Sensory Processing, Problem Behavior, Adaptive Behavior, and Cognition in Preschool Children With Autism Spectrum Disorders

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KEY WORDS
- adaptation, psychological
- autistic disorder
- child development disorders, pervasive
- behavior
- sensation disorders

OBJECTIVE. This retrospective study explored sensory processing characteristics in preschool-age children with autism spectrum disorders (ASD); the relationships between sensory processing and problem behavior, adaptive behavior, and cognitive function; and the differences in sensory processing between two subgroups (autism and pervasive developmental disorder–not otherwise specified).

METHOD. Study measures included the Short Sensory Profile (SSP), Aberrant Behavior Checklist–Community, Vineland Adaptive Behavior Scales, and Mullen Scales of Early Learning.

RESULTS. Most of the children with ASD had sensory processing challenges, and a significant relationship was found between SSP total scores and problem behavior scores; however, no significant relationships were found between SSP total scores and adaptive behavior and cognitive functioning. Although all the children had low Vineland scores, approximately one-quarter of the children had typical SSP scores. No significant differences in SSP scores were found between the subgroups.

CONCLUSION. The findings highlight the importance of comprehensive evaluations for children with ASD.

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Participation in daily life is often challenging for children with autism spectrum disorders (ASD). ASD affects 1 in 110 children in the United States (Centers for Disease Control and Prevention, 2009) and ranges in severity from autistic disorder to milder subtypes, such as Asperger's disorder and pervasive developmental disorder–not otherwise specified (PDD–NOS; American Psychiatric Association [APA], 1994). Children with ASD may have difficulty engaging in typical occupations of childhood, such as activities of daily living (ADLs), social participation, play, and education (American Occupational Therapy Association, 2008). Meaningful participation in home and community activities is an intervention priority for children with ASD, a priority that occupational therapists support by promoting engagement in childhood occupations.

Participation and skill in everyday activities can be influenced by many factors, one of which is sensory processing. The term *sensory processing* refers to the receiving, organizing, and interpreting of sensory stimuli using the seven sensory systems (e.g., tactile, vestibular, auditory; Miller & Lane, 2000). Although not diagnostically a core feature of ASD, sensory processing differences in children with ASD have been well documented (Ben-Sasson et al., 2009; Huebner, 2001; Kern et al., 2006). Symptoms may include unusual responses to sensory stimuli, such as overresponsivity or underresponsivity (Dahlgren &

Gillberg, 1989; Dawson & Watling, 2000; Gabriels, Cuccaro, Hill, Ivers, & Goldson, 2005; Lord, 1995). For example, "over-responsivity behaviors such as resistance to touch and sensitivity to noise may limit the child's participation above and beyond his/her core social deficits" (Ben-Sasson et al., 2008, p. 823).

Although not specific to ASD, limited participation in sensory experiences significantly hinders a child's active exploration of the environment. Children may have difficulties performing ADLs and engaging with others because of atypical sensory responses. Moreover, behavioral and emotional problems have been associated with sensory processing differences (Baker, Lane, Angley, & Young, 2008), and sensory symptoms have been significantly related to stereotyped interests and repetitive behaviors in ASD (Chen, Rodgers, & McConachie, 2009; Rogers, Hepburn, & Wehner, 2003; Wiggins, Robins, Bakeman, & Adamson, 2009).

Occupational therapists use several methods to gather information about a child's sensory history and sensory characteristics, including parent interviews, clinical observations, and questionnaires. One questionnaire is the Sensory Profile (Dunn, 1999), a standardized parent-report measure. Using the Sensory Profile, many studies have documented significant differences in the way children with ASD respond to sensory experiences compared with typically developing peers. Dunn, Myles, and Orr (2002) compared Sensory Profile scores between children aged 8–14 yr with Asperger syndrome and children without disabilities. Children with Asperger syndrome had lower scores than children without disabilities in auditory processing and modulation factors related to hyporesponsiveness and hyperresponsiveness, suggesting difficulty responding appropriately to stimuli and regulating emotional responses.

In another study, researchers found that 85% of the Sensory Profile items differentiated children with ASD from typically developing children (Kientz & Dunn, 1997). Differences were evident in the way children with ASD responded to touch and auditory input. Children with ASD also scored differently from typically developing peers on 17 of 20 emotional–social items, such as "poor frustration tolerance" and "needs more protection from life than other children." Watling, Deitz, and White (2001) found that 85% of young children with ASD aged 3–6 yr scored lower than children without autism on at least one of the following Sensory Profile factors: Sensory Seeking, Emotionally Reactive, Low Endurance/Tone, Oral Sensitivity, Inattention/Distractibility, Poor Registration, Fine Motor/Perceptual, and Other.

Additionally, many studies have focused on sensory responsivity in children with ASD. In a meta-analysis of 14 studies (Ben-Sasson et al., 2009), the differences between ASD groups and typically developing groups were more pronounced for underresponsivity. This finding is similar to that of Schoen, Miller, Brett-Green, and Nielsen (2009), who reported that children with ASD aged 5–15 yr were less reactive to sensory stimuli than typically developing peers. Similarly, Baker et al. (2008) reported that children with autism aged 2–9 yr scored more than 2 standard deviations (*SD*s) below the mean on the Short Sensory Profile (SSP; McIntosh, Miller, & Shyu, 1999) domain of Underresponsive/Seeks Sensation.

Researchers have recently become interested in the relationship between sensory processing and both problem and adaptive behaviors (Jasmin et al., 2009; Liss, Saulnier, Fein, & Kinsbourne, 2006; Rogers et al., 2003; Wiggins et al., 2009). In a study of young children aged 17–45 mo, Wiggins and colleagues (2009) reported a significant correlation between the SSP and the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 1999) stereotyped interest and behavior score, but not the ADOS social and communication score. Similarly, Rogers and colleagues (2003) reported that sensory processing scores as measured by the SSP were significantly correlated with the ADOS repetitive and restricted behavior score, but not the ADOS social and communication score in children with autism ($n = 26$). They also found that sensory responsivity was more strongly associated with levels of adaptive behavior than with severity of autism symptoms.

Commonly used measures of problem or aberrant behavior and adaptive behavior are the Aberrant Behavior Checklist–Community (ABC–C; Aman & Singh, 1994) and the Vineland Adaptive Behavior Scales (VABS; Sparrow, Balla, & Cicchetti, 1984), respectively. Using the ABC–C, Green, O'Reilly, Itchon, and Sigafoos (2005) reported that many aberrant behaviors were persistent and highly prevalent in their study of preschool children with developmental disabilities. Using the VABS, Jasmin and colleagues (2009) explored the relationship between sensory processing and daily living skills in children with autistic disorder aged 3–4 yr. Findings indicated that sensory avoiding was significantly correlated with daily living skills.

In summary, the literature suggests that a high prevalence of children with ASD have sensory processing differences and that these differences are associated with deficits involving problem behavior and adaptive behavior. Because sensory processing differences can affect participation in childhood occupations, along with problem and adaptive behaviors, these areas are relevant topics of research in occupational therapy. Additionally, as research

continues to delineate symptoms among ASD subgroups (e.g., autism, PDD–NOS), the sensory processing characteristics of ASD subgroups should be considered.

Purposes of the Study

The purposes of this retrospective study of children with ASD aged 3 through 4 yr were to describe their sensory processing characteristics, problem behavior, adaptive behavior, and cognitive functioning; to examine the relationships between the scores of these children on the SSP and on measures of problem behavior, adaptive behavior, and cognitive functioning; to compare levels of sensory processing to levels of adaptive behavior; and to explore the sensory processing differences between two subgroups of these children. Group 1 was children with autism, and Group 2 was children with PDD–NOS. Measures of sensory processing, problem behavior, and adaptive behavior were based on parent report.

Method

Research Design

In this retrospective study, we used data from a subgroup of participants in a larger Early Development Study at the University of Washington (UW) Autism Center. The larger study was funded by the National Institute of Child Health and Human Development. We described and compared the data related to sensory processing, problem behavior, adaptive behavior, and cognitive ability. This study was approved by the UW Human Subjects Review Board.

Participants

Participants for the UW Early Development Study were recruited from local parent advocacy groups, public schools, the Division of Developmental Disabilities, clinics, hospitals, and the UW Infant and Child Subject Pool. For the subgroup of participants in the current study, inclusion criteria consisted of having a diagnosis of ASD; having a complete SSP at 3 or 4 yr of age; and not having a diagnosis of Rett syndrome or Fragile X syndrome or a concomitant diagnosis of cerebral palsy, Down syndrome, deafness, or significant prematurity (28 wk gestation or less).

Diagnosis

Diagnostic clinicians at the UW Autism Center Research Program evaluated each participant. The clinicians, who included doctoral-level clinical psychologists and qualified graduate students in clinical psychology, administered two assessments to evaluate the symptoms of autistic disorder as defined in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM–IV;* APA, 1994). Symptoms include qualitative impairments in communication and social interaction and the presence of restricted behavioral patterns and interests. The clinicians administered the Autism Diagnostic Interview–Revised (ADI–R; Lord, Rutter, & Le Couteur, 1994) to parents and the Autism Diagnostic Observation Schedule–Generic (ADOS–G; Lord et al., 2000) to the child participants. In addition, clinical judgment was part of the diagnostic process to identify the presence or absence of autism symptoms in the *DSM–IV*. The autism diagnosis was defined as meeting criteria for autistic disorder on both the ADOS–G and ADI–R, along with meeting *DSM–IV* criteria for autistic disorder on the basis of clinical judgment. If a participant scored within 2 points of meeting ADI–R criteria and met *DSM–IV* and ADOS–G criteria, the participant was also given the diagnosis of autistic disorder. A diagnosis of PDD–NOS was made when participants qualified for PDD–NOS on the ADOS–G, met criteria for autistic disorder on the ADI–R or missed qualifying on the ADI–R by 2 or fewer points, and at least met the *DSM–IV* criteria for PDD–NOS on the basis of clinical judgment.

Instruments

The SSP is a standardized parent questionnaire developed as a screening instrument to identify children with sensory processing difficulties and associated behaviors. The SSP differs from the complete Sensory Profile Caregiver Questionnaire (125 items) in that it consists only of items related to sensory events. Behaviors, such as social–emotional and fine motor abilities, are excluded. A Likert scale ranging from 1 to 5 is used to score 38 SSP items; a score of 1 is given for behaviors "always" occurring, and a score of 5 is given for behaviors "never" occurring. The raw scores are used to produce seven section scores for Tactile Sensitivity, Taste/Smell Sensitivity, Movement Sensitivity, Underresponsive/Seeks Sensation, Auditory Filtering, Low Energy/Weak, and Visual/Auditory Sensitivity. The total score ranges from 38 to 190, with cutoff points available for classification categories (typical performance = raw scores ≥155; probable difference [−1 to −2 *SD*s] = raw scores of 142–154; definite difference [>2 *SD*s below the mean] = raw scores ≤141).

The most reliable score is the SSP total score. Internal reliabilities for the SSP, calculated using Cronbach's alphas, ranged from .70 to .90; internal validity was measured by looking at the intercorrelations of the SSP total and section scores, and correlations were in the low to

moderate range (.25–.76; Dunn, 1999). Construct validity was examined by comparing SSP scores with physiological response data (i.e., electrodermal response [EDR]). Using the Sensory Challenge Protocol, a procedure used to measure an individual's response to 50 sensory stimuli, Miller et al. (1999) recorded the electrodermal activity of 15 children and found that children with abnormal EDR had lower SSP scores on all sections than children with EDR in the normal range ($p \leq .05$), thus supporting the construct validity of the SSP.

The ABC–C is a 58-item measure of maladaptive or problem behaviors known to occur in people with moderate to profound mental retardation. Although the ABC–C was designed for children aged 6–18 yr, it has been used by researchers (Green et al., 2005) to examine problem behaviors in children aged 35–55 mo with developmental delays. Each item is scored on a scale of 0–3 (0 = *not at all a problem* and 3 = *problem is severe in degree*); higher ABC–C scores indicate more severe behaviors. Summed total scores range from 0 to 174. The scale includes five factors: (1) Irritability, Agitation, Crying; (2) Lethargy, Social Withdrawal; (3) Stereotypic Behavior; (4) Hyperactivity, Noncompliance; and (5) Inappropriate Speech. Green et al. (2005) reported that the ABC–C items are nearly identical to the original Aberrant Behavior Checklist (ABC; Aman & Singh, 1986) items, but the Community version relates to naturalistic settings instead of residential institutions, making it appropriate for rating the severity of behaviors in preschool-age children living in the community. Neither the manual for the ABC (Aman & Singh, 1986) nor the supplemental manual for the ABC–C (Aman & Singh, 1994) discusses the reliability or validity for this age group. However, in a study of preschool-age children with developmental delays (mean age = 51 mo), Sigafoos, Pittendreigh, and Pennell (1997) identified the ABC as a reliable instrument for assessing challenging behaviors in young children.

The VABS measures four domains of adaptive behavior—Communication, Daily Living Skills, Socialization, and Motor Skills—yielding scores for each of the domains and a Vineland Adaptive Behavior Composite score (V–ABC). Consisting of 297 items, the VABS Survey Form is a caregiver interview applicable for children and youth from birth to 18 yr, 11 mo. The standardization sample included approximately 3,000 children and youth in various types of educational programs (e.g., regular classroom, speech impaired program, learning disabled program). When readministered 2 to 4 wk later to children 3 yr to 4 yr, 11 mo ($n = 74$), the test–retest reliability coefficient for the V–ABC score was .89 (Sparrow et al., 1984). The manual reports VABS criterion-related validity using correlations between VABS scores, scores from other adaptive behavior scales, and measures of intelligence (Sparrow et al., 1984).

The Mullen Scales of Early Learning: AGS Edition (Mullen, 1995) is an individually administered, standardized measure of cognitive functioning in young children. The Early Learning Composite (ELC) is calculated using scores from four cognitive scales: Visual Reception, Receptive Language, Expressive Language, and Fine Motor. The ELC is derived from the *T* scores for the four cognitive scales. The median internal reliability of the ELC is high, at .91, using Guilford's formula to compute the coefficients (Mullen, 1995). For children aged 25–44 mo, interscorer reliabilities on the Mullen scales ranged from .98 to .99 using the intraclass correlation coefficient (K. Allen, personal communication, August 1, 2011). Concurrent validity was established with the Bayley Scales of Infant Development (Bayley, 1969). The ELC correlated highly ($r = .70$) with the Bayley Mental Development Index (K. Allen, personal communication, August 1, 2011).

Data Analyses

Data analyses were completed using SPSS 14.0 (SPSS, Inc., Chicago). Descriptive statistics were used to describe children's scores on measures of sensory processing, problem behavior, adaptive behavior, and cognition, and frequency counts were used to compare SSP category scores to categories of V–ABC scores. Descriptive statistics also were used to determine whether score distributions met the assumptions for the use of parametric statistics. Because the scores generally were not normally distributed, nonparametric statistics were used.

Spearman rank-order correlation coefficients were used to examine relationships between scores on the SSP and the other three measures. To explore the sensory processing differences between the two subgroups of children with ASD (autism and PDD–NOS), we used the Mann–Whitney *U* statistic. Results having a probability value of $p < .05$ (two-tailed) were considered statistically significant. Consequently, the possibility of a Type 1 error was increased for analyses involving multiple comparisons; therefore, the findings should be interpreted with caution and regarded as exploratory. Last, for exploratory purposes, we determined percentages of children in each of three SSP classification categories—typical, probable difference, and definite difference—both for the ASD group as a whole and for the autism and PDD–NOS subgroups.

Results

Description of Sample

Forty-two of the 75 children with ASD in the University of Washington Autism Center Early Development Study met inclusion criteria for the current study. Of the 42 children with ASD, 28 had a diagnosis of autism and 14 had a diagnosis of PDD–NOS. The mothers' ages ranged from 19 to 42 yr (median = 32 yr) at the time of birth, and the length of pregnancy ranged from 31 to 44 wk (median = 39.5 wk). Forty-one of the children with ASD had birth weights greater than 5 lb, 8 oz. The birth weights of the children ranged from 4 lb, 12 oz, to 11 lb, 8 oz (median = 8 lb, 4 oz). At the time of administration of the SSP and ABC–C, the children's ages ranged from 36 mo to 59 mo (median = 45.5 mo).

Findings

First, we examined scores on multiple measures for the whole group of 42 children with ASD. Descriptive statistics for the SSP total scores were as follows: Mean = 140.1, median = 140.5, low/high = 90/174, and *SD* = 20.2, indicating that more than half of the children had scores in the definite difference range (≤141). Table 1 displays descriptive statistics and the relationships between SSP total scores and problem behavior, adaptive behavior, and IQ. With the exception of the ABC–C, higher scores relate to better performance on the measures. Higher levels of sensory processing difficulties were consistently associated with higher levels of behavior challenges across the categories of behavior problems. Although higher levels of sensory processing difficulties tended to be mildly associated with lower levels of adaptive behavior (r_s = .30), the relationship was not significant. Differences in sensory processing were not associated with level of cognitive ability. Children with fewer sensory challenges did not tend to have higher cognitive ability.

Next, we examined the relationship between degree of sensory processing difference and level of adaptive behavior to see the extent to which children scored either low on both measures (e.g., low on the SSP and low on the V–ABC) or high on one measure and low on the other (e.g., typical on the SSP and low on the V–ABC). Table 2 shows the number of children with no, probable, and definite sensory processing impairment according to their level of adaptive behavior. For 3 of the 42 children in the ASD group, the VABS was not complete. Of the 39 children with complete V–ABC scores, all had scores more than 1 *SD* below the mean, indicating a limited score range that reflected consistent deficits in adaptive behavior. Although a majority of children had SSP scores indicative of probable or definite sensory differences, 26% had SSP scores in the typical performance range.

In Table 3, the SSP total score and each of the seven section scores for the children with autism are compared with scores for the children with PDD–NOS. Higher scores on the SSP indicate fewer sensory processing challenges. Although the PDD–NOS group median scores for total score and four of seven section scores were slightly higher than those for the autism group, no significant differences on SSP total or section scores between the autism and PDD–NOS groups were found.

Last, Table 4 reports the percentage of children who scored in each SSP category (typical, probable difference, definite difference) for each of the seven SSP section scores and the SSP total score. Relative to the group as a whole, 35 (83%) of the 42 children with ASD had one or more section scores in the definite difference range. For the total score and each of the section scores, a higher percentage of children in the PDD–NOS group than in the autism group had scores in the typical range.

Table 1. Descriptive Statistics and Relationships Between SSP Total Scores and Measures of Problem Behavior, Adaptive Behavior, and IQ

		Scores				Relationship to SSP Total Score	
Measure	*n*	*M*	Median	Low/High	*SD*	r_s[a]	*p* (2-tailed)
ABC–C Total Score[b]	42	44.3	41.0	2/126	26.3	−.54	<.001
ABC–C Irritability, Agitation, Crying[b]	42	11.8	9.5	1/35	8.4	−.41	.007
ABC–C Lethargy, Social Withdrawal[b]	42	9.8	8.5	0/33	7.2	−.46	.002
ABC–C Stereotypic Behavior[b]	42	4.8	4.0	0/18	4.5	−.38	.012
ABC–C Hyperactivity, Noncompliance[b]	42	15.3	13.0	1/41	9.9	−.45	.003
ABC–C Inappropriate Speech[b]	42	2.7	2.0	0/9	2.5	−.35	.023
Vineland Adaptive Behavior Composite[c]	39	61.1	59.0	48/84	9.9	.30	.062
Mullen Early Learning Composite[d]	42	60.4	51.5	49/106	15.9	.07	.673

Note. ABC–C = Aberrant Behavior Checklist–Community; *M* = mean; *SD* = standard deviation; SSP = Short Sensory Profile.
[a]Spearman rank order correlation coefficient. [b]Aberrant Behavior Checklist–Community (no appropriate normative values available). [c]Vineland Adaptive Behavior Scales (*M* = 100, *SD* = 15). [d]Mullen Scales of Early Learning (*M* = 100, *SD* = 15).

Table 2. Number of Children in Each SSP Classification Category, by V–ABC *SD* Score (*N* = 39)

V–ABC Score	No. of Children in Each SSP Total Score Category		
	Typical	Probable Difference	Definite Difference
−1 *SD* to mean	0	0	0
−2 *SD* to −1 *SD*	5	1	4
Greater than −2 *SD*	5	8	16

Note. *SD* = standard deviation; SSP = Short Sensory Profile; V–ABC = Vineland Adaptive Behavior Composite.

Discussion

According to parent reports, a majority of the preschool children aged 3 through 4 yr with ASD in our sample had sensory processing challenges, and we found a significant relationship ($p < .001$, two-tailed) between degree of sensory processing impairment and level of problem behavior as indicated by the ABC–C total score. This finding held true across different types of behavior challenge, including irritability, lethargy, stereotypic behavior, hyperactivity, and inappropriate speech. Lane, Young, Baker, and Angley (2010) reported similar findings and found a strong predictive association between sensory processing dysfunction and problem or maladaptive behaviors.

Table 3. Comparisons Between the Autism Group (*n* = 28) and PDD–NOS Group (*n* = 14) on SSP Section Scores and Total Scores

SSP Section	Raw Scores				*p*[a] (2-tailed)
	M	Median	Low/High	*SD*	
Tactile Sensitivity					.46
Autism	26.9	27.5	15/34	5.0	
PDD–NOS	28.1	29.0	18/35	5.5	
Taste/Smell Sensitivity					.78
Autism	12.3	11.5	4/20	4.4	
PDD–NOS	12.4	9.5	6/20	5.7	
Movement Sensitivity					.27
Autism	12.9	13.5	9/15	2.2	
PDD–NOS	13.6	14.5	9/15	2.0	
Underresponsive/Seeks Sensation					.09
Autism	23.9	25.0	14/33	4.7	
PDD–NOS	26.3	27.5	9/33	6.2	
Auditory Filtering					.78
Autism	18.7	19.0	12/25	4.0	
PDD–NOS	18.8	18.5	7/26	5.2	
Low Energy/Weak					.97
Autism	26.1	29.0	12/30	5.5	
PDD–NOS	27.4	28.0	22/30	2.8	
Visual/Auditory Sensitivity					.52
Autism	17.2	18.0	9/24	3.9	
PDD–NOS	17.7	18.5	7/25	5.0	
Total SSP					.29
Autism	137.9	137.5	105/173	17.8	
PDD–NOS	144.4	145.0	90/174	24.3	

Note. ASD = autism spectrum disorder; *M* = mean; PDD–NOS = pervasive developmental disorder–not otherwise specified; *SD* = standard deviation; SSP = Short Sensory Profile.
[a]Mann–Whitney *U* test.

Table 4. Percentage of Children in the ASD Group (*n* = 42) and the Autism (*n* = 28) and PDD–NOS (*n* = 14) Subgroups Who Scored in Each SSP Classification Category

SSP Section	SSP Classification Category (%)		
	Typical	Probable Difference	Definite Difference
Tactile Sensitivity			
ASD	40.5	19.0	40.5
Autism	35.7	25.0	39.3
PDD–NOS	50.0	7.1	42.9
Taste/Smell Sensitivity			
ASD	30.9	16.7	52.4
Autism	25.0	25.0	50.0
PDD–NOS	42.9	0.0	57.1
Movement Sensitivity			
ASD	71.4	7.1	21.4
Autism	64.3	10.7	25.0
PDD–NOS	85.7	0.0	14.3
Underresponsive/Seeks Sensation			
ASD	38.1	28.6	33.3
Autism	25.0	35.7	39.3
PDD–NOS	64.3	14.3	21.4
Auditory Filtering			
ASD	23.8	19.1	57.1
Autism	21.4	25.0	53.6
PDD–NOS	28.6	7.1	64.3
Low Energy/Weak			
ASD	69.0	14.3	16.7
Autism	64.3	17.9	17.9
PDD–NOS	78.6	7.1	14.3
Visual/Auditory Sensitivity			
ASD	42.9	33.3	28.8
Autism	39.3	35.7	25.0
PDD–NOS	50.0	28.6	21.4
Total SSP			
ASD	23.8	23.8	52.4
Autism	21.4	17.9	60.7
PDD–NOS	28.6	35.7	35.7

Note. Because of rounding error, not all percentages add up to 100. ASD = autism spectrum disorder; PDD–NOS = pervasive developmental disorder–not otherwise specified; SSP = Short Sensory Profile.

All of the children with ASD had challenges in adaptive behavior. When V–ABC scores were correlated with SSP total scores, however, the relationship was weak ($r = .30$, $p = .06$). This result partially reflects the limited score range for the V–ABC for this sample ($SD = 9.9$), which was expected given that all of the children scored more than 1 *SD* below the mean.

From a clinical perspective, the most relevant data are reported in Table 2, which shows that 26% of children

whose level of adaptive behavior was >1 *SD* below the mean did not have sensory processing differences. This finding suggests that a subgroup of children with ASD and adaptive behavior challenges do not have sensory processing challenges as reported by parents. Even so, the majority of the children in the study did have sensory processing differences, and this finding is consistent with other studies (Lane et al., 2010; Wiggins et al., 2009). Also, the finding of a high prevalence of adaptive behavior challenges in this group is consistent with the work of Baker et al. (2008).

Results related to cognitive function indicate that the children studied had highly variable scores that ranged from >2 *SD*s below the mean to above the mean and that their level of sensory impairments was not correlated with level of cognitive ability. This result suggests that cognitive functioning is not predictive of sensory processing difficulties as reported by parents and vice versa.

When we explored differences in SSP scores between the two subgroups of children (autism and PDD–NOS), although scores for the PDD–NOS group tended to be higher, we found no significant differences for SSP total scores or for the seven section scores. However, as can be seen in Table 4, for the SSP total score and for all seven section scores, a higher percentage of children in the PDD–NOS group scored in the typical range. Although this finding suggests a trend, because of the small sample size, these results are inconclusive and further study is merited.

Limitations and Strengths

The study has two primary limitations. First, we performed numerous analyses on small samples. Because the probability value was set at $p < .05$, the possibility of a Type 1 error was increased for analyses involving multiple comparisons. The second issue was that information is limited regarding the reliability and validity of the ABC–C when used with preschool-age children.

The main strength of this study was that consistent diagnostic criteria were used. Unlike many studies in the literature, for our study the children completed comprehensive diagnostic evaluations.

Future Research

Recommendations for future research include replicating this study with a larger sample. Additionally, the validity of future research may be enhanced by using a wider range of assessments, including observational measures of behavior across different contexts, parent reports, and electrodermal response measures.

Implications for Occupational Therapy Practice

The findings of this study suggest that occupational therapists have an important role in the interdisciplinary team process of evaluating preschool children with ASD.

- Because a majority of the children in the study presented with sensory processing differences and a significant relationship was found between levels of sensory processing and problem behaviors, it is important that a comprehensive evaluation include a focus on identifying a child's sensory processing characteristics and a consideration of how these characteristics might influence a child's behavior.
- The findings related to the heterogeneity of the children with ASD in this study and the existence of a subgroup of children with ASD who have typical sensory processing highlight the importance of comprehensive evaluations focused on identifying a child's strengths and challenges to inform intervention. ▲

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References

Aman, M. G., & Singh, N. N. (1986). *Aberrant Behavior Checklist (ABC).* East Aurora, NY: Slosson Educational Publications.

Aman, M. G., & Singh, N. N. (1994). *Aberrant Behavior Checklist–Community: Supplementary manual.* East Aurora, NY: Slosson Educational Publications.

American Occupational Therapy Association. (2008). Occupational therapy practice framework: Domain and process (2nd ed.). *American Journal of Occupational Therapy, 62,* 625–683. http://dx.doi.org/10.5014/ajot.62.6.62

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

Baker, A. E. Z., Lane, A., Angley, M. T., & Young, R. L. (2008). The relationship between sensory processing patterns and behavioural responsiveness in autistic disorder: A pilot study. *Journal of Autism and Developmental Disorders, 38,* 867–875. http://dx.doi.org/10.1007/s10803-007-0459-0

Bayley, N. (1969). *Bayley Scales of Infant Development.* San Antonio, TX: Psychological Corporation.

Ben-Sasson, A., Cermak, S. A., Orsmond, G. I., Tager-Flusberg, H., Kadlec, M. B., & Carter, A. S. (2008). Sensory clusters of toddlers with autism spectrum disorders: Differences in affective symptoms. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 49,* 817–825. http://dx.doi.org/10.1111/j.1469-7610.2008.01899.x

Ben-Sasson, A., Hen, L., Fluss, R., Cermak, S. A., Engel-Yeger, B., & Gal, E. (2009). A meta-analysis of sensory modulation symptoms in individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39,* 1–11. http://dx.doi.org/10.1007/s10803-008-0593-3

Centers for Disease Control and Prevention. (2009). Prevalence of autism spectrum disorders—Autism and Developmental Disabilities Monitoring Network, United States, 2006. *MMWR Surveillance Summaries, 58,* 1–20. Retrieved from www.cdc.gov/mmwr/preview/mmwrhtml/ss5810a5811.htm

Chen, Y. H., Rodgers, J., & McConachie, H. (2009). Restricted and repetitive behaviours, sensory processing and cognitive style in children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39,* 635–642. http://dx.doi.org/10.1007/s10803-008-0663-6

Dahlgren, S. O., & Gillberg, C. (1989). Symptoms in the first two years of life: A preliminary population study of infantile autism. *European Archives of Psychiatry and Neurological Sciences, 238,* 169–174. http://dx.doi.org/10.1007/BF00451006

Dawson, G., & Watling, R. (2000). Interventions to facilitate auditory, visual, and motor integration in autism: A review of the evidence. *Journal of Autism and Developmental Disorders, 30,* 415–421. http://dx.doi.org/10.1023/A:1005547422749

Dunn, W. (1999). *Sensory Profile: User's manual.* San Antonio, TX: Psychological Corporation.

Dunn, W., Myles, B. S., & Orr, S. (2002). Sensory processing issues associated with Asperger syndrome: A preliminary investigation. *American Journal of Occupational Therapy, 56,* 97–102. http://dx.doi.org/10.5014/ajot.56.1.97

Gabriels, R. L., Cuccaro, M. L., Hill, D. E., Ivers, B. J., & Goldson, E. (2005). Repetitive behaviors in autism: Relationships with associated clinical features. *Research in Developmental Disabilities, 26,* 169–181. http://dx.doi.org/10.1016/j.ridd.2004.05.003

Green, V. A., O'Reilly, M., Itchon, J., & Sigafoos, J. (2005). Persistence of early emerging aberrant behavior in children with developmental disabilities. *Research in Developmental Disabilities, 26,* 47–55. http://dx.doi.org/10.1016/j.ridd.2004.07.003

Huebner, R. A. (2001). *Autism: A sensorimotor approach to management.* Gaithersburg, MD: Aspen.

Jasmin, E., Couture, M., McKinley, P., Reid, G., Fombonne, E., & Gisel, E. (2009). Sensori-motor and daily living skills of preschool children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39,* 231–241. http://dx.doi.org/10.1007/s10803-008-0617-z

Kern, J. K., Trivedi, M. H., Garver, C. R., Grannemann, B. D., Andrews, A. A., Savla, J. S., et al. (2006). The pattern of sensory processing abnormalities in autism. *Autism, 10,* 480–494. http://dx.doi.org/10.1177/1362361306066564

Kientz, M. A., & Dunn, W. (1997). A comparison of the performance of children with and without autism on the Sensory Profile. *American Journal of Occupational Therapy, 51,* 530–537. http://dx.doi.org/10.5014/ajot.51.7.530

Lane, A. E., Young, R. L., Baker, A. E. Z., & Angley, M. T. (2010). Sensory processing subtypes in autism: Association with adaptive behavior. *Journal of Autism and Developmental Disorders, 40,* 112–122. http://dx.doi.org/10.1007/s10803-009-0840-2

Liss, M., Saulnier, C., Fein, D., & Kinsbourne, M. (2006). Sensory and attention abnormalities in autistic spectrum disorders. *Autism, 10,* 155–172. http://dx.doi.org/10.1177/1362361306062021

Lord, C. (1995). Follow-up of two-year-olds referred for possible autism. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 36,* 1365–1382. http://dx.doi.org/10.1111/j.1469-7610.1995.tb01669.x

Lord, C., Risi, S., Lambrecht, L., Cook, E. H., Jr., Leventhal, B. L., DiLavore, P. C., et al. (2000). The Autism Diagnostic Observation Schedule–Generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders, 30,* 205–223. http://dx.doi.org/10.1023/A:1005592401947

Lord, C., Rutter, M., DiLavore, P., & Risi, S. (1999). *Autism Diagnostic Observation Schedule–WPS edition.* Los Angeles: Western Psychological Services.

Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism Diagnostic Interview–Revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 24,* 659–685. http://dx.doi.org/10.1007/BF02172145

McIntosh, D. N., Miller, L. J., & Shyu, V. (1999). Development and validation of the Short Sensory Profile. In W. Dunn (Ed.), *Sensory Profile manual* (pp. 59–73). San Antonio, TX: Psychological Corporation.

Miller, L. J., & Lane, S. J. (2000). Toward a consensus in terminology in sensory integration theory and practice: Part 1. Taxonomy of neurophysiological processes. *Sensory Integration Special Interest Section Quarterly, 23*(1), 1–4.

Miller, L. J., McIntosh, D. N., McGrath, J., Shyu, V., Lampe, M., Taylor, A. K., et al. (1999). Electrodermal responses to sensory stimuli in individuals with fragile X syndrome: A preliminary report. *American Journal of Medical Genetics, 83,* 268–279. http://dx.doi.org/10.1002/(SICI)1096-8628(19990402)83:4<268::AID-AJMG7>3.0.CO;2-K

Mullen, E. M. (1995). *Mullen Scales of Early Learning: AGS edition.* Circle Pines, MN: American Guidance Service.

Rogers, S. J., Hepburn, S., & Wehner, E. (2003). Parent reports of sensory symptoms in toddlers with autism and those with other developmental disorders. *Journal of Autism and Developmental Disorders, 33,* 631–642. http://dx.doi.org/10.1023/B:JADD.0000006000.38991.a7

Schoen, S. A., Miller, L. J., Brett-Green, B. A., & Nielsen, D. M. (2009). Physiological and behavioral differences in sensory processing: A comparison of children with autism spectrum disorder and sensory modulation disorder. *Frontiers*

in Integrative Neuroscience, 3, 29. http://dx.doi.org/10.3389/neuro.07.029.2009

Sigafoos, J., Pittendreigh, N., & Pennell, D. (1997). Parent and teacher ratings of challenging behaviour in young children with developmental disabilities. *British Journal of Learning Disabilities, 25,* 13–17. http://dx.doi.org/10.1111/j.1468-3156.1997.tb00003.x

Sparrow, S. S., Balla, D. A., & Cicchetti, D. V. (1984). *The Vineland Adaptive Behavior Scales: Survey form manual.* Circle Pines, MN: American Guidance Service.

Watling, R. L., Deitz, J., & White, O. (2001). Comparison of Sensory Profile scores of young children with and without autism spectrum disorders. *American Journal of Occupational Therapy, 55,* 416–423. http://dx.doi.org/10.5014/ajot.55.4.416

Wiggins, L. D., Robins, D. L., Bakeman, R., & Adamson, L. B. (2009). Brief report: Sensory abnormalities as distinguishing symptoms of autism spectrum disorders in young children. *Journal of Autism and Developmental Disorders, 39,* 1087–1091. http://dx.doi.org/10.1007/s10803-009-0711-x