all the children for a number of reasons, including schools not sending the information to the clinics or because of challenging behaviors (i.e., the child was not testable).

CFA Findings

Results are presented for parents and teachers separately. Overall, both parent and teacher data yielded acceptable fits. Parent ratings led to better fits than those based on teacher ratings. Indices of fit for both models improved when the ADHD factor was broken up into its constituent subtypes.

Parent Ratings

The top panel of Table 2 presents factor loadings for the parent ratings of ASD youngsters, while the lower panel presents the inter-factor correlations for the general factors. In general, factor loadings were quite high. The average factor loadings were as follows: ADHD-Inattentive, .53; ADHD-Hyperactivity, .30; ADHD, .57; ODD, .82; CD, .76; GAD, .72; and Depression, .71. The CFA for the parent ratings of children with ASD was the best fitting of the four models presented here (RMSEA = 0.051, CFI = 0.98, GFI = 0.958, and RMSR = 0.096). Indices of fit were quite similar (RMSEA = .043; CFI = .985; GFI = .958; RMSR = .098) when the model was submitted to CFA in the subsample of ASD children with SIQ above 70 ($n = 266$). The same model also provided good fit for the parent reports of non-ASD children (RMSEA = 0.052, CFI = 0.978, GFI = 0.954, and RMSR = 0.111). As depicted in Table 2, inter-factor correlations averaged .59 and ranged in magnitude from 0.40

Table 2 Factor loadings and inter-factor correlations for the child symptom inventory-4: parent ratings for children with ASD ($N = 463$)

CSI-4 items[a]	Factor loadings[b]						
	F1	F2	F3	F4	F5	F6[c]	F7
1. Careless mistakes	.54		.51				
2. Difficulty paying attention	.65		.49				
3. Doesn't seem to listen	.27		.51				
4. Difficulty following through	.62		.55				
5. Difficulty organizing tasks	.67		.50				
6. Avoids tasks mental effort	.52		.54				
7. Loses things for activities	.48		.57				
8. Easily distracted	.49		.54				
9. Forgetful in daily activities	.56		.49				
10. Fidgets with hands and feet		.42	.50				
11. Difficulty remaining seated		.60	.57				
12. Runs about or climbs		.68	.55				
13. Difficulty playing quietly		.41	.63				
14. Acts as if driven by a motor		.66	.49				
15. Talks excessively		−.03	.63				
16. Blurts out answers		−.12	.74				
17. Difficulty awaiting turn		.15	.66				
18. Butts into activities		−.09	.81				
19. Loses temper				.81			
20. Argues with adults				.84			
21. Defies what is told to do				.80			
22. Deliberately annoys others				.77			
23. Blames others for mistakes				.80			
24. Touchy or easily annoys				.77			
25. Angry and resentful				.92			
26. Tries to get even				.82			
27. Lies to get things					.75		
28. Bullies, threatens, intimidates					.88		
29. Starts physical fights					.84		
30. Deliberately destroy property					.74		
31. Physically cruel to people[d]					.86		
32. Plays hookey[e]					.71		
33. Stolen things when not looking[e]					.61		
34. Physically cruel to animal[d]					.67		
35. Overconcerned about abilities						.60	
36. Difficulty controlling worries						.73	
37. Acts restless or edgy						.81	
38. Irritable for most of the day						.92	
39. Tense or unable to relax						.78	
40. Difficulty sleeping							.50
41. Depressed most of the day[d]							.85
42. Show little interest[d]							.64
43. Recurrent thoughts of death[d]							.78
44. Feels worthless/guilty							.88
45. Low energy/tired							.55
46. Little confidence							.81

Table 2 continued

CSI-4 items[a]	Factor loadings[b]						
	F1	F2	F3	F4	F5	F6[c]	F7
47. Feels things never work out							.89
48. Changes in appetite/weight							.49
49. Changes in sleep habits							.47
50. Change in activity level							.62
51. Changes in concentration							.80
Inter-factor correlations[f]							
			F3	F4	F5	F6	F7
F3			1				
F4			.59	1			
F5			.60	.80	1		
F6			.52	.68	.45	1	
F7			.40	.59	.50	.72	1

Note: F1 = inattentive; F2 = hyperactive; F3 = ADHD; F4 = ODD, F5 = CD; F6 = GAD, F7 = Mood

[a] Abbreviated version of item. [b] With the exception of items 15–18, all factor loadings were significant at $\alpha < .01$. [c] Never =0; sometimes=1; often, very often=2. [d] Never = 0; sometimes often, very often = 1. [e] Seven conduct disorder items (*stays out at night*, *runs away*, *robbed*, *set fires*, *broken into someone's home*, *used a weapon*, and *preoccupied with sexual activity*) were dropped from the analyses due to extremely low endorsement rates.[f] All correlation coefficients were significant at the at $\alpha < .01$

(between Depression and ADHD) to 0.80 (between ODD and CD).

Teacher Ratings

The top panel of Table 3 presents factor loadings for the teacher ratings of ASD youngsters, while the lower panel presents inter-factor correlations. Again, factor loadings were quite high. The average factor loadings were as follows: ADHD-Inattentive, .66; ADHD-Hyperactivity, .08; ADHD, .59; ODD, .80; CD, .78; GAD, .48; and Depression, .72. They were acceptable (RMSEA = 0.068, CFI = 0.965, GFI = 0.936, and RMSR = 0.125). They improved slightly (RMSEA = .048, CFI = .984, GFI = .953, and RMSR = .114) when the model was submitted to CFA in the subsample of ASD children with FSIQ above 70 ($n = 245$). The same basic structure, when applied to the teacher reports of non-ASD children, provided a weaker model that did not explain the data as well (RMSEA = 0.095, CFI = 0.948, GFI = 0.953, and RMSR = 0.152). Despite this decrement in overall fit, the resulting indices for the teacher reports suggest that this model is a reasonable representation of these data. The smallest and largest inter-factor correlations were between the same factors as the parent ratings, but their magnitude changed to 0.23 and 0.86, respectively.

Table 4 summarizes indices of fit for all four models. The fit statistics indicate that the models are reasonable approximations of the data for ASD youngsters. Table 5 presents factor scores for both parent and teacher ratings.

Correlations with Subject Characteristics

We examined the relationship between CSI factor scores, gender, age, and IQ. CSI factor scores were computed by tabulating items found in Tables 2 and 3. For both parent and teacher ratings, factor scores did not differ across genders. For parent ratings, only the GAD and Depression factors were statistically associated with age at a $p < .01$ level, with correlations of .14 and .24, respectively. IQ was statistically associated at the $p < .01$ level with ODD ($r = .19$), GAD ($r = .16$), and Depression ($r = .19$). For teacher ratings, only the ADHD-Hyperactivity and ADHD total scores were statistically associated with age at the $p < .01$ level, with correlations of $-.16$. Teacher factor scores were not associated with IQ.

Discussion

The accurate delineation of clinical phenotypes has been identified as one of the most pressing methodological issues in understanding pathogenic processes, and this is particularly problematic for researchers in neurobehavioral disorders (e.g., Szatmari et al. 2007). Therefore, the validation of clinical phenotypes is taking center stage in this era of extraordinary advances in microbiology. To this end, the present study assessed the validity of DSM-IV-defined psychiatric syndromes in a large sample of children with ASD with one approach (multivariate statistics). To the best of our knowledge this study is the first of its kind and

Table 3 Factor loadings and inter-factor correlations for the child symptom inventory-4: teacher ratings for children with ASD ($N = 430$)

CSI-4 Items[a]	Factors and loadings[b]						
	F1	F2	F3	F4	F5[c]	F6[d]	F7
1. Careless mistakes	.67		.33				
2. Difficulty paying attention	.68		.48				
3. Doesn't seem to listen	.60		.50				
4. Difficulty following through	.78		.46				
5. Difficulty organizing tasks	.78		.38				
6. Avoids tasks mental effort	.55		.55				
7. Loses things for activities	.61		.31				
8. Easily distracted	.58		.47				
9. Forgetful in daily activities	.73		.26				
10. Fidgets with hands and feet		.39	.64				
11. Difficulty remaining seated		.42	.74				
12. Runs about or climbs		.43	.78				
13. Difficulty playing quietly		.21	.82				
14. Acts as if driven by a motor		.37	.77				
15. Talks excessively		−.14	.73				
16. Blurts out answers		−.37	.63				
17. Difficulty awaiting turn		−.13	.84				
18. Butts into activities		−.44	.86				
19. Loses temper				.83			
20. Argues with adults				.77			
21. Defies what is told to do				.84			
22. Deliberately annoys others				.74			
23. Blames others for mistakes				.69			
24. Touchy or easily annoys				.76			
25. Angry and resentful				.88			
26. Tries to get even				.87			
27. Lies to get things					.70		
28. Bullies, threatens, intimidates[e]					.86		
29. Starts physical fights					.83		
30. Stolen things when not looking					.67		
31. Deliberately destroy property[e]					.85		
32. Stolen things physical force[f]					.66		
33. Physically cruel to people					.88		
34. Overconcerned about abilities						.49	
35. Difficulty controlling worries						.75	
36. Acts restless or edgy						.87	
37. Tense or unable to relax						.92	
38. Depressed most of the day							.86
39. Show little interest							.56
40. Recurrent thoughts of death[e]							.70
41. Feels worthless/guilty[e]							.86
42. Low energy/tired							.30
43. Little confidence							.69
44. Feels things never work out							.89
45. Change in activity level							.89
46. Changes in concentration							.74

Table 3 continued

CSI-4 Items[a]	Factors and loadings[b]						
	F1	F2	F3	F4	F5[c]	F6[d]	F7
Inter-factor correlations[d]							
			F3	F4	F5	F6	F7
F3			1				
F4			.61	1			
F5			.58	.86	1		
F6			.34	.50	.32	1	
F7			.23	.51	.30	.64	1

Note: F1 = inattentive; F2 = hyperactive; F3 = ADHD; F4 = ODD, F5 = CD; F6 = GAD, F7 = Mood

[a] Abbreviated version of item. [b] With the exception of items 15, 16, & 17 all factor loadings were significant at $\alpha < .01$. Loading for item 16 was significant at $\alpha < .05$. [c]Never=0; sometimes=1; often, very often=2. [d] Never=0; sometimes=1; often, very often=1; [e] Two conduct disorder items (*plays hookey* and *used a weapon*) were dropped from the analyses due to extremely low endorsement rates. [f]One GAD item (*irritable*) was dropped from the analyses due to estimation difficulties. [f]All correlation coefficients were significant at $\alpha < .01$.

Table 4 Indices of fit for parent and teacher ratings of child symptom inventory-4

Informant	RMSEA (90% CI)	CFI	GFI	RMSR
Parent ratings				
ASD ($n = 464$)	0.051 (0.048, 0.054)	0.98	0.958	0.096
Outpatient ($n = 185$)	0.052 (0.046, 0.056)	0.978	0.954	0.111
Teacher ratings				
ASD ($n = 430$)	0.068 (0.065, 0.070)	0.965	0.936	0.125
Outpatient ($n = 172$)	0.095 (0.09, 0.099)	0.948	0.953	0.152

Table 5 Means, SDs, and ranges for parent ($n = 463$) and teacher ($n = 430$) CSI factor scores

Factors	Teacher (mean; SD; range)	Parent (mean; SD; range)
ADHD—inattention	16.8 (6.1; 3–27)	15.9 (6.9; 0–27)
ADHD—hyperactivity	12.7 (6.4; 1–27)	10.0 (7.1; 0–27)
ADHD—total	29.5 (10.9; 6–54)	25.8 (12.0; 0–54)
Oppositional defiant disorder	8.4 (6.1; 0–24)	7.0 (5.9; 0–24)
Conduct disorder	1.4 (2.8; 0–21)	1.3 (2.5; 0–20)
Generalized anxiety disorder	4.2 (3.6; 0–15)	3.9 (3.2; 0–12)
Depression	8.6 (4.9; 4–30)	5.9 (4.0; 2–27)

represents an initial step in what will be a very protracted and likely controversial process.

In general, obtained results supported the validity of the five CSI-4 symptom categories (ADHD, ODD, CD, GAD, and Depression) and in so doing the conceptual model on which it is based; namely, the DSM-IV. Factor loadings were substantial for most items, suggesting that they are good indicators of the diagnostic construct being measured. One striking pattern was the weak association of impulsivity items with their factor. Incorporating an additional impulsivity factor did not help to account for additional unexplained variance and increase model fit. Although consistent with some very preliminary molecular genetic findings suggesting that CSI-4 "impulsivity" scores appear to evidence different associations with risk genotypes (e.g., Gadow et al. in press; Roohi et al. in press), much additional work remains on the development of this behavioral construct in children with ASD.

The pattern of obtained correlations between CSI-4 factors reflected in part the well-documented symptom overlap in the diagnostic constructs and the pervasiveness of co-morbidity, both of which are well documented in the literature. For example, difficulty concentrating and excessive motor activity are associated with both ADHD and GAD. Similarly, worry is characteristic of both GAD and Depression. Moreover, a voluminous literature about psychiatric co-morbidity in non-ASD individuals supports association between ADHD and ODD, ODD and CD, GAD and Depression, and ADHD and Depression (e.g., Angold et al. 1999), and many of these associations appear to hold true for children with ASD as well (e.g., Gadow et al. in press; Gadow et al. 2006; Leyfer et al. 2006; Weisbrot et al. 2005). In this study, factor scores evidenced a pattern of correlation that was highly similar to numerous studies of CSI-4 symptom category scores in non-ASD samples (see Gadow and Sprafkin 2007). The relationship between ODD and CD factors was the strongest in both parent and teacher reports, with correlations between the factors at 0.8 and 0.86, respectively. Although these correlations are high, there is still a non-trivial amount of unique variance that the factors do not share. Even with a correlation as

high as .86, roughly one quarter of the variance in each factor is unaccounted for.

The high degree of similarity across raters supports the robustness of results. Conclusions are further bolstered by the fact that the DSM-IV model evidenced comparable levels of internal construct validity in both ASD and non-ASD samples. Although models cannot be directly compared across the two populations, if they were not similar the CFA would not have fit and/or models would be significantly different across samples. The validity of these results is supported by a growing literature indicating that the prevalence; relative prevalence with regard to other disorders; associations with age and gender; patterns of co-morbidity; and risk/protective factors of psychiatric syndromes in ASD and non-ASD referrals are similar (e.g., Gadow et al. 2006; Gadow et al. in press).

Although space constraints preclude a comprehensive review of the construct validity of CSI-4 symptom category scores, we briefly comment on several prior studies. First, children with ASD who meet CSI-4 symptom criteria for specific syndromes such as ADHD (Gadow et al. 2006), ODD (Gadow et al. in press), or anxiety disorder (Weisbrot et al. 2005) are in fact different from youngsters who do not meet criteria in ways that appear to support caseness. Second, "diagnostic groups" differ from each other in a manner consistent with notions about differential diagnosis. Third, studies of the association between psychosocial (Gadow et al. in press) and genetic (Gadow et al. in press; Roohi et al. in press) risk factors with various CSI-4 symptom domains demonstrate patterns of relations that further support differential etiologies within the ASD population. Whether these findings apply equally to other DSM-IV-referenced measures for use with children with ASD or whether "diagnostic" CSI-4 information has relevance for treatment response or long-term therapeutic outcome is currently unknown. This remains, nevertheless, a seemingly useful line of investigation.

It goes without saying that cognitive ability is a major consideration in studies of children with ASD. Skuse (2007) made a cogent argument that co-morbid intellectual disability (ID) in individuals with ASD likely evidences unique etiology, complicates differential diagnosis, and therefore may obfuscate the pursuit of understanding ASD pathogenesis. Interestingly, in the current study, IQ did not impact analyses in a significant fashion. Only a few CSI factors were statistically associated with IQ, and the magnitude of these correlations was small. The CFAs in the subsamples of youngsters with IQs above the ID range did not significantly alter most indices of fit that were obtained with the entire sample. Nevertheless, at the level of individual item analyses, there may be important group differences in behavioral presentation. This remains a topic for future research.

Clinical Implications

The present study is but one in a series of investigations into the identification of clinical behavioral phenotypes in children with ASD and is predicated on the assumption that children with ASD experience psychiatric syndromes that are phenotypically similar to those of non-ASD peers and that a better understanding of their pathogenesis will likely have important implications for clinical management and possibly prevention. A crucial step in this enterprise is to determine if these apparent syndromes are "real". In other words, do they present similarly in ASD children? Are children with and without the syndrome unique in clinically meaningful ways? Are they etiologically or clinically distinct from other seemingly similar syndromes? Answers to these and related questions help to establish the validity of the diagnostic construct. There currently is no expert consensus, however, as to whether behavioral syndromes in children with ASD are caused by the same constellation of variables that are believed to result in psychiatric syndromes in children without ASD. This debate is of no small consequence. If behavioral syndromes are similar in the two populations, then the extensive literature about non-ASD samples has important heuristic value for understanding behavioral disturbances in children with ASD.

The results of the present study suggest that the nosological model for classifying child psychiatric disorders in general may apply to children with ASD. If true, then the clinical assumptions about psychiatric diagnoses have relevance for ASD as well and will include the need to determine to what extent these behaviors contribute to impairment over and above the core features of ASD and, if impairing, the selection of interventions appropriate for the specific type of disorder.

Limitations

Interpretation of the results of this study is subjected to several qualifications. Generalization of study findings is bounded by participant, assessment, and methodological features. It is possible that somewhat different findings might be evidenced with samples drawn from different locales, but this caveat applies to almost all published ASD scales. It is possible that referral biases may have resulted in a more psychiatrically impaired ASD sample than a community-based, epidemiological sample. However, similar potential biases would also apply to our child psychiatric outpatient sample. Moreover, the current sample was biased towards higher functioning individuals. Along the same lines, it is possible that the structure of psychiatric disorders would vary across ASD subtypes (autistic disorder, Asperger's disorder, PDD-NOS). Lastly, the present study did not specifically test whether obtained

factor structures were statistically different for the two informants, nor did we compare our obtained findings to those of a community-based non-ASD sample. Owing to the complexity of these analytic procedures and the breadth of topics already discussed in this report, these issues will be addressed in future publications.

It is important to emphasize that we examined the severity of co-occurring psychiatric symptoms and not categorical diagnoses. Rating instruments, even with sound psychometric properties, are not intended to replace a clinical diagnosis. Rating instruments will likely have false positives for a variety of reasons. They do not (a) assess if responses are normal ones due to contextual factors, (b) measure onset or duration of symptoms, (c) have hierarchical or exclusion rules, or (d) typically assess impairment. Nevertheless, in terms of generating a better understanding of the etiology of neurobehavioral disorders to include ASD, molecular biology is definitely moving in the direction of using dimensional measures as component or instrumental phenotypes (e.g., Abrahams and Geschwind 2008; Szatmari et al. 2007).

Future Directions

Psychopathology research in ASDs has been complicated by a host of factors, including its relatively low incidence, and language and cognitive delays. This has led to inconsistencies in diagnostic practices and hampered research on etiology, course, and treatment. Unraveling the nosology of psychopathology is a complex endeavor. Progress will be made only with programmatic research and multiple research strategies. The nosology of psychopathology will likely be elucidated through a collection of studies using different modalities (e.g., interviews, rating scales), raters (e.g., parents, trained raters), and populations. Future studies need to consider younger and older populations as well as those with ID and assess the relationship between behavior problems and psychiatric syndromes. It is expected that these efforts will some day inform intervention through the delineation of clinical phenotypes and the identification of variables implicated in some way in the pathogenesis of psychiatric syndromes or moderate treatment response.

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