

# Sensory Integration

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## Research Brief: Sensory Responsiveness and Problem Sleep Behaviors in Children With Autism Spectrum Disorders

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Individuals with autism spectrum disorders (ASDs) are known to demonstrate responses to sensory stimulation that are different from those of their typically developing peers (Ben-Sasson et al., 2009; Schoen, Miller, Brett-Green, & Hepburn, 2008). A high percentage of children with ASD also experience sleep disorders in the form of frequent night waking or difficulty getting to sleep (Krakowiak, Goodlin-Jones, Hertz-Picciotto, Croen, & Hansen, 2008). Sensitivity to sensory stimuli has been suggested as a contributing factor to sleep problems in other populations of children (Milner, Cuthbert, Kertesz, & Cote, 2009; Shani-Adir, Rozenman, Kessel, & Engel-Yeger, 2009). This research brief aims to explore the relationship between sensory responsiveness and sleep quality in children with ASD; preliminary data will be presented.

### Sleep as an Occupation

Sleep is identified as a unique and essential area of occupation according to the *Occupational Therapy Practice Framework: Domain and Process, 2nd Edition* (American Occupational Therapy Association, 2008). Although sleep patterns vary throughout development, it is believed that more sleep is needed during critical periods of brain growth, specifically during the first 2 years of life (Dahl, 2007); during early childhood neurological connections are formed that provide the foundation for all future learning and behavior. As such, sleep is acknowledged as being not merely a state of rest, but a state of activity that serves to facilitate neural organization and restoration (Breedlove, Rosenzweig, & Watson, 2007). Poor sleep quality often manifests as behaviors such as inattention, reduced cognitive performance, and impaired motor coordination (Malow et al., 2006; Moran, Carvalho, Prado, & Prado, 2005; Paavonen et al., 2010). Therefore sleep is an important daily life task that should be examined in the context of the individual's overall behavioral and physiological functioning.

### Sleep in Autism

Although sleep disturbances occur in 20% to 40% of the general pediatric population, sleep disturbances in those with ASD have been estimated at around 40% to 80%, indicating that this is a significant area of concern (Richdale & Schreck, 2009; Krakowiak et al., 2008). Some of the most common sleep difficulties reported include frequent night

waking, early morning wake times, restlessness during sleep, and difficulty falling asleep (Krakowiak et al., 2008; Mayes & Calhoun, 2009). Although sleep difficulties have not been linked with IQ, children with ASD who are poor sleepers show higher scores related to affective problems and more difficulty with reciprocal social interaction (Malow et al., 2006). Mayes and Calhoun (2009) also found that sleep problems increased with severity of autism symptoms.

### Sensory Processing and Sleep

It has been proposed that some sleep problems are related to difficulties with sensory responsiveness, particularly when children are easily over aroused by sensory stimuli. Shochat, Tzischinsky, and Engel-Yeger (2009) found that, in typically developing school-aged children, tactile sensitivity significantly predicted sleep difficulties. Further, both tactile sensitivity and sensation seeking were significant predictors for behavioral problems. Similarly, Shani-Adir and colleagues (2009) found that sensory over responsivity was correlated with lower sleep quality in children with atopic dermatitis (a type of eczema). Reinforcing both of these behavioral studies, EEG research supports the notion that sensory gating impairments (P50 sensory gating) are present in poor sleepers during pre-sleep wakefulness (Milner et al., 2009). These authors noted that "good sleepers can initiate and maintain sleep by disengaging from the environment in an automatic and effortless manner and can successfully gate irrelevant stimuli" (p. 335). This finding suggests that for individuals with exaggerated responses to sensory stimuli, sleep may be a more effortful process, possibly stemming from difficulty disengaging from the sensory environment.

### Sleep, Sensory Processing, and ASD

While not currently identified as a core deficit in the diagnosis of ASD, atypical responses to sensory stimulation have been widely reported in this population. According to parent report, children with ASD demonstrate behaviors associated with both under and over responsivity to sensory stimuli, sometimes in combination (Baranek, David, Poe, Stone, & Watson, 2006; Leekam, Nieto, Libby, Wing, & Gould, 2007). Given the high rate of occurrence of

How have you addressed sleep disturbances with children with an ASD? Share your strategies in the SISIS Forum at <http://otconnections.aota.org/forums/19.aspx>.

atypical sensory responsiveness in the ASD population, there was reason to examine the relationship between responses to sensory stimuli and sleep quality in children with an ASD. The following hypotheses were established: (a) children with an ASD would demonstrate a higher prevalence of both sleep problems and atypical responses to sensory stimuli; and (b) there would be a high and significant correlation between behaviors associated with sensory over responsiveness (sensory avoiding or sensory sensitivity) and number of sleep problems.

## Methods

### Sample

Fifty five children ages 6 to 12 years were recruited through flyers, word of mouth, and the Interactive Autism Network; 27 children with a diagnosis of an ASD and 28 children without either an ASD or sensory modulation disorder were enrolled. Siblings of children with an ASD were excluded from the control group, as were children with identified psychological disorders (e.g., attention deficit hyperactivity disorder). All children were screened by investigators for typical intelligence using the Leiter International Performance Scale—Revised nonverbal scale of intelligence (Leiter-R) (Roid & Miller, 1997).

### Procedures

This study was approved by the sponsoring university's Institutional Review Board prior to beginning participant recruitment. Initial phone contact was made with all families to determine eligibility to participate in the study. After determination of eligibility, parents were mailed a Sensory Profile (Dunn, 1999), the Child Behavior Checklist (CBCL) (Achenbach & Rescorla, 2001), the informed consent and assent, and a short demographic questionnaire. Report of sleep behaviors was acquired as a function of the CBCL.

## Measures

### Sensory Profile

The Sensory Profile is a parent report questionnaire used to measure a child's behavioral responses to sensory stimulation. Quadrant scores for the Sensory Profile are consistent with Dunn's model of sensory processing, reflecting four categories of responsivity: (1) Low Registration, (2) Sensory Seeking, (3) Sensory Sensitivity, and (4) Sensory Avoiding (Dunn, 2006). Cut scores reflect a continuum of sensory processing abilities: Much Less Than Others (more than 2 standard deviations [SD] above the mean), Less Than Others (between 1 and 2 SD above the mean), Similar to Others (within 1 SD of the mean), More Than Others (between 1 and 2 SD below the mean), and Much More Than Others (less than 2 SD below the mean).

### Child Behavior Checklist

The school-age CBCL is part of the Achenbach System of Empirically Based Assessments, designed for children ages 6 to 18 years (Achenbach & Rescorla, 2001). The CBCL is completed by parents or caregivers who observe the children in their natural environments. Parents answer questions related to the child's behavior by scoring 0 = not true, 1 = somewhat or sometimes true, or 2 = very true or often true. For this study, questions from the CBCL that related to sleep quality, duration, or behavior were selected. These questions focused on the behaviors of: *nightmares*, *overtired*, *sleeps less than most kids*, *sleeps more than most kids*, *talks or walks in sleep*, and *trouble sleeping*.

## Results

### Demographic Data

There was no significant difference in age between the ASD and control (TYP) group members. Groups differed significantly on nonverbal IQ ( $p < .001$ ); a higher percentage of children in the ASD group were males.

### Frequency of Sleep Problems

Examining each sleep question on the CBCL separately, parents of children in the ASD group reported a higher frequency of problem sleep behaviors, reporting more *very true* responses than parents of typical children in all categories, except for the item related to having nightmares (Table 1). Numerical values were imposed on parent ratings (not true = 0, sometimes = 1, very true = 2) and a total *sleep index* was calculated for each subject by adding scores for each of the six sleep behavior questions. Total sleep index scores ranged from 0 to 6; frequency scores are presented in Table 2. Based on a Kruskal-Wallis one-way analysis of variance, children with ASD had a significantly higher frequency of problem sleep behaviors compared to typical children ( $p = .012$ ).

### Frequency of Atypical Sensory Responsiveness

Quadrant scores on the Sensory Profile were used to examine the frequency of atypical sensory responsiveness in children with and without an ASD. First, frequency counts for each quadrant were examined. The percentage of children who scored in the definite difference range (presents this behavior more than other children) was calculated. Children with an ASD had a higher percentage of definite difference scores in each quadrant of the Sensory Profile (Table 3), with 81% scoring in this range in at least one quadrant of the Sensory Profile. Using a MANCOVA model to test for group differences, children with an ASD had significantly lower scores (indicating greater dysfunction) across all four quadrants than their typical peers ( $p < .001$ ) even when differences in IQ were controlled for.

**Table 1. Item Level Scores on CBCL Sleep Questions**

	TYP				ASD	
	Not True	Sometimes	Very True	Not True	Sometimes	Very True
Nightmares	60.7%	25%	3.6%	65.4%	33.3%	-
Overtired	85.7%	3.6%	-	66.7%	25.9%	3.7%
Sleep Less than other children	82.1%	7.1%	-	66.7%	14.8%	11.1%
Sleep More than other children	89.3%	-	-	77.8%	11.1%	3.7%
Talks or Walks in Sleep	78.6%	10.7%	-	77.8%	11.1%	3.7%
Trouble Sleeping	75%	7.1%	7.1%	70.4%	3.7%	18.5%

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**Table 2. Frequency of Sleep Index Scores**

Scores calculated based on parent responses to 6 sleep questions on the CBCL.

Sleep Index Score	Total N	TYP	ASD
0	21	14	7
1	12	7	5
2	8	1	7
3	4	1	3
4	2	1	1
5	2	1	1
6	2	0	2

\* Missing values = 4

### Relationship Between Sleep and Sensory Responsiveness

To examine the relationship between sensory responsiveness and sleep behaviors, bivariate correlations were examined using the total sleep index score, first for the entire sample, then for each group separately. Quadrant scores on the Sensory Profile were used as an indicator of the child's pattern(s) of sensory modulation. When both groups were examined together, the total Sleep Index was moderately and significantly correlated to all four quadrants on the Sensory Profile: Low Registration ( $r = .467, p = .001$ ), Sensory Seeking ( $r = .426, p = .002$ ), Sensory Sensitivity ( $r = .473, p = .001$ ), and Sensory Avoiding ( $r = .541, p < .001$ ). For the TYP group alone, the relationship between sensory modulation and the total Sleep Index was only maintained for Sensory Seeking ( $r = .594, p = .002$ ) and Sensory Sensitivity ( $r = .424, p = .039$ ). For children with an ASD, the relationship between sleep problems was most strong in the domain of Sensory Avoiding ( $r = .578, p = .002$ ), with a more modest and borderline significant relationship in the areas of Low Registration ( $r = .361, p = .076$ ) and Sensory Sensitivity ( $r = .360, p = .07$ ).

### Discussion

The results of this study confirm that children with autism have a higher prevalence of both atypical responses to sensory stimuli and sleep disturbances compared to typical children. Interestingly, the patterns of linkage between responses to sensory stimuli and sleep differed between the ASD and TYP children. Sensory Avoiding correlated most strongly with sleep problems in children with an ASD, and Sensory Sensitivity and Sensory Seeking correlated most strongly with sleep difficulties in the TYP children. Both Sensory Sensitivity and Sensory Avoiding are considered indicative of a low sensory threshold according to Dunn's model of sensory processing, and of high arousal according to other investigators (Liss, Saulnier, Fein, & Kinsbourne, 2006). Our findings of a correlation between sleep problems in children with a low sensory threshold is commensurate with previous assertions that children who have difficulty filtering sensory stimuli may have difficulty lowering arousal or tuning out necessary environmental stimuli in order to fall asleep or stay asleep. Our findings suggest that this is true of children with and without ASD.

Sensory Seeking, on the other hand, is considered indicative of a high neuronal threshold according to Dunn's model. According to this model children seek high levels of sensory input in order combat low arousal levels. However, Liss and colleagues (2006) suggested that sensation seeking may occur in children with either high or low levels of arousal, and it may be used both to calm (e.g., seeking deep pressure by crawling under couch cushions) and to alert (e.g., seeking high intensity jumping on a trampoline). It has been suggested that children with ASD seek sensation as a means to calm or soothe (Liss et al., 2006); as such, if seeking successfully calms, sleep may not be problematic.

**Table 3. Percentage of Scores in Definite Difference (More Than) on the Sensory Profile**

	TYP	ASD
Low Registration	3.6%	55.6%
Sensory Seeking	3.6%	33.3%
Sensory Sensitivity	-	40.7%
Sensory Avoiding	-	51.9%

These preliminary results suggest that sensory responsiveness may be an important characteristic to consider in relation to sleep deficits in both diagnostic and non-diagnostic groups of children. Further investigation into these relationships is warranted.

### Limitations

This study is limited in its use of parent report measures to identify and quantify sleep disturbances in children. Nonetheless, parent report of sleep problems has been commonly used in the literature to distinguish good sleepers from poor sleepers, and parent report measures have been validated through the use of polysomnography and actigraphy in children with an ASD (Goldman et al., 2009; Malow et al., 2006). Although future studies should consider more objective measures of sleep in sensory responsiveness research, we feel that this preliminary parent report data is valid for identifying sleep disturbances in this sample of children.

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