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A NATIONAL STUDY OF AUTISTIC SYMPTOMS IN THE GENERAL POPULATION OF SCHOOL-AGE CHILDREN AND THOSE DIAGNOSED WITH AUTISM SPECTRUM DISORDERS

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Multi-Health Systems

We examined the interrelationships among symptoms related to autism spectrum disorders (ASD) using a large representative sample and clinical groups of children aged 6 to 11 and youth aged 12 to 18 years rated by parents ($N = 1{,}881$) or teachers ($N = 2{,}171$). The samples included individuals from the United States and Canada from the standardization and validity studies for the Autism Spectrum Rating Scales. A three-factor solution comprising Social/Communication, Unusual Behaviors, and Self-Regulation provided the best fit to the data and was replicated across parent and teacher ratings. High coefficients of congruence across sexes, raters, ethnic groups, and age groups and for clinical groups were obtained. Implications for understanding the symptoms related to ASD and their use in practice are provided. © 2012 Wiley Periodicals, Inc.

Autism spectrum disorder (ASD) is best conceptualized as a biologically determined set of behaviors that occurs with varying presentation and severity, which is likely the result of varying causes. The disorder occurs significantly more often in boys (Smalley, Asarnow, & Spence, 1988) and is found across all social classes (Gillberg & Schaumann, 1982). It is estimated that one of four children with autism experiences physical problems, including epilepsy (Rutter, 1970). Up to 75% of youth with ASD are generally found to experience intellectual deficiencies, although this proportion appears to be dropping in recent years (Klinger, O'Kelley & Mussey, 2009). Lotter (1974) first suggested that level of intellectual functioning and amount of useful language by 5 years of age were the best predictors of outcome, a finding that has been consistently supported over time (Gillberg & Steffenburg, 1987; Howlin, Goode, Hutton & Rutter, 2004; Venter, Lord & Schopler, 1992). Autism is a disorder in which individuals can evidence problems ranging from almost total impairment to near typical performance (for review, see Goldstein & Ozonoff, 2009). Children with autism experience a wide variety of developmental difficulties involving communication, socialization, thinking, cognitive skills, interests, activities, and motor skills (for review, see Goldstein, Naglieri & Ozonoff, 2009).

The *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric Association, 2000) criteria describe a group of pervasive developmental disorders, including ASD. The criteria for autistic disorder include three sets of behavioral descriptions. To qualify for the diagnosis, a child must present at least two symptoms from the first set of criteria and one from each of the second and third sets of criteria. The first set of criteria features qualitative impairment in social interaction, as manifested by impairment of nonverbal behaviors, including eye contact, facial expression, body postures, and gestures of social interaction; failure to develop peer relationships appropriate to developmental level; markedly impaired sharing of emotional states or

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interests with others, or expression of pleasure in other people's happiness; and lack of social or emotional reciprocity. The second set of criteria refers to qualitative impairment in communication as manifested by a delay or total lack of the development of spoken language without efforts to compensate through gestures; marked impairment in the ability to initiate or sustain conversation despite adequate speech; repetitive or stereotyped use of language or idiosyncratic language; and lack of varied, spontaneous make-believe play or social imitative play appropriate for the child's developmental level. The third set of criteria involves repetitive and stereotypic patterns of behavior; restricted interest or activities, including preoccupation in a certain pattern of behavior that is abnormal in intensity or focus; compulsive adherence to specific nonfunctional routines or rituals; repetitive motor mannerisms (self-stimulatory behavior); and persistent preoccupation with parts of objects. The second two sets of criteria include delay, prior to the age of 3, in social interaction, language as used in social communication, or symbolic or imaginative play. Finally, the child's clinical description should not be better accounted for by Rett's disorder or childhood disintegrative disorder.

It has been suggested that autism is the most complex developmental disorder with the best empirically based, cross-national diagnostic criteria (Volkmar & Klin, 2005). It is argued that data from a number of research groups from around the world have confirmed the usefulness of current diagnostic approaches (Magnusson & Saemundsen, 2001). Even as work begins on the *DSM-V*, it is clear that although some differences remain between the *International Classification of Diseases* (*ICD*) and *DSM* diagnoses of autism, these major diagnostic systems have become much more alike than different. Researchers have suggested that unlike many child psychiatric conditions, autism is distinct and thus represents a robust condition for purposes of categorical diagnoses (Volkmar, Lord, Bailey, Schultz & Klin, 2004). However, different as autistic children may be from typical children, it is still the case that autistic symptoms have yet to be broadly studied across the general population.

Many of the current diagnostic symptoms were historically arrived at by consensus rather than research. By the publication of *DSM-III-R*, there were significant concerns about the overdiagnosis of the condition (Rutter & Schopler, 1992; Spitzer & Siegel, 1990). In particular, individuals with intellectual handicaps appeared to be overdiagnosed. The introduction of the *DSM-IV* was preceded by field trials in 21 sites, with 125 raters participating from the United States and around the world. Raters had a range of experience in the diagnosis of autism and a range of professional backgrounds. The field trial included information from nearly 1,000 cases seen by one or more raters; however, only clinical cases were examined. Thus, important data were generated about the homogeneity of this group but not about the relationship of these symptoms to the general population. These field trials were then used to construct the definition of autistic disorder for *DSM-IV*. A large study of the symptoms related to autism in the general population would help clarify the relationships among symptoms, which was the goal of this study.

As part of the development of the Autism Spectrum Rating Scales (ASRS; Goldstein & Naglieri, 2010), parent and teacher ratings of children in the general population, as well as those with specific developmental and related problems, were obtained for the normative, reliability, and validity studies. These data, collected by 70 site coordinators throughout the United States and Canada, afford the opportunity to study the presence of autistic symptoms in a normative population of school-age children, as well as in those diagnosed with autism spectrum and other clinical disorders. The strategy of using a large nationally representative sample of children is that the probability of sampling error is reduced, and generalization to the wider population is possible. The purpose of the present study was, therefore, to provide an examination of the inter-relationships among the symptoms related to ASDs using a large representative sample of children and youth.

Table 1
Demographic Characteristics of the Samples by ASRS Form

	Parent ($N = 1,881$)		Teacher ($N = 2,171$)	
	n	%	*n*	%
Gender				
Male	1,024	54	1,116	51
Female	842	45	1,042	48
Age Group (years)				
6–11	1,019	54	943	43
12–18	856	46	1,221	56
Ethnicity				
Asian	52	3	82	4
African American	189	10	311	14
Latino	304	16	376	17
White	1,239	66	1,269	59
Other	93	5	126	6
Clinical Status				
Nonclinical	1,446	77	1,662	77
Clinical	435	23	508	23
ASD	189	43	213	42
ADHD	104	24	128	25
Language Disorder	36	8	40	8
Anxiety/Depression	26	6	26	5
Other/Missing	80	18	101	20
Parental Education Level				
Less Than High School	107	6	-	-
High School or Equivalent	354	19	-	-
Some College	516	27	-	-
College or Higher	896	48	-	-
Geographic Region				
Northeastern U.S.	524	28	979	45
Midwestern U.S.	207	11	244	11
Southern U.S.	927	49	551	25
Western U.S.	180	10	140	6
Canada	43	2	257	12

Note. ASRS = Autism Spectrum Rating Scales; ASD = autism spectrum disorder; ADHD = attention-deficit hyperactivity disorder. Parental education level data were unavailable for Teacher Form participants. For specific clinical diagnoses, percentages represent proportion within clinical subsample.

Method

Participants

Two samples of children in the United States and Canada aged 6- to 18 years were rated by parents or teachers using the ASRS (Goldstein & Naglieri, 2009) between October 2006 and February 2009. These data were collected by 70 site coordinators who were compensated for their participation as part of the development and psychometric examination of the scales. As shown in Table 1, parents rated 1,881 youth (1,024 [54.4%] were male, and 842 [44.8%] were female). The mean age was 11.0 years ($SD = 3.7$ years), and the majority (65.9%) was White, although other ethnic groups (i.e.,

African American, Latino, Asian) were also well represented, with proportions generally falling within 5% of 2009 census values. Most cases (76.9%) were without a formal clinical diagnosis of any psychological disorder. Of those cases with a diagnosis, the most common categorizations were ASD (i.e., autistic disorder, Asperger's disorder, pervasive developmental disorder-not otherwise specified [PDD-NOS]; 43.4%) and attention-deficit hyperactivity disorder (ADHD; 23.9%). These cases were specifically targeted, including a higher proportion of ASD cases than would be expected in the population to ensure a large sample of cases ideal for development and validation of the ASRS. Teachers rated 2,171 participants (51.4% males and 48.0% females). The mean age of this group was 11.9 years ($SD = 3.7$ years), and the sample was 58.5% White, and other groups (i.e., African American, Latino, Asian) were also well represented, with proportions falling within 5% of 2009 census values. Most cases (76.6%) did not have a formal clinical diagnosis of any psychological disorder, and of those who did, the most common categorizations were ASD (41.9%) and ADHD (25.2%). Clinical diagnoses were established using official, formal criteria, including evaluation based on *DSM-IV-TR* or *ICD-10* guidelines from a mental health professional. More details about the development of the ASRS normative samples can be found in the test manual (Goldstein & Naglieri, 2010).

Measure

The ASRS (Goldstein & Naglieri, 2010) was designed to assess behaviors associated with ASD among children aged 2 to 5 years (no. of items = 70) and youth aged 6 to 18 years (no. of items = 71), as rated by parents and/or teachers. Each of the items is rated using a 5-point Likert scale (0 = Never, 1 = Rarely, 2 = Occasionally, 3 = Frequently, 4 = Very Frequently), scored such that higher scores are indicative of ASD-type behaviors. Preliminary content structure and item generation were based on a comprehensive review of both current theory and literature on the assessment of ASDs (autistic disorder, Asperger's disorder, and PDD-NOS), the *DSM-IV-T*R (APA, 2000) and *ICD-10* (World Health Organization, 1993) diagnostic criteria, as well as the authors' clinical and research experiences. Only the version for individuals aged 6 to 18 years was included in this study. The ASRS scale structure includes three empirically derived ASRS Scales (Social/Communication, Unusual Behaviors, Self-Regulation), eight content-derived Treatment Scales (Peer Socialization, Adult Socialization, Social/Emotional Reciprocity, Atypical Language, Stereotypy, Behavioral Rigidity, Sensory Sensitivity, Attention), a *DSM-IV-TR* Scale based on the *DSM-IV-TR* symptomatic criteria for autistic disorder and Asperger's disorder, and a Total Score.

Separate normative samples for parent and teacher ratings each included data from 960 male and female clinical and non-clinical youth from diverse demographic backgrounds (i.e., race/ethnicity, geographic region, parental education level) from the United States, and represent subsamples of the participants used in this study. Reliability and validity results are described in the ASRS manual (Goldstein & Naglieri, 2010). In each normative sample, internal consistency of the Total Score was .97. Validity was established by moderate to strong correlations between the ASRS and other ASD-related measures, such as the Gilliam Autism Rating Scale Second Edition (Gilliam, 2006) and the Gilliam Asperger's Disorder Scale (Gilliam, 2001). ASRS also demonstrated high mean differences in the Total Scores between youth with a formal ASD diagnosis from those with no clinical diagnosis or a non-ASD diagnosis (i.e., Cohen's *d*-ratios ranging from 0.89 to 2.17). Further validity evidence was provided by classification statistics demonstrating approximately 91% overall classification accuracy for each of the parent and teacher ratings in distinguishing youth with a formal ASD diagnosis from those without any clinical diagnosis. More details about validity of the scales can be found in the test manual (Goldstein & Naglieri, 2010).

Data Analysis

Exploratory factor analyses (EFA) were conducted on the 71 ASRS items using PASW Statistics 18 and following well-documented procedural guidelines (see reviews by Costello & Osborne, 2005; Norris & Lecavalier, 2010; Reise, Waller, & Comrey, 2000; Russell, 2002; Tabachnick & Fidell, 2007). The main goal of the analyses was to identify the structure of the theoretical construct manifested by the ASRS. Principal axis factoring was the specific extraction method used, given that the data were not expected to be normally distributed at the item level in these largely nonclinical samples. Because all extracted factors are presumed to represent elements of a single underlying continuum—ASDs—and are therefore expected to intercorrelate, an oblique rotation (direct quartimin) was used to allow the factors to correlate with each other. ASRS items may be considered ordered-categorical (5-point Likert scale); therefore, the polychoric correlation matrix of ASRS items was analyzed (see Olsson, 1979), even though results using the Pearson correlation matrix were very similar to those using the polychoric correlation matrix (Goldstein & Naglieri, 2010). Each of the samples easily met the sample size requirements suggested for EFA (e.g., Comrey & Lee, 1992; see reviews by Norris & Lecavalier, 2010; Tabachnick & Fidell, 2007; Thompson, 2004). Aside from the decision to analyze the polychoric correlation matrix and the use of the larger (normative plus non-normative) samples, these analyses followed the same procedure as those in the ASRS manual (Goldstein & Naglieri, 2010).

Factor congruence analyses (Burt, 1948; Harman, 1976; Reise et al., 2000; Tucker, 1951; Wrigley & Neuhaus, 1955) were performed to establish the similarity of the factor loading patterns across demographic groups. These analyses involve repeating EFA within each group of interest, then comparing the resulting pattern matrix loadings across groups. Specifically, we conducted four comparisons: males versus females, White versus non-White ethnic groups, younger (6–11 years) versus older (12–18 years), and clinical (i.e., ASD, ADHD, etc.; see Table 1)versus. general population youth. A coefficient of congruence, which is similar to a Pearson correlation and ranges from –1.0 to 1.0, was generated for each factor, for each comparison. Values above .90 are generally accepted as an indicator of consistency of loadings between two groups (see Reynolds & Ramsay, 2003).

Results

For both the parent and teacher ratings, the majority of ASRS items showed positively skewed frequency distributions because the raters' endorsement of symptoms was low. This pattern was expected, given that the majority of the sample was nonclinical. These distributions supported our decision to use principal axis factoring extraction. The number of factors to retain was determined primarily through scree plot examination and conceptual interpretability. The Kaiser criterion (i.e., the "eigenvalues greater than one" rule) was not strongly considered, given that most researchers concur that it is highly unreliable (e.g., Cliff, 1988; Zwick & Velicer, 1986; see review by Hayton, Allen, & Scarpello, 2004). Parallel analysis (PA; Horn, 1965) was also used; however, as detailed later, the results were very discrepant with those reached by other criteria. Eigenvalues and variance explained by the first 10 factors of the parent and teacher ratings are displayed in Table 2. For both the parent and teacher samples, the scree plots showed a large first factor, typical of data composed of highly correlated items representing a single higher-order factor—in this case, ASD. The scree plots illustrated a clear drop in eigenvalues after the third factor. That is, the third factor explained a meaningful amount of variance over the fourth factor, but the fourth factor did not explain a meaningful amount of variance over the fifth and subsequent factors. This pattern suggested that a three-factor solution was optimal. Nonetheless, to explore the possibility that the scree plot analysis

Table 2
Eigenvalues and Percentage of Variance Explained in Exploratory Factor Analyses of ASRS Parent and Teacher Forms

	Parent		Teacher	
Factor	Eigenvalue	% of Variance	Eigenvalue	% of Variance
1	34.86	49.10	36.80	51.83
2	4.21	5.93	6.43	9.05
3	3.82	5.38	4.41	6.21
4	1.56	2.20	2.00	2.82
5	1.36	1.91	1.38	1.94
6	1.23	1.73	1.18	1.66
7	1.08	1.52	1.09	1.54
8	1.03	1.45	0.94	1.33
9	0.93	1.31	0.83	1.17
10	0.85	1.20	0.73	1.03

Note. ASRS = Autism Spectrum Rating Scales. $N = 1{,}881$ for ASRS Parent Form and $N = 2{,}171$ ASRS Teacher Form.

may be over- or under-extracting by one factor, we also examined the two- and four-factor solutions for interpretability.

PA results (O'Connor, 2000) suggested 17 factors for both the parent and teacher samples. These results clearly demonstrated over-extraction, and were surprising as many authors have praised PA as perhaps the most accurate method for determining the number of factors in an EFA solution (e.g., Zwick & Velicer, 1986). However, researchers have also demonstrated that PA results may be influenced by certain data characteristics such as sample size. Specifically, Zwick and Velicer (1986) noted that PA slightly overestimated the number of factors as the person-to-item ratio increased from 2:1 to 5:1. In our samples, the person-to-item ratios were roughly 26:1 (parent) and 31:1 (teacher). To test the hypothesis that the sample size was directly related to the number of factors in our PA, we conducted several PA analyses on random subsamples of the parent rating data with sample sizes of $N = 1{,}000$ (a 14:1 person–item ratio), 500 (a 7:1 person–item ratio), 355 (a 5:1 person–item ratio), and 142 (a 2:1 person–item ratio). A clear trend emerged from these analyses, as the number of factors suggested by the PA in these subsamples dropped from the original 17 to 15, 10, 7, and 4 respectively. Other data characteristics, such as non-normality and the use of ordered-categorical data, may have jointly influenced these results (see Tabachnick & Fidell, 2007). Importantly, precedence for the overextraction of factors by PA in an autism assessment was reported by Stewart and Austin (2009).

In interpreting the factors resulting from the EFA, items were retained on a factor if they had a loading of at least .30. This value is similar to the minimal rule of thumb suggested by Tabachnick and Fidell (2007) and indicates roughly 10% overlapping variance between the item and the factor. Cross-loadings were defined as any item with loadings within .10 of each other across multiple factors. Items that loaded on no factors or had cross-loadings were not assigned to an ASRS scale (Goldstein & Naglieri, 2010). Given that a three-factor solution was considered optimal for both the parent and teacher ratings, this solution will be described first. The two- and four-factor solutions will then be described in the context of the three-factor solution.

Ratings by Parents

Three-Factor Solution. Item loadings for the parent data three-factor solution are listed in Table 3. Each of the factors was interpretable. High-loading items on the first factor included

Table 3
Pattern Matrix Loadings From Exploratory Factor Analysis of ASRS Parent Form Data

		Factor		
Item #	Item Description	1	2	3
51	Insistence on routines	**.848**	–.014	–.017
54	Align objects	**.819**	–.164	.040
24	Routine repetition	**.804**	.044	.032
22	Detail obsession	**.793**	–.015	–.037
40	Detail overfocus	**.782**	–.036	.059
53	Object fascination	**.755**	–.046	.007
26	Echoing	**.741**	.081	.027
29	Smell sensitivity	**.723**	.016	–.006
49	Routine expectation	**.711**	.085	–.037
62	Noise sensitivity	**.707**	.044	–.079
63	Routine change upsetting	**.706**	.108	–.089
48	Subject overfocus	**.695**	.074	–.039
65	Attachment to objects	**.694**	–.108	–.183
21	Speech out of context	**.667**	.100	–.126
68	Odd pronoun usage	**.639**	.005	–.130
13	Reaction to routine change	**.636**	.164	–.116
46	Flap hands	**.630**	–.082	–.171
25	Touch sensitivity	**.626**	.034	–.196
67	Twirl/spin/bang items	**.600**	.093	–.127
2	Fabric sensitivity	**.587**	.136	.074
50	Uncommon interests (peers)	**.542**	**.309**	–.029
27	Pica	**.535**	.055	–.182
37	Uncommon interests (adults)	**.522**	**.360**	.097
38	Resist human contact	**.485**	.021	–.279
20	Odd speech	**.482**	.147	**–.302**
17	Immature language	**.464**	.194	–.223
64	Play by himself/herself	**.350**	.053	**–.312**
57	Incomplete tasks	–.059	**.868**	–.052
44	Unfinished homework/chores	–.141	**.854**	–.030
35	Attend to homework/chores	–.008	**.813**	–.099
36	Careless mistakes	–.053	**.776**	–.016
30	Distracted	.051	**.757**	–.019
1	Disorganized	–.094	**.736**	–.123
18	Gets in trouble	.018	**.707**	.001
60	Interrupts	.287	**.668**	.143
71	Fidgets	.249	**.628**	–.002
7	Impatient	.167	**.617**	–.060
58	Language off-topic	**.422**	**.553**	.097
52	Attend to fun tasks	.098	**.520**	–.242
6	Fights	.147	**.505**	.059
34	Eye contact with adults	.080	**.501**	–.239
16	Forgetful	.124	**.462**	–.214
5	Follows instructions	.025	**.423**	**–.381**
19	Social problems (peers)	.229	**.409**	**–.334**

(Continued)

Table 3
Continued

Item #	Item Description	Factor 1	Factor 2	Factor 3
66	Social problems (adults)	.224	**.391**	**–.350**
41	Unpopular	.238	**.372**	–.155
56	Initiate conversation	–.061	–.074	**–.867**
42	Share enjoyment	–.084	.060	**–.850**
31	Play with peers	.017	–.048	**–.830**
23	Maintain conversation	–.013	–.033	**–.819**
43	Interested in others' ideas	–.039	.117	**–.798**
8	Share activities	–.001	.032	**–.794**
70	Respond to peers	.121	–.010	**–.769**
3	Seek company	.072	–.202	**–.719**
39	Caring	–.049	.036	**–.718**
69	Interact with peers	.102	.157	**–.714**
9	Eye contact during conversation	.123	.046	**–.710**
33	Respond to adults	.010	.138	**–.679**
61	Eye contact during interactions	.135	.039	**–.675**
55	Smiling	.179	–.011	**–.665**
28	Understand feelings	.061	.156	**–.628**
45	Grasp humor	.252	–.006	**–.619**
32	Social cues	.211	.042	**–.602**
10	Sustains effort	–.135	**.335**	**–.568**
12	Play inappropriately	.185	–.022	**–.559**
15	Understand viewpoints	.134	.228	**–.489**
14	Talk with peers	.248	.240	**–.473**
47	Listens	.035	**.370**	**–.469**
4	Emotional expression	.198	.030	**–.418**
59	Talk with adults	.207	.286	**–.411**
11	Eye contact while listening	.205	**.303**	**–.397**

Note. ASRS = Autism Spectrum Rating Scales. $N = 1{,}881$. Items loading at least ± .300 appear in bold.

stereotypical and repetitive behaviors, such as "insist on certain routines" and "line up objects in a row." This factor included 26 items, explained 49.10% of the total variance, and had an eigenvalue of 34.86. We named this factor *Unusual Behaviors*. The second factor contained items pertaining to attention ("become distracted"), impulsivity ("have problems waiting his/her turn"), and noncompliance ("argue and fight with other children"). This factor contained 16 items, accounted for 5.93% of the total variance, had an eigenvalue of 4.21, and was labeled *Self-Regulation*. Items loading highly on the third factor assessed problems in the domains of social interaction, including playing with others, communicating verbally, and communicating nonverbally. This factor included 23 items, explained 5.38% of the total variance, had an eigenvalue of 3.82, and was named *Social/Communication*. The remaining six items cross-loaded across multiple factors. The correlations among these three factors were $r = .53$ (Unusual Behaviors and Self-Regulation), .65 (Self-Regulation and Social/Communication), and .53 (Unusual Behaviors and Social/Communication; all $p < .001$). Cronbach's alpha values for the three factors were .95, .95, and .94, respectively.

Two-Factor Solution. The first factor (eigenvalue = 34.86, 49.10% explained variance) in the two-factor solution contained 50 items and comprised items from the Social/Communication and Unusual Behaviors factors from the three-factor solution. The second factor (eigenvalue = 4.21, 5.93% explained variance) included 19 items and was similar to the Self-Regulation factor from the three-factor solution. The remaining five items cross-loaded across the two factors. The two factors correlated at $r = .63$. Merging of social, communication, and odd behaviors into one factor and self-regulation as a second is inconsistent with conceptualizations of the ASD, as well as most empirical findings (e.g., Austin, 2005; Kamp-Becker, Ghahreman, Smidt, & Remschmidt, 2009; Matson, Boisjoli, & Dempsey, 2009; Pandolfi, Magyar, & Dill, 2010). Taking into consideration the scree plot data and the inadequate fit of these items to factors, we considered this solution to be under-factoring.

Four-Factor Solution. In the four-factor solution, the first factor (eigenvalue = 34.86, 49.10% explained variance) contained 24 items and was similar to the Unusual Behaviors factor from the three-factor solution. The second factor (eigenvalue = 4.21, 5.93% explained variance) included 17 items and was similar to the Self-Regulation factor from the three-factor solution. The third factor (eigenvalue = 3.82, 5.38% explained variance) contained 25 items and was similar to the Social/Communication factor from the three-factor solution. No items loaded on the fourth factor (eigenvalue = 1.56, 2.20% explained variance). The remaining five items cross-loaded across multiple factors. Correlations among the factors ranged from $r = .12$ to $r = .66$. This solution strongly suggested over-extraction, given there were no items on the fourth factor.

Ratings by Teachers

Three-Factor Solution. Pattern matrix loadings for the teacher data three-factor solution are listed in Table 4. Each of the factors was easily interpretable, with results similar to the parent data. The first factor described stereotypical and repetitive behaviors, and was named *Unusual Behaviors*. This factor included 28 items, explained 51.83% of the total variance, and had an eigenvalue of 36.80. The second factor included items that assess social, verbal, and nonverbal communication difficulties and was named *Social/Communication*. This factor included 20 items, explained 9.05% of the total variance, and had an eigenvalue of 6.43. The third factor contained items assessing inattention, impulsivity, and noncompliance, and was labeled *Self-Regulation*. This factor contained 17 items, accounted for 6.21% of the total variance, and had an eigenvalue of 4.41. Five items cross-loaded across multiple factors, and another failed to load on any factor. Correlations among these three factors were $r = .49$ (Unusual Behaviors and Social/Communication), .53 (Social/Communication and Self-Regulation), and .42 (Unusual Behaviors and Self-Regulation; all $p < .001$). Cronbach's alpha values for the three factors were .96, .96, and .95, respectively.

Two-Factor Solution. In the two-factor solution, the first factor (eigenvalue = 36.80, 51.83% explained variance) contained 44 items and comprised items from the Self-Regulation and Unusual Behaviors factors from the three-factor solution. The second factor (eigenvalue = 6.43; 9.05% variance explained) included 22 items and was similar to the Social/Communication factor from the three-factor solution. Five items cross-loaded across the two factors, which correlated .58. Similar to the conclusions drawn from the parent data and given scree plot results, this solution was considered to be under-factoring.

Four-Factor Solution. In the four-factor solution, the first factor (eigenvalue = 36.80, 51.83% explained variance) contained 26 items and was similar to the Unusual Behaviors factor from the three-factor solution. The second factor (eigenvalue = 6.43; 9.05% variance explained) included 20 items and was similar to Social/Communication factor from the three-factor solution. The third

Table 4
Pattern Matrix Loadings From Exploratory Factor Analysis of ASRS Teacher Form Data

		Factor		
Item #	Item Description	1	2	3
22	Detail obsession	**.926**	.061	–.216
51	Insistence on routines	**.908**	.026	–.004
40	Detail over focus	**.877**	–.005	–.171
63	Routine change upsetting	**.873**	.037	.034
49	Routine expectation	**.862**	.003	–.010
24	Routine repetition	**.854**	.069	.001
53	Object fascination	**.799**	.003	–.069
48	Subject over focus	**.795**	.080	–.060
54	Align objects	**.792**	–.045	–.077
2	Fabric sensitivity	**.771**	.047	.082
65	Attachment to objects	**.771**	.016	.050
13	Reaction to routine change	**.769**	.033	.161
62	Noise sensitivity	**.763**	.049	.124
29	Smell sensitivity	**.758**	–.007	.112
46	Flap hands	**.752**	–.126	.009
25	Touch sensitivity	**.750**	.186	.046
26	Echoing	**.682**	.051	.187
21	Speech out of context	**.673**	.131	.136
38	Resist human contact	**.672**	.275	–.009
68	Odd pronoun usage	**.639**	.136	.019
67	Twirl/spin/bang items	**.619**	.023	.206
50	Uncommon interests (peers)	**.599**	–.022	**.352**
27	Pica	**.586**	.110	.163
20	Odd speech	**.581**	.254	.147
37	Uncommon interests (adults)	**.557**	–.061	**.422**
17	Immature language	**.526**	.153	.256
41	Unpopular	**.491**	.144	.240
34	Eye contact with adults	**.359**	.277	.286
42	Share enjoyment	–.136	**.914**	.012
56	Initiate conversation	.027	**.899**	–.174
31	Play with peers	.025	**.890**	–.087
3	Seek company	.054	**.858**	–.265
8	Share activities	–.014	**.844**	–.013
23	Maintain conversation	–.006	**.841**	–.057
43	Interested in others' ideas	–.042	**.790**	.182
70	Respond to peers	.099	**.757**	.053
9	Eye contact during conversation	.107	**.754**	.051
55	Smiling	.026	**.748**	.076
69	Interact with peers	.122	**.675**	.166
61	Eye contact during interactions	.166	**.667**	.057
45	Grasp humor	.155	**.665**	.041
32	Social cues	.112	**.655**	.209
39	Caring	–.050	**.642**	.191
28	Understand feelings	.080	**.620**	.226

(Continued)

Table 4
Continued

Item #	Item Description	Factor 1	Factor 2	Factor 3
4	Emotional expression	.080	**.601**	–.090
15	Understand viewpoints	.054	**.582**	**.308**
33	Respond to adults	.031	**.570**	**.313**
12	Play inappropriately	.006	**.517**	.231
14	Talk with peers	**.430**	**.507**	.054
64	Play by himself/herself	**.471**	**.487**	–.134
11	Eye contact while listening	**.360**	**.442**	.123
59	Talk with adults	**.336**	**.390**	.250
44	Unfinished homework/chores	–.074	.072	**.861**
57	Incomplete tasks	–.034	.110	**.818**
36	Careless mistakes	–.033	.045	**.809**
35	Attend to homework/chores	.121	.052	**.787**
30	Distracted	.121	.020	**.779**
18	Gets in trouble	.122	–.045	**.748**
1	Disorganized	.000	.100	**.747**
5	Follows instructions	–.065	.282	**.652**
10	Sustains effort	–.167	**.403**	**.633**
60	Interrupts	**.435**	–.197	**.585**
71	Fidgets	**.381**	–.037	**.582**
58	Language off-topic	**.440**	–.153	**.569**
7	Impatient	**.425**	–.053	**.558**
6	Fights	.252	–.113	**.557**
16	Forgetful	.183	.152	**.546**
47	Listens	.032	**.402**	**.507**
52	Attend to fun tasks	**.300**	.215	**.447**
66	Social problems (adults)	**.323**	.298	**.413**
19	Social problems (peers)	**.334**	**.311**	**.380**

Note. ASRS = Autism Spectrum Rating Scales. $N = 2{,}171$. Items loading at least ± .300 appear in bold.

factor (eigenvalue = 4.41, 6.21% explained variance) contained 15 items and was similar to the Self-Regulation factor from the three-factor solution. None of the items loaded the highest on the fourth factor (eigenvalue = 2.00, 2.82% explained variance). The remaining six items cross-loaded across multiple factors. Correlations among the factors ranged from $r = .03$ to $r = .55$. Given that the fourth factor contained no items, this solution clearly illustrates over-factoring.

Overall, the combination of scree plot analysis and interpretability suggested that the three-factor solution was optimal for both the parent and teacher samples. Further, the three-factor solution was the only solution of those tested that was consistent across the parent and teacher samples.

Congruence Analyses. Coefficients of congruence were calculated for the three-factor solution between sexes (males vs. females), ethnic groups (White vs. non-White), age groups (6–11 years vs. 12–18 years), and clinical status (clinical vs. general population). Scree plots and interpretability favored a three-factor solution in each demographic group. Across groups, the cumulative variance explained by the first three factors ranged from 53.1% to 68.9%. Factor correlations ranged from .25 to .70, with the majority above .50. Cronbach's alpha values for the scales ranged from .92

Table 5
Coefficients of Congruence From Exploratory Factor Analyses Between Demographic Comparison Groups

ASRS Form	Comparison Groups	Unusual Behaviors	Social/Communication	Self-Regulation
Parent	Male/female	.99	.99	.98
	White/non-White	.98	.98	.98
	6–11 years/12–18 years	.98	.98	.98
	Clinical/nonclinical	.96	.94	.96
Teacher	Male/female	.99	.99	.99
	White/non-White	.99	.99	.98
	6–11 years/12–18 years	.97	.95	.94
	Clinical[a]/nonclinical	.97	.96	.96

Note. ASRS = Autism Spectrum Rating Scales.
[a]Polychoric correlation matrix from teacher clinical data were nonpositive definite therefore, exploratory factor analyses conducted on Pearson correlations.

to .97. Congruence coefficient results for the parent and teacher data are displayed in Table 5. These coefficients ranged from.94 to.99, exceeding the generally accepted cutoff of .90 and clearly indicative of a similar pattern of factor loadings across the various groups.

Discussion

The primary purpose of this investigation was to study the inter-relationships among symptoms associated with ASD using EFA with large samples of individuals representative of the U.S. general population, as rated by parents or teachers. Our overarching goal was to assess whether items related to social interactions and communication form two groups of symptoms (as suggested by APA, 2000; Austin, 2005; Lecavalier, 2005; Lecavalier et al., 2006; Lord et al., 2000; Stewart & Austin, 2009), or one (as suggested by Adrien et al., 1992; Constantino, 2009; Constantino et al., 2004; Frazier, Youngstrom, Kubu, Sinclair, & Rezai, 2008; Georgiades et al., 2007; Gillberg & Schaumann, 1982; Snow, Lecavalier, & Houts, 2009). We tested this hypothesis by determining how many factors emerge when behaviors that represent our current conceptualization of ASD were rated using the ASRS. Our results strongly suggested that, for school-aged children and youth, social and communication symptoms related to ASD form one, not two, factors in the ASRS item set. Additionally, we found three distinct but correlated factors: Social/Communication, Unusual Behaviors, and Self-Regulation. The three-factor model emerged as the most viable factorial solution for both parent and teacher raters, and, assuming the same factor structure, there was considerable consistency of factor solutions by sex, race/ethnicity, age, and clinical status. This study does have limitations, which should first be considered.

Limitations of this study include the relatively small number of children and youth with an ASD included in the analysis. Although there was a significant number of children and youth with a clinical diagnosis of any kind for both parent ($n = 435$) and teacher ($n = 508$) raters, the number of youth with an ASD diagnosis was only 189 and 213, respectively. These subsamples were not large enough to establish stable and meaningful EFA solutions if the recommended 5:1 person-to-item ratio recommended for EFA were followed (e.g., Comrey & Lee, 1992; Norris & Lecavalier, 2010; Tabachnick & Fidell, 2007). However, MacCallum, Widaman, Zhang, and Hong (1999) noted that relatively small sample sizes may provide accurate EFA results under certain conditions (e.g., size of communality estimates, factor saturation). Nonetheless, future research using a larger sample of individuals with ASD is desirable to adequately replicate the factor structure of the ASRS for this population. Information about the youths' IQ and language functioning was also unavailable

and may affect the manifestation of ASD or other emotional and behavioral issues. Furthermore, although congruence coefficients demonstrated high overlap in the pattern of ASRS factor loadings between White and non-White youth, larger subsamples of the specific racial/ethnic minority groups (e.g., Asian, African American, Latino) would also be very useful in establishing the consistency of the ASRS factor structure across these demographic categories. The consistency of the EFA results across Parent and Teacher Forms suggests that the factor structure is similar across multiple rater perspectives and settings. Examination of this factor structure using different software programs (e.g., SAS) or through confirmatory factor analysis may be an avenue for future research. In addition, the data are based on rater observations rather than direct assessment of children and adolescents, and a subsample of individuals with ASD of varying ability levels was not specifically examined. Despite these limitations, there are several implications of the findings.

The convergence of social and communication symptoms in our findings was consistent with suggestions by Gillberg and colleagues (Gillberg, 1984; Gillberg, 1991; Gillberg & Billstedt, 2000; Gillberg & Coleman, 1996; Gillberg, Steffenburg & Schaumann, 1991), who have argued that social and communication symptoms represent a unitary phenomenon in etiology and presentation. Similarly, children with autism have limitations in socialization as well as linguistic expression (Harrison & Oakland, 2003; Sparrow, Cicchetti & Balla, 2005). Additionally, daily living skills have been found to be the least impaired with socialization and communication skills the most impaired (Schatz & Hamdan-Allen, 1995; Bölte & Poustka, 2002). Recent factor analyses of various ASD symptoms (see Adrien et al., 1992; Constantino, 2009; Constantino et al., 2004; Frazier et al., 2008; Georgiades et al., 2007; Hoekstra, Bartels, Cath, & Boomsma, 2008; Snow et al., 2009) provide further evidence for the merging of social and communication symptoms. It is also important to recall that the social and communication items did not separate in the four-factor solutions of either the parent or teacher ASRS ratings. Moreover, Goldstein & Naglieri (2009) reported that social and communication items formed one factor on the ASRS for children aged 2 to 5 years of age. These findings imply that representing social and communication symptoms as one symptom cluster should be considered in the forthcoming *DSM-V* (www.DSM5.org).

It is important to recognize that the emergence of a Self-Regulation factor in our analyses is particularly important because it is not part of the *DSM-IV-TR* diagnostic criteria of autistic disorder or other formal assessments of ASDs (e.g., Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001; Gilliam, 2006; Lord et al., 1997, 2000). The fact that a Self-Regulation factor emerged from our EFAs is not in and of itself support for its relevance as an ASD factor; this result only demonstrates that enough Self-Regulation items were included in the assessment to form a cohesive factor. These findings suggest that researchers should further examine the role of self-regulation for children with ASD (see also Ronald, Edelson, Asherson & Saudino, 2010) and that clinicians should carefully evaluate self-regulation problems in children suspected of having ASD because of the critical link between social and communication problems in this population. Clearly, this is an important area for future research.

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