

## CHAPTER 3: AUTISM NORMATIVE SAMPLE

### Procedure and Demographic Characteristics

Norms for children with autism are based on 1,052 children diagnosed with autism by licensed PhD psychologists, board certified child psychiatrists, or a board certified developmental pediatrician using DSM-IV criteria. All clinicians have extensive autism expertise and experience evaluating children with autism and experience in using the CASD. Components of the diagnostic evaluation included

intervention, school, and medical records. The CASD was completed by the clinician based on a parent interview and the other available information. Demographic data are presented in Table 1.

### CASD Total Score Results

As shown in Table 2, CASD total scores for the 1,052 children with autism in the autism normative sample were all in the autism range ( $\geq 15$ ). CASD

**Table 1**  
**Demographic Data for the Autism Normative Sample ( $N = 1,052$ )**

Age	Mean 6.4	SD 3.2	Range 1-16		
	1-2 years 8.2% ( $n = 86$ )	3-5 years 36.5% ( $n = 384$ )	6-8 years 31.1% ( $n = 327$ )	9-12 years 18.5% ( $n = 195$ )	13-16 years 5.7% ( $n = 60$ )
IQ <sup>1</sup>	Mean 86.5	SD 28.2	Range 8-146		
	IQ < 80 36.7% ( $n = 386$ )	IQ $\geq$ 80 63.3% ( $n = 666$ )			
Gender	Male 83.4% ( $n = 877$ )	Female 16.6% ( $n = 175$ )			
Race	White 90.5% ( $n = 952$ )	Nonwhite 9.5% ( $n = 100$ )			
SES	Professional <sup>2</sup> 35.0% ( $n = 368$ )	Nonprofessional 65.0% ( $n = 684$ )			

<sup>1</sup>WISC-III or WISC-IV, WPPSI-III, Stanford-Binet-IV, or Bayley Mental Scale depending on the child's developmental level.

<sup>2</sup>One or both parents have a professional or managerial occupation.

a semi-structured interview with the parent focusing on early history and current symptoms; behavior rating scales completed by parents, teachers, and child care providers; observations of the child during the evaluation; and a review of early

total scores did not differ as a function of gender or race. Mean CASD scores were slightly higher in nonprofessional than professional families and in preschool than school age children, but the mean CASD scores differed by only 1 point and effect

sizes were small ( $d = .3$ ). Similarly, the correlation between age and CASD scores was statistically significant ( $r = -.18, p < .0001$ ), but the effect size was small (explained variance = 3.4%). Children with IQs below 80 had a mean CASD score 1.7 points higher than children with IQs of 80 or more, yielding a medium effect size ( $d = .5$ ). CASD scores decreased with increasing IQ ( $r = -.27$ , explained variance = 7.2%). These findings are consistent with previous research showing that overall autism severity decreases with increasing IQ

was less than 2 points higher in LFA than in HFA and all children in both groups had CASD total clinician scores of 15 or higher. As shown in Table 3, symptom profiles for children with LFA and HFA were overwhelmingly similar. The most common symptoms were #5 problems with social skills (99% of the children), #29 selective attention (98%), #1 social isolation or difficulty making friends (98%), #6 obsessive interests (95%), #8 distress with change (93%), and #25 overreactivity, meltdowns, or aggression (91%). Only six of the

**Table 2**  
CASD Total Clinician Scores for the Autism Normative Sample ( $N = 1,052$ )

	<i>n</i>	Mean	<i>SD</i>	Range	<i>t</i>	<i>p</i>	<i>d</i>
Total sample	1,052	21.7	3.4	15-30			
IQ < 80	386	22.8	3.2	15-30	8.2	<.0001	0.5
IQ ≥ 80	666	21.1	3.4	15-29			
Male	877	21.6	3.5	15-30	1.9	>.05	0.2
Female	175	22.2	3.1	15-29			
Age < 6	470	22.2	3.4	15-30	4.2	<.0001	0.3
Age ≥ 6	582	21.3	3.4	15-30			
White	952	21.7	3.4	15-30	0.1	>.05	0.0
Nonwhite	100	21.7	3.3	15-29			
Professional	368	21.0	3.5	15-30	5.0	<.0001	0.3
Nonprofessional	684	22.1	3.3	15-30			

(Carter et al., 2007; Eaves, Ho, & Eaves, 1994; Matson & Shoemaker, 2009; Mayes, Calhoun, Murray et al., 2009; Mayes, Calhoun, Murray, Morrow et al., 2012; Miller & Ozonoff, 2000; Perry, Condillac, Freeman, Dunn-Geier, & Belair, 2005; Pilowsky, Yirmiya, Shulman, & Dover, 1998; Prior et al., 1998) and increasing age (Church & Coplan, 1995; McGovern & Sigman, 2005; Schopler, Reichler, & Renner, 1986, Schopler, Van Bourgondien, Wellman, & Love, 2010).

### Item Analysis

Although IQ was moderately correlated with CASD total scores, the mean CASD total score

30 symptoms were exhibited by less than 50% of children with HFA, and only two were present in less than half of children with LFA. The least common symptoms (present in less than 50% of children with LFA and HFA) were #13 distress with commotion or crowds and #28 unusual fears. Four additional symptoms were found in less than half of children with HFA only (#14 fascination with repetitive movements, #15 abnormal sensory inspection, #17 high pain tolerance, and #20 language regression).

**Table 3**

**Percent of School and Preschool Age Children with HFA (IQ  $\geq$  80) and LFA (IQ  $<$  80) in the Autism Normative Sample Exhibiting each Clinician Completed CASD Symptom (N = 1,052)**

CASD SYMPTOM	Total sample <i>n</i> = 406	IQ $\geq$ 80		IQ $<$ 80	
		$\geq$ 6	age $<$ 6	$\geq$ 6	age $<$ 6
<b>Problems with Social Interaction</b>					
Social isolation, difficulty making friends	98	96	97	100	100
Limited reciprocal interaction (e.g., poor eye contact)	84	82	79	83	94
Self-absorbed, in own world	84	87	73	90	89
Socially indiscriminate, insensitive behavior	73	76	73	78	65
Problems with social skills	99	99	97	99	100
<b>Perseveration</b>					
Obsessions (e.g., restricted interests and fixations)	95	96	94	96	93
Repetitive play (e.g., lining up toys)	74	61	75	82	92
Distress with change	93	95	95	93	85
Stereotypies (e.g., hand flapping, toe walking)	78	70	71	88	92
<b>Somatosensory Disturbance</b>					
Crave movement (e.g., climbing, jumping, spinning)	57	44	59	55	80
Unresponsive to verbal input (e.g., to name)	84	84	87	81	86
Hypersensitive to sounds, smell, or light	75	79	77	80	61
Distress with commotion or crowds	47	48	40	53	45
Fascination with repetitive movements (e.g., fans)	37	25	32	44	59
Abnormal sensory inspection (e.g., mouthing, smelling)	54	47	51	55	73
Tactile defensiveness	66	67	69	65	61
High pain tolerance	45	37	47	56	51
Sleep disturbance	63	64	66	64	57
Picky eater	70	68	72	64	75
<b>Atypical Communication and Development</b>					
Language regression or slowing after 1 year	31	16	23	37	63
Normal motor and delayed speech milestones	70	56	75	75	86
Communication impairment	90	84	84	98	99
Atypical, repetitive vocalizations or speech	88	86	87	92	93
Special abilities (e.g., memory, visual-mechanical)	80	84	85	69	75
<b>Mood Disturbance</b>					
Overreactive, meltdowns, aggression	91	92	93	89	86
Moody, emotionally labile	74	73	76	70	74
Problems with empathy or expressing emotions	63	68	49	64	68
Unusual fears	41	42	40	40	39
<b>Problems with Attention and Safety</b>					
Selective attention	98	99	98	97	95
Poor safety awareness	74	64	78	80	85

## CHAPTER 4: NATIONAL STANDARDIZATION SAMPLE

### Procedure and Demographic Characteristics

The national standardization sample consists of 1,417 children, including 925 typical children, 55 children with autism (excluding children diagnosed with Asperger's disorder or PDD-NOS), and 437 nonautistic clinical children. Diagnoses were those listed in each child's educational or clinical records. Most of the cases were collected in 2011 in all four Census regions of the United States (see percentages of Region in Table 4). Examiners were principally school or clinical psychologists or educational as-

essment specialists with years of experience and graduate level training in assessment and administration of tests. Examiners followed a stratified sampling model provided by the publisher with designated combinations of age, gender, ethnicity, and parental education required for each case in their Census region. Examiners submitted protocols to the publisher after each set of testing sessions. Examiners were paid for their time and examinees were given small monetary rewards for the time parents expended on completing the checklist or

**Table 4**  
**Demographic Data for the Standardization Sample (N = 1,417)**

Age	Mean 9.2 SD 4.3 Range 1-18				
	1-2 years 4.0% (n = 57)	3-5 years 19.8% (n = 280)	6-8 years 22.7% (n = 321)	9-12 years 27.2% (n = 386)	13-18 years 26.3% (n = 373)
Gender	Male 52.4% (n = 742)	Female 47.6% (n = 675)			
Race	White 65.6% (n = 929)	Black 14.6% (n = 207)	Hispanic 13.8% (n = 196)	Asian 3.4% (n = 48)	Other 2.6% (n = 37)
Region	Northeast 37.8% (n = 535)	Midwest 13.1% (n = 185)	South 36.6% (n = 519)	West 12.6% (n = 178)	
Community	Rural 27.1% (n = 384)	Urban 72.9% (n = 1,033)			
Mother Education <sup>1</sup>	1-11 years 11.9% (n = 169)	High school 23.6% (n = 335)	Some college 18.5% (n = 262)	College degree 31.0% (n = 439)	Postgraduate degree 14.3% (n = 202)
Father Education <sup>1</sup>	1-11 years 10.5% (n = 149)	High school 26.0% (n = 368)	Some college 15.2% (n = 215)	College degree 28.6% (n = 405)	Postgraduate degree 13.5% (n = 191)

<sup>1</sup>Some education data are missing (primarily because of single-parent households) including 10 mothers (0.7%) and 89 fathers (6.3%).

interview. Quality control measures were employed by Stoelting Company by eliminating all personal information and assigning a subject code. Protocols were reviewed for accuracy, making corrections in scoring, and providing feedback to examiners. CASD standardization occurred in conjunction with standardization of the Leiter-3 (Roid, Miller, Koch, & Pomplun, in press), a nonverbal test of intelligence. Examiners were trained in administering the CASD at several sites throughout the United States by Dr. Jamie Martin and Dr. Gale Roid, two clinically experienced psychologists. Examiners viewed the CASD training DVD. Approximately half of the CASDs were completed independently by the parent ( $n = 785$ ) and half by the clinician based on a parent interview ( $n = 632$ ). Demographic data are presented in Table 4.

with autism had CASD clinician scores in the autism range (15-30). Therefore, the 632 CASD clinician scores differentiated children with, and without, autism with 99.5% accuracy (specificity 100% and sensitivity 86.4%). Positive predictive power (percent scoring  $\geq 15$  diagnosed with autism) was 100% and negative predictive power (percent  $< 15$  not diagnosed with autism) was 99.5%. Because only three children in the autism group had CASD clinician scores below 15 and all 1,052 children in the autism normative sample had CASD clinician scores of 15 or higher, it is possible that parents of the three outliers under-reported autistic symptoms during the clinical interview or that the three children did not actually have autism.

**Table 5**  
**CASD Total Scores for the Standardization Groups and Classification Accuracy**  
**Using a CASD Total Score  $\geq 15$  = Autism ( $N = 1,417$ )**

Diagnosis	Clinician completed CASD				Parent completed CASD			
	<i>n</i>	<i>M/SD</i>	Range	Accuracy	<i>n</i>	<i>M/SD</i>	Range	Accuracy
Typical	315	0.9/1.8	0-13	100%	610	1.4/2.5	0-19	99.7%
Autism <sup>1</sup>	22	18.8/4.4	8-25	86.4%	33	22.6/5.0	6-30	93.9%
Nonautistic clinical	295	3.8/3.2	0-13	100%	142	5.2/5.3	0-25	92.3%
Language disorder/deaf <sup>2</sup>	22	1.1/2.3	0-10	100%	15	2.1/3.2	0-10	100%
Learning disability	49	1.6/2.4	0-12	100%	24	1.6/2.5	0-8	100%
ADHD <sup>3</sup>	193	4.5/3.2	0-13	100%	87	5.8/4.6	0-19	94.3%
Mental retardation <sup>4</sup>	31	4.5/3.0	0-11	100%	16	10.6/7.7	1-25	62.5%
Total sample	632			99.5%	785			98.1%

<sup>1</sup>Autistic disorder not including Asperger's disorder or PDD-NOS.

<sup>2</sup>Language disorder, deaf, or hearing impaired with or without a learning disability.

<sup>3</sup>ADHD with or without a learning disability, language disorder, oppositional-defiant disorder, anxiety disorder, and depression.

<sup>4</sup>Mental retardation including children with cerebral palsy and traumatic brain injury.

### CASD Total Score Results

As shown in Table 5, all typical children and all nonautistic clinical children in the standardization sample earned CASD clinician scores in the nonautistic range (0-14). All except three of the children

Overall classification accuracy for the 785 CASD parent scores was 98.1%. As shown in Table 5, when the CASD was independently completed by the parent, classification accuracy for three groups

was slightly below the classification accuracy percentages for the CASD completed by the clinician based on a parent interview. Even so, parent accuracy was extremely high. For children who had a diagnosis of autism, classification accuracy was slightly higher for the CASD completed by parents than for the CASD completed by clinicians.

Comprehensive clinical evaluations by a licensed psychologist were conducted for 205 of the children

disorder, generalized anxiety disorder, separation anxiety disorder, obsessive-compulsive disorder, and specific phobia. For the three anxiety groups large enough to permit statistical analysis, mean CASD total clinician scores did not differ significantly between ADHD children “who had” versus “did not have” each type of anxiety disorder (separation anxiety  $M = 5.7, t = 0.8, p = .43$ , generalized anxiety disorder  $M = 5.7, t = 1.3, p = .18$ , and social anxiety disorder  $M = 5.2, t = 0.5, p = .64$ ).

**Table 6**  
**CASD Total Scores for the Standardization ADHD Groups and Classification Accuracy**  
**Using a CASD Total Score  $\geq 15 =$  Autism ( $N = 205$ )**

Diagnosis	Clinician completed CASD				Parent completed CASD			
	<i>n</i>	<i>M/SD</i>	Range	Accuracy	<i>n</i>	<i>M/SD</i>	Range	Accuracy
ADHD only	70	2.9/2.4	0-8	100%	16	2.7/2.5	0-8	100%
ADHD and anxiety	29	4.6/3.1	0-10	100%	10	4.9/2.4	2-8	100%
ADHD and ODD	54	6.9/2.5	1-13	100%	15	7.6/5.3	0-19	86.7%

with ADHD in the standardization sample to determine the presence or absence of comorbid oppositional-defiant disorder (ODD), anxiety disorder, and depression (dysthymic disorder or major depression). Components of the diagnostic evaluation were a semi-structured interview with the parent; behavior rating scales completed by parents, teachers, and child care providers; child interview; observations of the child during psychological testing; and a review of early intervention, school, and medical records. Children with ADHD and comorbid ODD, anxiety disorder, and/or depression all earned CASD total clinician scores below the autism range (Table 6). The mean CASD total clinician score for children with ADHD and ODD and/or an anxiety disorder (6.2) increased by only 0.4 points when depression was also present. Mean CASD total clinician scores were 4.0 points higher for children with ODD and ADHD versus ADHD alone, and they were 1.7 points higher for children with an anxiety disorder and ADHD versus ADHD alone. Anxiety disorders included social anxiety

For typical children in the standardization sample, CASD total clinician scores were not significantly related to age ( $r = -.05, p = .42$ ) and did not differ between males and females ( $t = 1.5, p = .14$ ), racial groups ( $F = 0.8, p = .53$ ), maternal and paternal education level ( $F = 0.2, p = .96$  and  $F = 0.3, p = .91$ ), and urban versus rural community ( $t = 1.4, p = .17$ ). The only significant difference was that typical children in the West region scored higher on the clinician CASD than did children in the other regions ( $F = 7.2, p < .0001$ ), which may be an examiner effect more so than regional effect. Regardless, mean CASD scores for typical children in the West (3.0) and in the other regions (0.8) were far below the autism cutoff of 15.

#### Item Analysis

With only two exceptions, none of the CASD symptoms was present in the majority of children in any of the five nonautistic standardization groups (Table 7). The exceptions were CASD item #5 (problems with social skills), which was present in

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58% of children with mental retardation, and CASD item #25 (overreactive, meltdowns, or aggression), which was reported in 53% of children with ADHD. As shown in Table 8, this high frequency for ADHD was in children who had ADHD with ODD. In contrast to the results for children without autism, almost all CASD symptoms were found in the majority of children in the autism normative sample. Two symptoms were very common in the autism normative sample, but rarely occurred ( $\leq 5\%$ ) in any of the five nonautistic standardization groups (Table 7). These were #2 limited reciprocal interaction (such as poor eye contact) found in 84% of the children with autism and 0-5% of children in the nonautistic groups and #7 repetitive play (e.g., lining up toys) present in 74% of the children with autism and 0-3% of children in the nonautistic groups. None of children in the five nonautistic groups had #14 fascination with repetitive movements (e.g., fans), whereas 37% of children with autism did. Language regression after 1 year (#20) was found only in children with autism (31%) and nonautistic children with mental retardation (6%) and not in any of the other standardization groups. *(Table 7 Shown on Page 11)*

None of the CASD symptoms was found in the majority of children with ADHD alone or ADHD and an anxiety disorder (Table 8), whereas 25 of the 30 symptoms were found in the majority of children with autism (Table 3). Six of the 30 CASD symptoms were reported in the majority of children with ADHD and ODD, including #4 socially indiscriminate or insensitive behavior, #5 problems with social skills, #18 sleep disturbance, #25 overreactive, meltdowns, or aggression, #26 moody or emotionally labile, and #30 poor safety awareness. When comparing all of the nonautistic clinical subgroups (ADHD and ODD, ADHD and anxiety disorder, mental retardation, language disorder or hearing impairment, and learning disability), mean CASD clinician scores were highest for children with ADHD and ODD ( $M = 6.9$ ) versus the other groups ( $M = 1.1 - 4.6$ ). However, none of the children with ADHD and ODD scored in the autism range on the CASD and their mean score was far below the mean of 21.7 for children with autism.

*(Table 8 Shown on Page 12)*

**Table 7**  
**Percent of Typical and Nonautistic Clinical Children**  
**Exhibiting each Clinician Completed CASD Symptom in the Standardization Sample**

CASD SYMPTOM	Typical <i>n</i> = 315	ADHD 193	LD 49	MR Language Disorder 31 22	
<b>Problems with Social Interaction</b>					
Social isolation, difficulty making friends	3	21	10	35	14
Limited reciprocal interaction (e.g., poor eye contact)	2	5	2	3	0
Self-absorbed, in own world	3	2	4	6	0
Socially indiscriminate, insensitive behavior	4	33	4	32	4
Problems with social skills	2	40	16	58	4
<b>Perseveration</b>					
Obsessions (e.g., restricted interests and fixations)	2	3	6	13	9
Repetitive play (e.g., lining up toys)	2	1	0	3	0
Distress with change	6	24	12	13	9
Stereotypies (e.g., hand flapping, toe walking)	1	6	0	23	0
<b>Somatosensory Disturbance</b>					
Crave movement (e.g., climbing, jumping, spinning)	1	6	0	3	4
Unresponsive to verbal input (e.g., to name)	2	25	0	23	0
Hypersensitive to sounds, smell, or light	5	14	4	19	0
Distress with commotion or crowds	2	10	6	6	4
Fascination with repetitive movements (e.g., fans)	0	0	0	0	0
Abnormal sensory inspection (e.g., mouthing, smelling)	3	5	0	6	4
Tactile defensiveness	3	20	6	13	4
High pain tolerance	10	7	4	3	9
Sleep disturbance	5	39	8	23	0
Picky eater	5	20	14	13	0
<b>Atypical Communication and Development</b>					
Language regression or slowing after 1 year	0	0	0	6	0
Normal motor and delayed speech milestones	2	14	0	6	4
Communication impairment	3	5	8	29	14
Atypical, repetitive vocalizations or speech	3	4	4	10	9
Special abilities (e.g., memory, visual-mechanical)	9	2	2	13	4
<b>Mood Disturbance</b>					
Overreactive, meltdowns, aggression	7	53	18	23	0
Moody, emotionally labile	3	32	12	29	0
Problems with empathy or expressing emotions	0	8	4	6	9
Unusual fears	2	3	0	3	0
<b>Problems with Attention and Safety</b>					
Selective attention	1	20	4	13	0
Poor safety awareness	0	30	6	13	0

**Table 8**  
**Percent of Children with ADHD with or without ODD and Anxiety**  
**Exhibiting each Clinician-Completed CASD Symptom in the Standardization Sample**

CASD SYMPTOM	ADHD only ( <i>n</i> = 70)	ADHD and ODD ( <i>n</i> = 54)	ADHD and anxiety ( <i>n</i> = 29)
<b>Problems with Social Interaction</b>			
Social isolation, difficulty making friends	11	32	28
Limited reciprocal interaction (e.g., poor eye contact)	1	6	10
Self-absorbed, in own world	1	0	0
Socially indiscriminate, insensitive behavior	24	57	10
Problems with social skills	27	76	38
<b>Perseveration</b>			
Obsessions (e.g., restricted interests and fixations)	0	2	0
Repetitive play (e.g., lining up toys)	1	2	0
Distress with change	9	32	28
Stereotypies (e.g., hand flapping, toe walking)	3	7	7
<b>Somatosensory Disturbance</b>			
Crave movement (e.g., climbing, jumping, spinning)	6	13	0
Unresponsive to verbal input (e.g., to name)	23	39	28
Hypersensitive to sounds, smell, or light	11	17	28
Distress with commotion or crowds	1	7	28
Fascination with repetitive movements (e.g., fans)	0	0	0
Abnormal sensory inspection (e.g., mouthing, smelling)	4	6	7
Tactile defensiveness	17	22	38
High pain tolerance	3	11	0
Sleep disturbance	30	56	41
Picky eater	20	20	31
<b>Atypical Communication and Development</b>			
Language regression or slowing after 1 year	0	0	0
Normal motor and delayed speech milestones	16	20	14
Communication impairment	10	0	0
Atypical, repetitive vocalizations or speech	6	2	0
Special abilities (e.g., memory, visual-mechanical)	0	0	0
<b>Mood Disturbance</b>			
Overreactive, meltdowns, aggression	26	94	41
Moody, emotionally labile	6	69	28
Problems with empathy or expressing emotions	0	19	10
Unusual fears	0	2	3
<b>Problems with Attention and Safety</b>			
Selective attention	20	20	21
Poor safety awareness	17	65	17

## CHAPTER 5: VALIDITY AND RELIABILITY STUDIES

### Diagnostic Validity

For the standardization sample, classification accuracy was 99.5% for CASD clinician scores and 98.1% for parent scores. These results are supported by previous studies showing strong validity and reliability for the CASD (Mayes & Calhoun, 1999, 2004a, 2011; Mayes et al., 2001; Mayes, Calhoun, Mayes, & Molitoris, 2012; Mayes, Calhoun, Murray et al., 2009; Murray et al., 2011; Tryon et al., 2006). These published studies demonstrated that the CASD differentiated children with autism from children with ADHD with 99.5% accuracy and from typical children with 100% accuracy (Mayes, Calhoun, Murray et al., 2009), was equally effective in identifying HFA or Asperger's disorder and LFA (Mayes & Calhoun, 1999, 2004a, 2011), had excellent congruence with DSM-IV based clinical diagnoses (Mayes et al., 2001), had 90% clinician-parent diagnostic agreement (Mayes, Calhoun, Murray et al., 2009), and had high diagnostic agreement with other autism instruments, including 98% with the Childhood Autism Rating Scale (Mayes, Calhoun, Murray et al., 2009), 94% with the Gilliam Asperger's Disorder Scale (Mayes, Calhoun, Murray et al., 2009), and 93% with the Autism Diagnostic Interview-Revised (Murray et al., 2011).

### Concurrent Validity

#### *Agreement between the CASD, CARS, and GADS*

A previous study (Mayes, Calhoun, Murray et al., 2009) demonstrated excellent diagnostic agreement between the CASD and the Childhood Autism Rating Scale (CARS, Schopler et al., 1986) and the Gilliam Asperger's Disorder Scale (GADS, Gilliam, 2001) in 190 children with LFA, 190 children with HFA, 76 children with ADHD, and 64 typical children. For children with LFA, HFA, or ADHD, correlations between clinician scores were .82 for the CASD and CARS and .81 for the CASD and GADS ( $p < .0001$ , explained variance  $> 65\%$ ). Diagnostic agreement between the CASD and CARS completed by clinicians was 98% and between the CASD and GADS, it was 94%.

#### *Agreement between the CASD and ADI-R*

A study by Murray et al. (2011) compared the CASD

(completed independently by parents in 10 minutes) and the Autism Diagnostic Interview-Revised (ADI-R, Rutter, Le Couteur, & Lord, 2008), a 2 to 2½ hour interview with the parents. Diagnostic agreement between the instruments was 93%. The sample comprised 29 children with suspected autism spectrum disorder referred for participation in a social skills training study. All participants had a diagnosis of autistic disorder, Asperger's disorder, or pervasive developmental disorder-NOS from a community professional. The study was designed to include individuals who might not meet criteria for autistic disorder in order to provide a broad range of scores to assess agreement between the measures. The children were 12-17 years of age with IQs of 64-144. Twenty-four of the 29 children scored in the autism range on both the CASD and ADI-R, and three scored below the cutoff on both the ADI-R and CASD. The remaining two children were below the autism cutoff on the parent completed CASD, but not on the clinician completed ADI-R.

#### *Agreement between the CASD and DSM-IV*

In a sample of 110 children with LFA and 47 children with HFA 1-14 years of age, all children had CASD scores  $\geq 15$  and there was 100% diagnostic agreement between the CASD diagnosis and that of a board certified child psychiatrist using DSM-IV criteria (Mayes et al., 2001).

### Construct Validity

#### *Factor Analysis*

**The 30 CASD symptoms are grouped according to clinical relevance into six subscales: 1) Problems with social interaction, 2) Perseveration, 3) Somatosensory disturbance, 4) Atypical communication and development, 5) Mood disturbance, and 6) Problems with attention and safety.** Principal component factor analysis (with a varimax rotation) for the combined standardization and autism normative samples ( $N = 2,469$ ) revealed two factors for the CASD symptoms. All 11 symptoms on three of the six clinical subscales (problems with social interaction, mood disturbance, and problems with attention and safety) were on factor one with 11 additional symptoms (factor loadings .52 to .78).

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The second factor contained the eight remaining CASD symptoms from the perseveration, somatosensory disturbance, and atypical communication and development clinical subscales (i.e., #7 repetitive play, #9 stereotypies, #10 crave movement, #14 fascination with repetitive movements, #15 mouthing and smelling objects, #17 high pain tolerance, #20 language regression, and #21 normal motor and delayed speech milestones). Factor loadings for these symptoms were .50 to .75. The finding of two factors is consistent with other autism instruments which also have two factors (CARS-2 Standard Version, Schopler et al., 2010 and Autism Spectrum Rating Scales, Goldstein & Naglieri, 2010).

### **Reliability**

#### ***Clinician-Parent Agreement***

In a study of referred children with autism or ADHD (Mayes, Calhoun, Murray et al., 2009), the correlation between paired clinician and parent CASD total scores was .93 ( $p < .0001$ , explained variance 86%), and percent agreement as to whether the children fell below versus at or above the CASD autism cutoff of 15 was 90%. Mean CASD total clinician scores (21.8) and parent scores (21.3) for the same children with autism did not differ significantly from each other ( $t = 1.6, p = .12$ ).

#### ***Internal Consistency***

Cronbach's alpha was very high (.97) for the combined standardization and autism normative samples ( $N = 2,469$ ), indicating excellent internal consistency for the 30 CASD symptoms.

## CHAPTER 6: DIFFERENTIAL DIAGNOSIS

### Autism versus ADHD

ADHD is a common childhood disorder that, together with autism, comprises a large portion of referrals for child diagnostic evaluations. **Children with autism and children with ADHD have many overlapping features that can complicate a differential diagnosis.** These include inattention, impulsivity, and overactivity (Frazier et al., 2001; Gadow, DeVincent, Pomeroy, & Azizian, 2005; Mayes & Calhoun, 2004b, 2006a, 2007, 2008, 2011; Sturm, Fernell, & Gillberg, 2004), difficulty with social skills (Clark, Feehan, Tinline, & Vostanis, 1999; de Boo & Prins, 2007), mood and behavior problems (Connor, Steeber, & McBurnett, 2010; Gadow et al., 2005; Mayes & Calhoun, 2011), early language delay (Mayes & Calhoun, 1999, 2011; Miniscalco, Hagberg, Kadesjo, Westerlund, & Gillberg, 2007), and sleep problems (Mayes, Calhoun, Bixler, & Vgontzas, 2009).

**Children with autism and children with ADHD also have similar neuropsychological weaknesses, including executive function deficits (Corbett, Constantine, Hendren, Roche, & Ozonoff, 2009), slow processing speed (Calhoun & Mayes, 2005), dysgraphia (Mayes & Calhoun, 2004b, 2007), and learning disability in written expression (Mayes & Calhoun, 2006b, 2007).** Children with autism and ADHD do not differ on psychometric measures of attention or on maternal ratings of attention deficit (Mayes, Calhoun, Mayes, & Molitoris, 2012). In view of the fact that ADHD symptoms are common in autism, the DSM-IV (American Psychiatric Association, 2000) states that an additional diagnosis of ADHD is not given if a child has an autism spectrum disorder. Because ADHD symptoms are present in both disorders, some children with autism are initially misdiagnosed with ADHD and a diagnosis of autism is often delayed (Hartley & Sikora, 2009).

**Although ADHD symptoms are common in autism, autistic symptoms are rare in children with ADHD (Mayes, Calhoun, Mayes, & Molitoris, 2012).** In a study of 847 children with autism and 158 children with ADHD 2-16 years of age (Mayes, Calhoun, Mayes, & Molitoris, 2012), children with

autism were easily distinguished from children with ADHD using CASD clinician scores. All children with autism had 15 or more of the 30 CASD symptoms ( $M = 22$ ), and none of the children with ADHD did ( $M = 4$ ), including those with comorbid ODD and anxiety disorder. This is consistent with data in the CASD standardization study showing that none of the children with ADHD scored in the autism range on the clinician CASD. Some autism scales do not differentiate ADHD and autism as well as other instruments. For example, 36% of children with ADHD-Combined type met the autism criterion on the Social Responsiveness Scale in a study by Reiersen, Constantino, Volk, and Todd (2007).

**The study by Mayes, Calhoun, Mayes, and Molitoris (2012) indicates that autistic symptoms are uncommon in ADHD, but ADHD symptoms are part of autism, consistent with the DSM-IV's contention.** However, one interesting difference in attention problems was revealed between children with autism and children with ADHD in the study. Children with HFA and LFA had a significantly higher frequency of selective attention (98%) than children with ADHD (21%). Unlike most children with ADHD who have difficulty sustaining their focus on anything, children with autism have the ability to hyperfocus on activities of interest to them, such as spending hours twirling a string, assembling puzzles, drawing repetitive pictures, or reading a book.

### Autism versus Oppositional-Defiant Disorder

Children with autism and children with ODD have similar mood and behavior problems. In comparison to the norm, children with autism have significantly more opposition and aggression (Gadow et al., 2005; Guttman-Steinmetz, Gadow, & DeVincent, 2009; Kanne & Mazurek, 2010; Murphy, Healy, & Leader, 2009) and irritability, explosiveness, and moodiness (Brereton, Tonge, & Einfeld, 2006; Mayes et al., 2012; Mayes, Calhoun, Murray, Ahuja, & Smith, 2011). Only 17% of parents of children with autism describe their children as predominantly happy, pleasant, and cooperative (Mayes & Calhoun, 1999). In a study of 435 children with autism (Mayes et al., 2011), 42% met DSM-IV criteria for ODD. However,

because mood and behavior problems are common in autism, an additional diagnosis of ODD may not be necessary, just as the DSM-IV states that ADHD not be diagnosed in autism because it is part of autism itself.

Like most children with autism, children with ODD are moody, hypersensitive, and overreactive, they have difficulty with social skills and making friends, and they insist on doing things their way. In a study by Mayes, Calhoun, Mayes, and Molitoris (2012), children with ADHD-Combined type and ODD had significantly higher frequencies on nine CASD items than children with ADHD-Combined type without ODD. These nine items reflected problems with social skills (e.g., difficulty making friends and socially insensitive behavior), emotional regulation (overreactivity, moodiness, and distress with change), safety awareness, and sleep. **However, in this same study, only two of the 30 CASD symptoms (problems with social skills and overreactivity, meltdowns, or aggression) were present in the majority of children with ADHD and ODD, whereas almost all CASD symptoms were present in the majority of children with autism.** None of the children with ADHD and ODD in the study had a CASD clinician score in the autism range, similar to the findings for the CASD national standardization sample.

### **Autism versus Anxiety Disorders**

Children with autism have significantly higher parent ratings of anxiety than typical children (Bellini, 2004; Gadow et al., 2005; Kim, Szatmari, Bryson, Streiner, & Wilson, 2000; Russell, & Sofronoff, 2005). In a study of 350 school age children with autism (Mayes, Calhoun, Murray, Ahuja, & Smith, 2011), mothers of 79% of the children with HFA and 67% of the children with LFA reported anxiety, worrying, or fearfulness in their children. In another study (Mayes, Calhoun, Murray, & Zahid, 2011) involving 277 preschool children with autism, anxiety was reported by 62% of mothers of children with HFA and 36% of mothers of children with LFA.

In a sample of school-age children, children with HFA did not differ significantly on maternal ratings of anxiety from a comparison group of children who had an anxiety disorder and no autism (Mayes, Calhoun, Mur-

ray, Ahuja, & Smith, 2011). **Although both children with autism, and children with an anxiety disorder, have high levels of anxiety, there are many qualitative differences in symptoms.** Social avoidance in individuals with social anxiety disorder results from social anxiety, whereas in autism, social avoidance may stem from social indifference. Children with social anxiety are slow to warm up, but do enjoy interacting with familiar people, whereas children with autism may prefer to play alone, even when with people they know. Repetitive behaviors in autism (e.g., spinning wheels on a car or drawing the same pictures over and over) are driven by pleasure, whereas compulsions in obsessive-compulsive disorder serve to decrease anxiety. For example, a child may have an obsessive fear of germs and engage in compulsive hand washing to reduce anxiety. Fears are common in children with autism and in children with an anxiety disorder, but phobias in autism are often atypical (e.g., elevators, steps, toilets, vacuum cleaners, and balloons, Mayes & Calhoun, 1999), in contrast to more typical childhood fears (e.g., fear of the dark) or those common in specific phobia (e.g., fear of dogs). Anxious children may exhibit nervous mannerisms (e.g., nail biting or hair twirling) or tics (e.g., eye blinking, head jerking, or throat clearing), which are different from the repetitive movements or stereotypies seen in autism (e.g., toe walking, rocking, and hand flapping).

In a study by Mayes, Calhoun, Mayes, and Molitoris (2012), children with ADHD-Combined type and an anxiety disorder had higher frequencies than children with ADHD alone on four CASD items (#2 limited reciprocal social interaction, #13 distress with commotion and crowds, #16 tactile defensiveness, and #26 moodiness). Children with ADHD-Inattentive type and an anxiety disorder had higher frequencies than children with ADHD-Inattentive type alone on two CASD items (#8 distress with change and #13 distress with commotion or crowds). None of the children with ADHD and an anxiety disorder had CASD clinician scores in the autism range.

### **Autism versus Depression**

Children with autism have higher than normal levels of depression (Gadow et al., 2005; Hurtig et al., 2009;

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Kim et al., 2000; Mayes, Calhoun, Murray, Ahuja, & Smith, 2011). In a sample of 350 children with autism, mothers reported depressed mood in 54% of children with HFA and 42% of children with LFA (Mayes, Calhoun, Murray, Ahuja, & Smith, 2011). In a study by Mayes, Calhoun, Mayes, and Molitoris (2012), none of the children with ADHD and comorbid major depressive disorder or dysthymic disorder had a CASD clinician score in the autism range. In the standardization sample, mean CASD clinician scores for children with ADHD and comorbid anxiety and/or oppositional-defiant disorder increased by less than half a point when depression was also present.

#### **Autism versus Mental Retardation**

None of the children with mental retardation, cerebral palsy, or traumatic brain injury in the standardization study scored in the autism range on the CASD completed by clinicians. Although most CASD symptoms were found in the majority of children with autism, only one symptom (#5 problems with social skills) was reported in the majority of children with mental retardation. All CASD symptoms occurred in 31% or more of children with autism. In contrast, 12 symptoms (Table 7) were present in 6% or less of children with mental retardation.

#### **Autism versus Language Disorder and Hearing Impairment**

Children with autism, language disorder, and hearing impairment may all have language problems including delayed expressive and receptive language and difficulty with verbal expression, reciprocal conversational speech, and language comprehension. **All children with autism have communication impairment, as specified by the DSM-IV. However, children with a language disorder and no autism do not have the CASD cluster of unusual speech patterns specific to autism.** These include loss of speech between 1 and 2 years of age, atypical repetitive vocalizations, echolalia, scripting from movies and TV, and incessantly talking at people on topics of interest to self. Fifteen CASD symptoms that are very common in autism were not exhibited by any of the children with a language disorder or hearing im-

pairment in the standardization study (Table 7). All children with a language disorder or hearing impairment in the standardization sample scored below the autism range on the CASD completed by clinicians and parents, and their CASD clinician scores did not differ from those of the typical children ( $t = 0.4, p = .67$ ).

#### **Autism versus Learning Disability**

All children with a learning disability in the standardization sample had CASD clinician and parent scores below the autism range, with a mean of 1.6 for both. All CASD clinician symptoms occurred in fewer than 19% of children with a learning disability.