
Responses of Preschool Children With and Without ADHD to Sensory Events in Daily Life

Aviva Yochman,
Shula Parush,
Asher Ornoy

OBJECTIVE. The purpose of this study was to compare parents' perceptions of the responses of their preschool children, with and without attention deficit hyperactivity disorder (ADHD), to sensory events in daily life in Israel. In addition, the relationship between levels of hyperactivity and sensory deficits was examined.

METHOD. The Sensory Profile Questionnaire (SP) was completed by mothers of forty-eight 4- to 6-year-old children with ADHD, and mothers of 46 children without disabilities. A matched group comparison design was used to identify possible differences in sensory processing.

RESULTS. Based on the measure of mothers' perceptions, children with ADHD demonstrated statistically significant differences from children without ADHD in their sensory responsiveness as reflected in 6 out of 9 factor scores ($p < .001-.05$), and on their sensory processing, modulation, and behavioral and emotional responses, as reflected in 11 out of 14 section scores ($p < .001-.05$). Scores on the SP yielded statistically significant low to moderate correlations with scores on the hyperactive scale of the Preschool Behavior Questionnaire ($r = .28-.66$).

CONCLUSION. The findings of the present study suggest that young children with ADHD may be at increased risk of deficits in various sensory processing abilities, over and above the core symptoms of ADHD. Early identification and treatment of sensory processing deficits from a young age may extend our ability to support the successful performance of children with ADHD in meaningful and productive occupations.

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Aviva Yochman, MSc, OTR, is Lecturer, Coordinator of Pediatric Studies, School of Occupational Therapy, Hebrew University—Hadassah Medical School, PO Box 24026, Mount Scopus, Jerusalem, Israel; msshulap@pluto.huji.ac.il

Shula Parush, PhD, OTR, is Director of Graduate Studies, School of Occupational Therapy, Hebrew University—Hadassah Medical School, Jerusalem, Israel.

Asher Ornoy, MD, is Head of Laboratory of Teratology, Hebrew University—Hadassah Medical School, Jerusalem, Israel, and is Head of Department of Child Development and Rehabilitation, Israeli Ministry of Health, Jerusalem, Israel.

Attention deficit hyperactivity disorder (ADHD) is currently conceptualized as involving deficits in sustained attention, impulse control, and activity regulation to a degree that causes significant impairment of occupational performance at school, home, and in social settings (American Psychiatric Association [APA], 1994). In addition to the impairment caused by the core symptoms, researchers and clinicians have suggested that children with ADHD are frequently affected by deficiencies in sensory processing in general, and sensory modulation dysfunction in particular (Cermak 1988; Mangeot et al., 2001; Parush, Sohmer, Steinberg, & Kaitz, 1997). *Sensory processing* is an all encompassing term that refers to the way in which the central and peripheral nervous systems manage incoming sensory information, including the reception, modulation, integration, and organization of sensory stimuli (Miller & Lane, 2000). By contrast, *sensory modulation* relates to one specific component of this process (i.e., the “capacity to regulate and organize the degree, intensity, and nature of responses to sensory input in a graded and adaptive manner”) (Lane, Miller, & Hanft, 2000).

Researchers have attempted to describe the unique patterns of sensory responsiveness typical of children with ADHD, using both physiological and behavioral measures. Testing children with ADHD on physiological measures, such as the somatosensory evoked potential (SEP) (Parush et al., 1997), and electrodermal reactivity (EDR) (Mangeot et al., 2001), has shown that a significant percentage

of these children display differences in sensory reactivity compared to typical children. Various behavioral measures, such as parent questionnaires and examiner checklists, have indicated an increased sensitivity to sensory stimuli such as tactile (Ayres, 1964; Bauer, 1977; Lightsey, 1993), visual, auditory, and taste (Papadopoulos & Staley, 1997). In addition, research has indicated that children with ADHD may have deficits in vestibular and somatosensory functions, such as balance, postrotary nystagmus, (Mulligan, 1996) and tactile discrimination (Parush et al.). Additional deficits, believed to result largely from inefficient sensory processing, have also been described, such as problems in motor coordination and planning (Blondis, 1999; Kadesjo & Gillberg, 1998).

Recently, two studies incorporating the use of the Sensory Profile (SP) Questionnaire on children with and without ADHD (Dunn, 1999) have been performed, in order to understand parents' perceptions of their children's responses to sensory events in daily life across all sensory domains. Dunn and Bennett (2002) compared parents' perceptions of sensory behaviors of 70 children ages 3 to 15 years with ADHD to those of parents of 70 typical children matched for age and gender. Results indicated that parents' perceptions of children with ADHD differed significantly from those of children without disabilities in their sensory responsiveness on all 14 sections of the SP. The majority of items in which the most significant differences occurred clustered into four out of the nine factors: sensory seeking (factor 1), emotionally reactive (factor 2), inattention-distractibility (factor 5), and fine motor (factor 9). Additional significant differences that were not part of the factor structure related to visual perception and tactile responsiveness. These results indicate that children with ADHD may be characterized by a specific pattern of sensory related performance.

Mangeot et al. (2001) compared the occurrence of sensory modulation dysfunction (SMD) of 26 children with ADHD and a control group of 30 typically developing children (ages 5 to 13 years). The children were tested on various measures, including the Short Sensory Profile Questionnaire (SSP; McIntosh, Miller, Shyu, & Dunn, 1999). Their results indicated that children with ADHD displayed greater abnormalities in sensory modulation on both physiological and parent report measures. The children with ADHD showed significantly lower scores on six of the seven subscales of the SSP, particularly in sensory seeking, auditory filtering, and in sensitivity to tactile, auditory, visual, taste, and olfactory stimuli. In addition, on all subscales of the SSP except auditory filtering, greater variability was found in parents' perceptions of sensory responses among the children with ADHD. While

Mangeot et al. (2001) compared sensory processing across all systems, their study utilized the SSP (McIntosh et al., 1999), which was designed to be a screening tool only, and therefore does not provide a comprehensive and detailed description of sensory processing.

In summary, while studies seem to indicate that there may be sensory processing deficits among children with ADHD, most studies investigated isolated sensory systems only. Of the only two studies that did explore the sensory processing of children with ADHD across all sensory domains (Dunn & Bennett, 2002; Mangeot et al., 2001), the age range of the participants was wide and only a small number of preschool children were included. Research has indicated the existence of a developmental trend for sensory processing within some of the systems (Dunn & Daniels, 2001). Therefore, it seems appropriate to conduct a thorough investigation of these abilities within each distinct age group (Watling, Deitz, & White, 2001). In addition, since poor sensory processing abilities in young children may affect their social, cognitive, and sensory-motor development (Dunn, 2001), early identification and intervention may contribute to their overall well being.

Therefore, in this study, the SP scores of preschool children in Israel with and without ADHD in a relatively narrow age group of children ages 4–6 years were compared. Specifically, comparisons were made with respect to: (a) their section scores on the SP, reflecting parents' perceptions of their children's sensory processing, modulation, and behavioral and emotional responses; and (b) the factor scores of the SP, reflecting parents' perceptions of their children's responsiveness to sensory input, (i.e., overly responsive or underresponsive).

Also examined were the correlation between the severity of ADHD symptoms and sensory processing abilities, and the percentage of children in the ADHD group whose scores were more than 1.5 *SD* below the mean of the typically developing children.

Method

This study used a group comparison design to identify possible differences in sensory processing between children with and without ADHD on the SP.

Participants

Forty-eight children (39 males and 9 females) with ADHD and 46 typically developing control children (37 males and 9 females), matched by age, gender, and parental socioeconomic level, participated in this study. Ages ranged from 4–6 years (mean ADHD group age = 4.7 years, *SD* = 0.76; mean control group age = 4.8 years, *SD* = 0.62).

Participants were recruited from regular kindergartens and included all the children from three consecutive yearly cohorts in an Israeli town ($N = 2,092$). Selection criteria for ADHD included the following:

1. A score of $> 1.5 SDs$ above the mean on the hyperactivity or aggressive factors, or both, on both the teachers' and parents' Preschool Behavior Questionnaire (PBQ; Behar & Stringfield, 1974). (This cut off score was determined through a preestablished research protocol.)
2. Classification by a neuropediatrician as ADHD. Since a comprehensive medical assessment is needed in the evaluation of ADHD (Barkley, 1990; Shelton, 1994), the examination included both a physical and neurological examination as well as obtaining a detailed developmental and medical history of the child.
3. Normal intelligence, measured by the Wechsler Preschool and Primary Scale of Intelligence (WPPSI; Wechsler, 1967). This criterion was used to insure that the core symptoms demonstrated by the participants did not result from abnormally low intelligence.

The control group was matched to the research group by age, gender, and parental socioeconomic level, and had to: (a) score within one standard deviation (1 SD) of the mean on all scales on both parent and teachers PBQs, and (b) be of normal intelligence, as measured by the WPPSI.

Exclusion criteria for both groups of subjects included: diagnosis of any clearly defined developmental disorder (such as cerebral palsy or pervasive developmental disorder), and any apparent physical, sensory, or neurological deficits.

Instruments

Preschool Behavior Questionnaire (Behar & Stringfield, 1974). The PBQ is a behavioral questionnaire designed specifically for preschool children aged 3 to 6 years. The factors assessed by the questionnaire relate to 3 subscales: hostile-aggressive, anxious, and hyperactive-distractible behavior. Since the literature indicates that hyperactivity and aggression appear to be particularly intermingled in young children with symptoms of ADHD (Campbell, 1995; Campbell, Breaux, Ewing, & Szumowski, 1986), this study related to the information provided from the hyperactive-distractible and hostile-aggressive subscales (externalizing behaviors). The 30 items are rated on a scale of 0–2 (0 = behavior does not exist; 2 = behavior definitely exists).

The PBQ was standardized on a sample of 598 children ages 3–6 years. Test–retest reliability, performed on 89 children, was found to range from .60 to .94, and interrater reliability for teachers' ratings on the same number of children ranged from .67 to .84 (Behar & Stringfield, 1974). A number of studies have demonstrated acceptable levels of validity. Content validity studies were based on the relevant

literature and consensual validity of preschool teachers. Construct validity studies indicated that the PBQ significantly differentiates between hyperactive and typically developing preschool children (Behar, 1977; Campbell, 1995; Campbell, Szumowski, Ewing, Gluck, & Breaux, 1982; Prior, Leonard, & Wood, 1983). Criterion validity studies found the scores of the PBQ to correlate significantly with structured observation of classroom behavior and with other behavioral scales (Barkley, 1990; Behar, 1977).

The Sensory Profile (Dunn, 1999). The SP is a standardized sensory questionnaire with 125 items, in which care providers rate their children's responses to sensory events that occur in daily life. The questionnaire uses a 5-point Likert scale, corresponding to the frequency of each behavior (i.e., 1 = always, 5 = never). The SP items are written such that lower scores reflect undesirable behaviors. Scores and derived norms can be obtained on each of the 14 SP sections as well as on the 9 SP factors. The 14 subsections are divided into three overall sections: sensory processing, modulation, and behavioral and emotional responses. The 9 factors include sensory seeking, emotionally reactive, low endurance–tone, oral sensory sensitivity, poor registration, inattention-distractibility, sensory sensitivity, sedentary and fine motor-perceptual.

This study related to both the factor and section scores in order to obtain a more comprehensive picture of the children's sensory processing. Thus, whereas the section scores refer to individual sensory systems, the factor scores provide additional information regarding the child's level of responsiveness to sensory input across sensory systems (over and underresponsiveness). Since clinicians refer to factor as well as section scores, information regarding each will be presented in this study.

Reliability includes internal consistency estimates of .47 to .91. Content validity was established via literature review, expert review, and category analysis. Convergent and discriminant validity were demonstrated in a correlational study between the SP and the School Function Assessment (Dunn, 1999). In addition the SP correlated with sections of the Children's Autism Rating Scale that taps sensory processing, demonstrating construct validity (Kientz & Dunn, 1997). Research has also demonstrated that the SP can discriminate between children with and without various disabilities (Dunn, 1999; Ermer & Dunn, 1998).

Wechsler Preschool and Primary Scale of Intelligence (Wechsler, 1967). The purpose of the WPPSI is to measure general intelligence in children ages 3 years 11 months to 6 years 7 months. The test consists of 11 subtests. A verbal, performance, and total IQ score can be obtained. The WPPSI has been shown to be highly reliable in terms of

split half reliability (.77–.87), interrater (.84–.94), and test–retest reliability (.86–.91). The test also shows good validity with studies relating to concurrent validity (using the Stanford-Binet, WISC, and WISC-R as criteria), predictive validity (correlating WPPSI scores to achievement test scores), and construct validity (based on factor analytic studies) (Anastasi, 1988; Wechsler, 1967). In our study we used the Israeli version of the WPPSI that had been translated into Hebrew and standardized on a sample of 1,072 Israeli children. Research done on this version had determined that test–retest reliability was $r = .90-.92$ for the total IQ score. Concurrent validity testing was also done using the Stanford-Binet (.77–.86) (Liblich, 1973).

Procedure

After receiving the relevant permission from the Ministry of Education, supervisors, and kindergarten teachers, letters with a detailed explanation of the purpose and procedures of the research were circulated to all parents of kindergarten children between the ages of 4–6 years, from 3 consecutive yearly cohorts in a town in Israel. Out of a total of 2,092 parents, 774 parents (37%) gave their written consent to participate in the study. Both consenting mothers and the kindergarten teachers completed the PBQ (Behar & Stringfield, 1974). From these 774 children, 78 were identified as having symptoms of ADHD on both the teachers and parents PBQ questionnaires (10.7%). Parents of those 78 children were then contacted by the research coordinator, and given a detailed explanation regarding the next stage of the study. This stage included an individual examination of each child by a developmental pediatrician in order to further verify the diagnosis of ADHD and exclude other deficits, and the administration of the WPPSI by a developmental psychologist.

Forty-eight children who met the selection criteria for ADHD were subsequently chosen. Then 48 children without ADHD from the original pool of the 774 children were chosen and matched to the group of children with ADHD according to the control group criteria. Mothers of all these children were asked to complete the SP Questionnaire

(Dunn, 1999). Two of the parents of the children in the control group did not return the questionnaire, leaving 46 children in the control group.

Data Analysis

In order to test for group differences, the data were subjected to two multivariate analyses of variance (MANOVA). The first MANOVA addressed comparisons between the groups on the 14 SP section scores, and the second addressed comparisons between the groups on the 9 factor scores.

To examine the correlation between sensory processing and the severity of hyperactivity symptoms, Pearson correlation coefficients were computed between the PBQ questionnaire (hyperactivity scores) and the SP section and factor scores.

In order to determine the percentages of children with atypical sensory processing, the cutoff point was determined to be a score greater than 1.5 *SDs* below the mean score of the control group on each factor or section.

Results

Comparison of Group Scores on SP Factors

The results of the MANOVA on the 9 factors of the SP yielded a statistically significant result, $F(9, 84) = 11.06$, $p < .0001$), demonstrating a group effect on the factors. To examine the source of the significant differences, the data from each factor were subjected to univariate analyses of variances (ANOVAs). The statistics for the individual factors are presented in Table 1. The results indicated that scores for the ADHD group were significantly lower than the control group on 6 out of 9 factors (i.e., sensory seeking, emotionally reactive, oral sensory sensitivity, inattention-distractibility, sedentary, and fine motor-perceptual).

Comparison of Group Scores on SP Sections

The results of the MANOVA on the 14 sections of the SP also revealed statistically significant differences $F(14, 79) =$

Table 1. Results of MANOVA Analysis Comparing Factor Scores on the Sensory Profile Between Children With and Without ADHD.

Factor	Children Without ADHD		Children With ADHD		$F(9, 84) = 11.06, p < .0001$	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>F</i>	<i>p</i>
Sensory Seeking	78.62	4.77	66.20	9.86	59.62	<.001
Emotionally Reactive	72.05	6.44	62.76	9.23	31.82	<.001
Low Endurance–Tone	41.18	3.00	40.52	3.95	0.83	NS
Oral Sensitivity	42.30	2.99	38.46	5.81	16.04	<.001
Inattention–Distractibility	30.98	3.28	25.52	4.73	41.88	<.001
Poor Registration	35.26	3.12	34.09	5.24	1.72	NS
Sensory Sensitivity	16.31	3.38	16.06	4.19	0.10	NS
Sedentary	17.14	2.82	14.34	3.00	21.69	<.001
Fine Motor–Perceptual	13.74	1.45	10.33	2.50	64.60	<.001

Note. ADHD = attention deficit hyperactivity disorder.

Table 2. Results of MANOVA Analysis Comparing Section Scores on the Sensory Profile Between Children With and Without ADHD.

Section	Children Without ADHD		Children With ADHD		$F(14, 79) = 6.85, p < .0001$	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>F</i>	<i>p</i>
Sensory Processing						
Auditory Processing	35.93	3.41	30.98	4.87	32.40	< 0.001
Visual Processing	41.27	3.44	37.97	4.84	14.37	< 0.001
Vestibular Processing	48.11	6.26	46.45	4.99	2.04	NS
Touch Processing	78.55	6.67	74.16	9.84	6.37	0.013
Multisensory Processing	32.30	2.32	27.63	4.18	44.56	< 0.001
Oral Processing	56.17	3.77	52.12	6.72	12.87	0.001
Modulation						
Endurance–Tone	41.18	3.00	40.52	3.95	0.83	NS
Body Position and Movement	45.40	3.63	42.19	5.09	12.29	0.001
Activity Level	31.29	3.31	25.03	4.37	60.86	< 0.001
Emotional Responses	17.41	2.29	16.60	2.42	2.77	NS
Visual–Emotional–Activity	19.20	1.45	17.10	2.56	23.41	< 0.001
Behavior and Emotional Responses						
Social–Emotional	75.82	6.69	67.49	9.31	24.65	< 0.001
Behavior	26.99	2.21	22.36	3.35	62.13	< 0.001
Thresholds for Response	13.28	1.56	11.64	1.61	25.31	< 0.001

Note. ADHD = attention deficit hyperactivity disorder.

6.85, $p < .0001$), demonstrating a group effect on the SP section scores. The comparisons between the groups on the individual section scores (Table 2) revealed a significant difference on 11 out of 14 subsections. Within the sections containing items related to sensory processing, significant differences between children with ADHD and matched control children were found on auditory, visual, touch, multisensory, and oral sensory processing. Within the modulation section, significant differences were found on modulation related to body position and movement, movement affecting activity level, and visual input affecting emotional responses and activity level. Within the behavior and emotional responses, all three subsections were significantly different (emotional–social responses, behavioral outcomes of sensory processing, and items indicating thresholds for response).

The correlational analyses between the severity of hyperactivity as determined by the hyperactive PBQ scores of both parents and teachers, and the SP section and factor scores, yielded significant, low to moderate correlations (Table 3).

Finally, analysis was conducted in order to establish the actual percentage of children with ADHD whose scores on the SP were greater than 1.5 *SDs* below the mean of the typically developing children. Tables 4 and 5 present the percentages of children whose scores were below the cutoff points on the factor and section scores. Between 12.5% and 67% of the children with ADHD showed deficits on the various factors as opposed to a range of 6.5% to 15% for the typical children. Relatively high percentages of deficits were also found on the various sections, with the range being between 8% and 65% for the children with ADHD as opposed to 4% to 11% for the typical children.

Discussion

Children with ADHD demonstrated significant impairment of occupational performance (APA, 1994; Barkley, 1990). In addition to impairment caused by the core symptoms of ADHD, these children are at increased risk of associated deficits in various areas, one of these being sensory processing (Cermak, 1988; Mangeot et al., 2001; Miller, Reisman, McIntosh, & Simon, 2001). Sensory processing ability is one of the many factors that needs to be consid-

Table 3. Correlations Between Scores on the Behar (PBQ) Hyperactivity Scale^a, Sensory Profile Factors and Section Scores^b.

Factors	PBQ Teacher	PBQ Parent
Sensory Seeking	-.64**	-.58**
Emotionally Reactive	-.49**	-.50**
Low Endurance–Tone	-.02	-.16
Oral Sensitivity	-.36**	-.40**
Inattention–Distractibility	-.51**	-.55**
Poor Registration	-.04	-.18
Sensory Sensitivity	-.00	-.07
Sedentary	-.42**	-.37**
Fine Motor–Perceptual	-.63**	-.66**
Auditory Processing	-.50**	-.50**
Visual Processing	-.38**	-.35**
Vestibular Processing	-.12	-.16
Touch Processing	-.32**	-.37**
Multisensory Processing	-.19	-.28**
Oral Processing	-.55**	-.61**
Endurance–Tone	-.02	-.16
Body Position and Movement	-.33**	-.35**
Activity Level	-.63**	-.55**
Emotional Responses	-.16	-.21*
Visual–Emotional–Activity	-.44**	-.49**
Social–Emotional	-.42**	-.46**
Behavior	-.61**	-.62**
Thresholds for Response	-.40**	-.46**

Note. PBQ = Preschool Behavior Questionnaire.

^aHyperactivity Scale—higher scores represent greater dysfunction.

^bSensory Profile factors—lower scores represent greater dysfunction.

* $p < .05$; ** $p < .001$.

Table 4. Percentages of Children With and Without ADHD With Factor Scores on the Sensory Profile Below the Cut-Off Point* .

Factor	Children With ADHD		Children Without ADHD	
	<i>n</i>	%	<i>n</i>	%
Sensory Seeking	32	67	4	9
Emotionally Reactive	24	50	4	9
Low Endurance–Tone	13	27	5	11
Oral Sensitivity	18	40	3	6.5
Inattention–Distractibility	30	62.5	7	15
Poor Registration	12	25	4	9
Sensory Sensitivity	6	12.5	4	9
Sedentary	14	29	3	6.5
Fine Motor–Perceptual	31	65	3	6.5

Note. ADHD = attention deficit hyperactivity disorder.

*Cut off point determined to be 1.5 *SD* below the mean of the control group; the lower the score the greater the dysfunction.

ered in assessing the reasons why a child with ADHD may be experiencing difficulties participating in occupations necessary for adequate functioning in the home, at school, and during play. As such, the purpose of this study was to describe the sensory processing profile of preschool children with ADHD as perceived by their mothers.

The results of this study, indicating that children with ADHD were reported to have significantly lower scores on most of the sections and factors in the SP, suggest that these children have significantly different patterns of sensory processing and modulation compared to typical children. These results are consistent with those of other studies that have used both subjective behavioral and objective physiological measures (Ayres, 1964; Bauer, 1977; Lightsey, 1993; Mangeot et al., 2001; Parush et al., 1997).

The present findings are also in line with Dunn and Bennett's (2002) study, currently the only other study in which the long version of the SP was used with this population. Dunn and Bennett's comparison of section scores revealed statistically significant differences between the groups on all 14 sections, while in our study significant differences were found in 11 out of the 14. In addition, the discrepancies in scores between the ADHD and the control group were larger than those found in our study. In our analysis of the factor scores, significant differences were also found between the study groups on 6 out of 9 factors. Since Dunn and Bennett did not report on the factor scores in their study, no comparison could be made on this component.

The differences, albeit minor, between the results of Dunn and Bennett's (2002) study and the current one, could possibly be explained by differences in the nature of the study samples used. Since the participants of the present research were selected from the community rather than from treatment centers or clinics, they may have had less severe symptomatology as compared to children who are referred for services (Angold, Costeelo, & Erkanli, 1999;

Table 5. Percentages of Children With and Without ADHD With Sensory Profile Section Scores Below the Cut-Off Point* .

Sections	Children With ADHD		Children Without ADHD	
	<i>n</i>	%	<i>n</i>	%
Auditory Processing	25	52	3	6.5
Visual Processing	17	35	3	6.5
Vestibular Processing	4	8	4	9
Touch Processing	13	27	4	9
Multisensory Processing	26	54	3	6.5
Oral Processing	18	37.5	3	6.5
Endurance–Tone	13	27	5	11
Body Position and Movement	15	31	4	9
Activity Level	31	65	4	9
Emotional Responses	4	8	3	6.5
Visual–Emotional–Activity	24	50	5	11
SocialEmotional Behavior	18	37.5	3	6.5
Behavior	29	60	2	4
Thresholds for Response	13	27	2	4

Note. ADHD = attention deficit hyperactivity disorder.

*Cut-off point determined to be 1.5 *SD* below the mean of the control group; the lower the score the greater the dysfunction.

Jensen, Martin, & Cantwell, 1997). Furthermore, the fact that the current study's sample was comprised entirely of preschool children could also account for these differences. Thus for example, in Dunn and Bennett's study, significant differences were found between the children with and without ADHD on the vestibular section. In contrast, no significant differences were found in our study on this specific section. Since the items in the vestibular section describe active movement behaviors that typical younger children may tend to engage in routinely, it could explain why no significant differences occurred between our sample groups.

The results of correlational analysis between the PBQ and the SP scores indicated that among the children in the study with ADHD, the more deficits there were reported in sensory processing, the more hyperactive was the behavior. This pattern was reflected in the responses that were obtained from two independent sources, that is, through both parents' and teachers' responses on the PBQ. This finding serves to reinforce our findings regarding the sensory processing abilities of children with ADHD.

When relating to these results, one must take into account that the SP is a comprehensive instrument that addresses not only sensory processing, but also behaviors considered to be derivatives of sensory processing deficits, such as attention and social-emotional functioning. In order to examine the characteristics of sensory processing of children with ADHD, it is important to try and extract those behaviors that relate specifically to sensory processing, as opposed to those that are consistent with the diagnostic criteria for ADHD (attention, hyperactivity, and impulsivity). Dunn and Bennett (2002) emphasized this distinction in their study and their results indicated that significant differences exist between children with ADHD and typical children in behaviors specifically relating to sensory pro-

cessing, as well as behaviors relating to the core symptoms of ADHD.

In this study, the analysis of the *section* scores indicate that children in the ADHD group were reported to perform with significantly more problems on those sections that represent sensory processing issues per se, in addition to the behaviors reflective of the typical core behaviors of ADHD. Specifically, significant differences were found in auditory, visual, touch, and oral processing. These findings are strengthened by those of other researchers that indicated that children with ADHD may have sensory processing difficulties within these systems (Lightsey, 1993; Mangeot et al., 2001; Papadopulos & Staley, 1997; Parush et al., 1997).

In examining the specific items of these sections, they reflect behaviors that most probably result from overresponsivity (e.g., is sensitive to certain fabrics), underresponsivity (e.g., decreased awareness of pain and temperature), as well as behaviors that could perhaps be related to underlying difficulties in visual perception (e.g., has difficulty putting puzzles together) or various other performance components. Since the items seem to relate to various aspects of sensory processing, further research is necessary in order to understand the nature of these children's difficulties in more depth.

The *factors* scores, in which significant differences were found between the groups, could reflect either the core symptoms of ADHD (such as "inattention-distractibility") or behaviors that are characteristic of this population in general (such as "emotionally reactive" and "fine motor-perceptual" dysfunctions) (Doyle, Wallen, & Whitmont, 1995; DuPaul, McGoey, Eckert, & VanBrakle, 2001; Nixon, 2001; Whitmont & Clark, 1996). The fact that mothers of the children with ADHD in this study reported more sedentary behaviors in their children is puzzling. When parents were questioned on this point in order to investigate their responses more fully it was revealed that they perceived sedentary play to reflect behaviors such as television watching and playing computer games. These comments are in line with anecdotal reports from clinicians who often hear parents of children with ADHD complaining that their child spends too much time on such activities.

Our findings indicate that section and factor scores provide different perspectives, in that the sections reflected group differences with respect to sensory processing deficits per se, whereas factor scores differences were more reflective of symptoms that characterize ADHD in general. This highlights the importance of including both scales in the investigation of specific study samples.

It is important to note that not only do the factors and sections of the SP cluster items differently, and as such pro-

vide different types of information, (see description in the Instruments section), but the factors do not include all of the individual items of the questionnaire. For example, the sensory sensitivity factor does not include any items relating to the tactile system, and no significant differences between the groups were found on this factor. In contrast, in the *section* analysis, significant differences were found in touch processing.

In summary, the findings of the present study suggest that young children with ADHD seem to be at increased risk of deficits in a variety of sensory processing abilities, over and above the core symptoms of ADHD as reported by the mothers. Results of the frequency analysis indicated that when compared to reports of mothers of the typical children, a relatively high percentage of children with ADHD fall below the cut-off point for sensory processing deficits, thus indicating that this is not a marginal phenomenon. Nevertheless, this analysis also shows that in certain sections and factors that relate to sensory processing, many of the children with ADHD scored within normal limits on a number of subscales. This variability emphasizes the importance of relating to the individual child and not only to the characteristics of a group.

These results have theoretical as well as clinical implications for the ADHD population. The results of our study are in accordance with those of other studies that indicate that children with ADHD differ significantly from children without ADHD in their sensory processing. These differences seem to be consistent among different age groups. As noted, in comparing this study to that of Dunn and Bennett (2002), only minor differences were found between the findings of the studies, which could perhaps be attributed to development stage. Nevertheless, since differences were found, and due to the paucity of research, more research is necessary before we can arrive at more definitive conclusions regarding differences between age groups.

Since findings in our study suggest that children with ADHD seem to be at an increased risk of sensory processing deficits that are identifiable even at a young age, one should consider this area of functioning in the routine evaluation and treatment of children who are suspected of having ADHD. Since it is generally accepted that sensory processing enables the engagement in adaptive behaviors and can facilitate participation in meaningful and productive occupations (Dunn, 2001; Parham, 2002), early identification and treatment of deficits may improve the prognosis of children found to have such problems. Further, it could potentially prevent the development of secondary social-emotional and perceptual-motor problems. Finally, the current research, revealing the mothers' perceptions of sensory processing deficits in preschool children, is especially

relevant, since many preschool activities revolve around the sensory exploration of various objects and materials for learning.

Certain limitations of the research need to be taken into account when relating to the findings. One is the possibility of potential bias since the results are based only on parents' reports, which, by their very nature, are subjective and may be influenced by factors such as denial, over anxiety, or wishful thinking. On the other hand, in the intimate forum of daily life, parents are the most likely source for obtaining a rich and detailed picture of a young child's responses to sensory events.

Further, although taken from a large sample of three consecutive cohorts, the low consent rate (37% of the cohort), taken together with the use of only one geographic region, limit the generalizability of this study. Nevertheless, the careful matching of the children in the two groups served to strengthen the design.

Conclusion

Future research is indicated to investigate whether there could be distinct subgroups of children with ADHD who have sensory modulation dysfunction versus those who do not. In addition, more studies should be conducted to further examine if differences exist between distinct age groups, and if so, what is the exact nature of these differences and to what extent they could be attributed to the typical developmental process.▲

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Announcing a Special Issue on Families and Their Occupations

The September/October issue is dedicated to the topic of families and their occupations. The purpose of the special issue is to enhance understanding of families as a separate field of inquiry and the role of families in assessment and intervention of an individual. All articles, which include a range of topics from children, young adulthood, and gerontology, have been selected for their contribution to the literature and direct implications for occupational therapy.