Prevalence of Parents' Perceptions of Sensory Processing Disorders Among Kindergarten Children

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This study is the first to systematically examine estimated rates of sensory processing disorders using survey data. Parents of incoming kindergartners from one suburban U.S. public school district were surveyed using the Short Sensory Profile, a parent-report screening tool that evaluates parents' perceptions of functional correlates of sensory processing disorders (McIntosh, Miller, Shyu, & Dunn, 1999a). A total of 703 completed surveys were returned, which represents 39% of the kindergarten enrollment ($n = 1,796$) in the district for the 1999–2000 school year. Of the 703 children represented by the surveys, 96 children (13.7% of 703) met criteria for sensory processing disorders based upon parental perceptions. A more conservative prevalence estimate of children having sensory processing disorders based on parental perceptions was calculated by assuming that all non-respondents failed to meet screening criteria. This cautious estimate suggests that based on parents' perceptions, 5.3% (96 of 1796) of the kindergarten enrollment met screening criteria for sensory processing disorders. These percentages are consistent with hypothesized estimates published in the literature. Findings suggest a need for rigorous epidemiological studies of sensory processing disorders.

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Sensory processing in humans involves reception of a physical stimulus, transduction of the stimulus into a neural impulse, and perception, or, the conscious experience of sensation. These processes are foundational to learning, perception, and action (Kandel, Schwartz, & Jessell, 2000; Shepherd, 1994). Impairments can occur in some or all sensory systems including tactile, auditory, visual, gustatory, olfactory, proprioceptive, and vestibular systems (Bundy & Murray, 2002; Kandel et al.; Reeves, 2001). These sensory disorders can negatively affect development and functional abilities in behavioral, emotional, motoric, and cognitive domains (Kandel et al.; Shepherd, 1994).

Among children, prevalence estimates of sensory processing disorders based on clinical experience have ranged from 5% to 10% for children without disabilities (Ayres, 1989; Ermer & Dunn, in press). Estimated rates of sensory processing disorders for children with various disabilities have been derived from reliable and valid survey results and are reported to be as high as 40–88% (Adrien et al., 1993; Dahlgren & Gillberg, 1989; Kientz & Dunn, 1997; Ornitz, Guthrie, & Farley, 1977; Talay-Ongan & Wood, 2000). However, no prospective published data exist on the rate of sensory processing disorders in a non-referred (e.g., typically developing) population. Obtaining accurate prevalence estimates in a non-referred population is crucial to assess the public health impact of specific disorders within a community and to project care costs for affected individuals (Hennekens & Buring, 1987).

The literature hypothesizes a relation between sensory processing disorders and atypical behaviors ranging from mild disruptions in infant self-regulation (Reeves, 2001; Schaaf & Anzalone, 2001) to severe behavioral problems associated with pervasive developmental disorders such as fragile X syndrome (Hickman, 2001), cerebral palsy (Blanche & Nakasuji, 2001), and autistic spectrum disorders (Mailloux, 2001).

Functional problems associated with sensory processing disorders have been detailed in the literature. Parham and Mailloux (2001) outline five functional impairments associated with sensory processing disorders: decreased social skills and participation in play occupations; decreased frequency, duration, or complexity of adaptive responses; impaired self-confidence or self-esteem or both; deficient adaptive or daily life skills; and diminished fine-, gross-, and sensory-motor skill development. The lack of ability to play successfully with peers is proposed to be related to a lack of full participation in sensory and motor play from which cognitive and social skills emerge and develop (Bundy, 2002a). The fear, anxiety, or discomfort that accompanies everyday situations may significantly disrupt daily routines in the home environment (Parham & Mailloux). Moreover, school environments contain physical and social stimuli that frequently cause these children significant distress (Bundy, 2002b; Burleigh, McIntosh, & Thompson, 2002). While parents may struggle with issues long before children enter school, problems stemming from sensory processing disorders may become more apparent once a child enters a day-care or school environment (Burleigh et al.; Miller & Summers, 2001). Sensory problems may persist into adulthood, with related social and emotional difficulties (Kinnealey, Oliver, & Wilbarger, 1995).

Evidence of psychophysiological impairments in individuals with functional manifestations of sensory processing disorders also exists. These physiologic impairments include abnormal sympathetic and parasympathetic reactions in response to a laboratory paradigm presenting a series of sensory stimuli (McIntosh, Miller, Shyu, & Hagerman, 1999b; Miller et al., 1999; Miller & Summers, 2001; Schaaf, Miller, Sewell, & O'Keefe, 2003). Measures of electrodermal reactivity in response to sensory stimuli for individuals with severe sensory overresponsivity and fragile X syndrome were significantly greater in magnitude, with more responses per stimulus, and lower rates of habituation than controls (Miller et al., 1999). Children with clinically identified sensory processing disorders, intelligence within normal limits, and *no other diagnosis* also demonstrated significantly more frequent and larger amplitude electrodermal reactions, and habituated more slowly to sensory stimuli than age and gender matched controls (McIntosh et al., 1999b). Finally,

children with attention deficit hyperactivity disorder (ADHD) and symptoms of functional sensory processing disorders also showed greater physiologic reactivity to sensory stimuli than did the comparison group. The effects appear to be a result of larger initial reaction in the ADHD group, with subsequent habituation to levels similar to those of the typically developing children (Mangeot et al., 2001).

An association between functional symptoms of sensory disorders and physiologic reactions to sensory stimuli has been demonstrated. When groups are divided into normal (e.g., mid-range) versus abnormal (e.g., hyporeactive or hyperreactive) electrodermal reactivity, the hypo- and hyperresponsive groups demonstrated significantly more impairment on the Short Sensory Profile, a functional scale of sensory behaviors than did the mid-range group (McIntosh et al., 1999a).

Relations among sensory processing disorders and other regulatory disorders (e.g., emotional dysregulation, attention deficit disorders, behavior dysregulation) have been proposed (Linehan, 1993; Miller, Robinson, & Moulton, in press; Reeves, 2001; Schaaf & Anzalone, 2001; Schore, 1994). Although symptoms of sensory processing disorders can overlap with features in other conditions, particularly ADHD (Mangeot et al., 2001; Ognibene, McIntosh, Miller, & Raad, 2003), a dissociation between ADHD and sensory processing disorders has been suggested from empirical data. In a nationally stratified sample of typically developing children who participated in the standardization of the *Leiter International Performance Scale— Revised* (Roid & Miller, 1997), within the total sample (*n* = 2,410), 181 children had symptoms of either sensory or attention impairments or both. Fifty-six percent of those children who had symptoms of impaired attention (*n* = 131) demonstrated symptoms of impaired sensory processing (*n* = 74). The fact that within the sample with either sensory or attention impairments or both (*n* = 181), approximately the same percentage of children had symptoms of dysfunction *only* (28%; *n* = 50) as had symptoms of attention dysfunction only (31%; *n* = 57) is notable, suggesting that ADHD and sensory processing disorders are distinct conditions (see Table 1).

The overlap between phenotypic characteristics of ADHD and some sensory processing disorders has generated controversy regarding the validity of sensory processing disorders as a valid, distinct condition. It may be both a distinct syndrome and yet frequently co-occur with other diagnoses. Establishing the prevalence of sensory processing disorders is an important step in developing a research agenda related to further empirical study of this under-studied condition. More specifically, prevalence data express the burden

Table 1. Percent of National Stratified Sample With Symptoms of Sensory or Attention Impairments or Both.

| Sensory Symptoms | ADHD Symptoms | | Total |
	No	Yes	
No	2,229	57[a,b]	2,286
Yes	50[a,c]	74[a,d]	124
Total	2,279	131	2,410

[a]Those with either sensory or attention deficits or both, $n = 181$ (57 + 50 + 74)
[b]Attention impairment only: 57 (31% of 181)
[c]Sensory impairment only: 50 (28% of 181)
[d]Sensory and Attention impairments: 74 (41% of 181)

of sensory processing disorders in the population, provide information about factors that produce chronicity once the disorder has developed, and monitor the impact of prevention and intervention programs (Mausner & Kramer, 1985). Ultimately, empirical evidence clarifying the behavioral and physiologic phenotypes and prevalence of sensory processing disorders will inform the development of appropriate interventions to remediate functional problems in this disorder.

Method

Parents of kindergarten students in one school district were anonymously surveyed using the Short Sensory Profile (McIntosh et al., 1999a), a standardized self-report questionnaire assessing parents' perceptions of behavioral responsiveness of children to sensation.

Participants

Respondents were parents of kindergarten children from a Western, suburban, public school district in the United States that included 11 cities and 38 elementary schools. Anonymous questionnaires were received from 710 respondents in the district, which represented a return rate of 39% of the total 1999–2000 kindergarten enrollment of 1,796 students (School District, personal communication, September 5, 2003). This school district endorses inclusion of children with special needs in the regular education system, and in 2000, 12% of the K–12 children were enrolled in some special education services (School District, personal communication, September 5, 2003). Thus, some children on whom surveys were completed may have had some level of disability. The presence of four children older than age 6 suggests at least 1% of the sample had special needs.

Instrumentation

Family Information Questionnaire. A brief one-page demographic questionnaire titled Family Information was created for this study. The questionnaire contained questions about the child (e.g., age, race) and the child's family (e.g., parents' education).

Short Sensory Profile. The screening instrument used in this study was the *Short Sensory Profile*, a 38-item parent-rated screening instrument that evaluates functional behaviors related to sensory processing disorders (McIntosh et al., 1999a). The Short Sensory Profile was developed from extensive research and development on the Sensory Profile (Dunn, 1999). Items include functional behaviors that are symptomatic of sensory processing disorders. Sample items include: Tactile Sensitivity Item #3—Avoids going barefoot especially in sand or grass; Auditory Sensitivity Item # 1—Responds negatively to unexpected or loud noises (i.e., vacuum cleaner, dog barking, hairdryer); Low Energy Item #2—Tires easily, especially when standing or holding particular body position. Parents make subjective global ratings of their child on each item using a scale of 1 (always: the child responds in this manner every time) to 5 (never: the child never responds in this fashion), with higher scores representing more functional performance.

Detailed description of the development of the Short Sensory Profile has been previously reported, including item and subscale development and item analyses (McIntosh et al., 1999a). In summary, the reliability and validity of the tool are excellent. Internal reliability of the Short Sensory Profile total test is > .95 for a sample of children with and without disabilities (Cronbach's alpha) and subscale reliabilities range from .70 to .90 across three samples (McIntosh et al., 1999a). Inter-scale correlations were moderate in size, ranging from .25 to .76, suggesting that the subscales measure unique dimensions. Discriminant validity was demonstrated by comparing children with sensory processing disorders and an age and gender matched typically developing group ($n = 38$). The group with sensory processing disorders scored significantly lower (more abnormal) than the typically developing group. Convergent validity was determined by comparing the Short Sensory Profile scores to physiological evidence of sensory processing disorders: Abnormal Short Sensory Profile scores were significantly associated with abnormal electrodermal reactivity in response to sensory stimulation (McIntosh et al., 1999a).

Procedure

Survey Distribution. The study was conducted with a convenience sample. Research procedures were approved by the school district and key administrators (typically school principals) of all schools that enrolled kindergarteners in the district (35 of 38 schools in the district). The participating schools were contacted to establish individualized distribution procedures for each school (35 of the 38 schools). Each school was given English- and Spanish-version packets of survey materials to distribute to parents of kindergarten children along with other beginning-of-the-year school documents.

Survey packets contained a cover letter, a Family Information questionnaire, the Short Sensory Profile, and a self-addressed envelope. The cover letter explained the study to the parents. In it, parents were assured that their participation or nonparticipation would not affect their child's education, and that their responses would be anonymous. Parents were instructed to return completed materials in sealed envelopes either by hand delivery to the school or via mail to the research team. Parents were encouraged to return Family Information in a separate sealed envelope if confidentiality was a concern. A business-class envelope preaddressed to the research team accompanied the cover letter. Researchers collected envelopes from the schools 2 to 3 months after survey distribution.

Data Analysis. A cut-point for positive outcome on the screening was selected, consistent with criteria used to identify children with sensory processing disorders in ongoing psychophysiologic studies (Mangeot et al., 2001; McIntosh et al., 1999b; Miller et al., 1999). Using these criteria, a child was considered positive for sensory processing disorders if she or he had a total Short Sensory Profile score equal to or greater than 3 standard deviations below the mean, two subtest scores equal to or greater than 2.5 standard deviations below the mean ,or one subtest score equal to or greater than 4 standard deviations below the mean based on norms imputed from the Sensory Profile standardization sample (McIntosh et al., 1999b).

Results

Family Information

A total of 710 Family Information demographic surveys were returned. Family Information surveys were completed anonymously and were not linked to Short Sensory Profile data, thus, it was not possible to identify and remove Family Information surveys corresponding to incomplete or invalid Short Sensory Profile surveys (see below). Therefore, demographic data were compiled from all 710 returned Family Information surveys.

Demographic data from all participants were aggregated to summarize characteristics of the sample.

Most children in the sample were Caucasian and between 4 and 6 years old. Approximately half were male. Table 2 compares demographics of children in the study sample with population demographics of the school district, the county served by the school district, and the U.S. Demographics of survey respondents tend to reflect county demographics, but the sample was less ethnically diverse than the overall U.S. population (see Table 2).

Parents of children in the sample were, on average, more highly educated than the population of the county and of the United States. (see Table 3).

Sensory Processing Disorders

A total of 710 Short Sensory Profile surveys were returned. Seven of the 710 survey respondents did not complete two or more of the seven subtests. These surveys were considered invalid and their data removed from the aggregated group survey data. An additional 14 surveys had only one blank item on the entire survey. For these 14 surveys, scores for the one blank item were imputed by averaging the remaining scores in that specific subtest. The 14 surveys were then combined with 689 surveys that had complete data, resulting in a total of 703 valid surveys. Prevalence estimates were based on the 703 valid surveys, which resulted in a survey response rate of 39%.

Using the criteria suggested by McIntosh et al. (1999b) that identify children with sympathetic nervous system

Table 2. Demographic Comparisons Among Sample, District, County, and US: Gender and Race.

	Children in Study Sample n 710	Population in Target School District[a] N 26,974	Population in Target County[b] N 291,288	Population in U.S.[b] N 281,421,906
Gender				
Male	51.9%	51%	50.6%	49.1%
Female	48.1	49	49.4	50.9
Race[c]				
White	82.1%	81%	88.5%	75.1%
Black/African-American	1.3	2	0.9	12.3
American Indian/Alaskan Native	5.5	1	0.6	0.9
Asian/Pacific Islander	4.8	5	3.2	3.7
Hispanic/Latino	0.4	11	10.5	12.5
Other[d]	5.8	n/a	6.8	8.0

Note. Demographic characteristics for kindergarten children were not available by all column headings; hence sample demographics were compared to available general population demographics (all people of all ages) in the three right-hand columns.
[a]Source: School District, personal communication, March 21, 2002.
[b]Source: U.S. Census Bureau, Census 2000.
[c]U.S. Census Bureau labels are used for demographic categories.
[d]"Other" statistic reflects (1) Persons reporting some other race, and (2) Persons reporting two or more races. Data not reported by U.S. Census Bureau for Target School District.

Table 3. Demographic Comparisons Among Sample, County, and U.S.: Education of Individuals Ages 25 and Older.

Education[b]	Parents of Children in Study Sample[a]	Population Aged 25+ in Target County[b]	Population Aged 25+ in U.S.[b]
	n	*N*	*N*
	1,352	186,126	175,230,000
Some education	100%	100%	100%
High school or more	99.4	92.8	84.1
Some college or more	91.2	77.7	50.9
Bachelor's degree or more	70.5	52.4	25.6
Advanced degree	32.2	21.2	8.6

[a]Actual numbers and percentages based on survey responses.
[b]Source: U.S. Census Bureau, Census 2000.

Table 4. Estimated Number of Individuals With Sensory Processing Disorders (SPD) Based on 5.3% Prevalence Rate in Sample: Comparisons Among District, County, and U.S.

Disorders	Estimated Number of Individuals With Sensory Processing		
	Target School District	Target County	U.S.
Total Kindergarteners	95	211	220,347
	(1,796)[a]	(3,983)[b]	(4,157,491)[b]
Total Individual	1,430	15,438	14,915,361
	(26,974)[a]	(291,288)[b]	(281,421,906)[b]

Note. Numbers in parentheses represent actual total number of individuals in category before 5.3% prevalence calculation is used to calculate number of affected individuals.
[a]Source: School District, personal communication, September 05, 2003.
[b]Source: U.S. Census Bureau, Census 2000.

indicators of sensory processing disorders, 96 of the 703 valid returned surveys (13.7%) met cutpoint criteria for sensory processing disorders based on parents' perceptions of their child's sensory functioning. To ensure the estimate was sufficiently conservative, and because the response rate was low, a more cautious prevalence estimate was calculated, based on the assumption that *all* nonrespondents would fail to meet screening criteria for sensory processing disorders. With this assumption, 5.3% of the total kindergarten enrollment in the district (*n* = 96 of 1,796) met screening criteria for sensory processing disorders.

Table 4 summarizes the potential impact of the 5.3% prevalence rate on population estimates of the district, county, and the United States. Extrapolation of projected rates beyond the school district must be made with extreme caution due to sample restrictions that limit the generalizability of the findings. However, it is evident that even a conservative 5.3% prevalence represents a potentially large number of individuals nationwide. For example, using the obtained survey rate of 5.3%, over 220,000 kindergarten children in the United States may have sensory processing disorders. If the rate were extended to all individuals, nearly 15 million individuals in the United States could experience sensory processing disorders (Table 4).

Discussion

Establishing prevalence rates of sensory processing disorders is an important step in a program of research related to the etiology and effectiveness of intervention for sensory processing disorders, and in ongoing efforts toward public awareness and education about this condition. Using the Short Sensory Profile as a parent-report survey screening instrument, this study conservatively estimates (assuming that all nonrespondents were negative for sensory processing disorders) that 5.3% of kindergarten children in one suburban public school population met criteria for sensory processing disorders. The rate increased to 13.7% if the

assumption is made that nonrespondents' rates were equivalent to respondents' rates.

These estimates must be validated with a future rigorous epidemiologic study. However, the potential impact of the rate of sensory processing disorders suggested by this study is socially significant. Using the conservative 5.3% rate demonstrated in this study, over 220,000 kindergarten children in the United States may suffer from sensory processing disorders (Table 4). If the rate of 13.7% is used, over half a million kindergarten children may be affected (13.7% of 4,157,491) (U.S. Census Bureau, n.d.).

The rates suggested in this study (5.3% and 13.7%) are within the range of the prevalence of the disorder hypothesized in the literature, 5% to 10% for children without disabilities. Prior to this study, no prospective published data existed on the rate of sensory processing disorders in a non-referred (e.g., typically developing) population. The findings of this study support the need for more rigorous epidemiological studies of sensory processing disorders in the general population. This is especially important in light of the hypothesized relationship between sensory processing disorders and atypical behaviors.

Several limitations of this study should be noted. First, generalizability of these results is limited to the demographic group represented in this study. The sample was primarily a Caucasian, suburban group of kindergarten children who had well-educated parents. These demographics differ from the general population of the United States. To determine whether these rates as measured by the Short Sensory Profile are generalizable beyond this sample, prevalence rates need to be assessed in other population groups.

Second, the data in this study are based on a screening survey instrument. Although prevalence rates can be suggested from surveys, a rigorous study is needed to assess the physiologic and behavioral manifestations of sensory processing disorders in individuals identified by screening. The findings of this study suggest implementation of an epidemiologic study with intensive follow up diagnostic assess-

ments of those identified as positive for the disorder through screening in order to diagnostically validate the presence of a sensory processing disorder.

Third, this study did not evaluate the presence, or absence, of disorders other than sensory processing disorders. The percent of this sample that might have comorbid attention deficit hyperactivity disorder or other disorders is not known. Thus, the specific rate of sensory processing disorders not associated with other conditions is not clarified by this study. While the results of this study suggest that sensory processing disorders are prevalent enough to warrant further investigation, more research is needed to examine relations among sensory processing disorders and other disorders.

Fourth, the effect of comorbidity on rates of reported symptoms of sensory processing disorders should be carefully studied. In a recent study, a double-gating laboratory procedure was utilized to select "pure" ADHD and "pure" sensory processing disorder groups (Ognibene et al., 2003). Results indicated a double dissociation between groups based on two measures: response inhibition and sensory habituation. Further studies discriminating comorbid disorders from sensory processing disorders are needed, particularly in reference to rates of sensory processing disorders in the general population. These studies might utilize the methods of Ognibene et al. to assess children screened with the Short Sensory Profile combined with rating scales that target other disorders to determine differential prevalence of disorders such as ADHD compared to sensory processing disorders in a sample who are positive to screening criteria.

Fifth, the low response rate of 39% created several problems for interpreting the data. The anonymous nature of the survey prevented nonresponders from being contacted directly, and a repeat distribution of the survey to all parents was not conducted in order to avoid duplication of responses. A comparison of demographic data and community census data revealed that responders demographics were very similar to the target school district, with the exception that nonresponders were more likely identified with the Hispanic or Latino race (0.4% of survey respondents vs. 11% of the target school district) (see Table 2). To compensate for the low response rate, it was assumed all nonresponders failed to meet screening criteria. While this strategy produced a conservative response rate of 5.3%, the validity of the overall rate for the disorder in the population is limited by the low response rate of the sample.

Finally, developmental trajectories of sensory processing disorders are unknown (e.g., the prevalence of sensory processing disorders may rise or decline with age), thus it is not possible to generalize with confidence to populations older than the kindergarten sample surveyed in this study.

If future research confirms the prevalence rates found in this study, the high rate would emphasize the need for screening, diagnosis, and treatment of children with sensory processing disorders. The prevalence of the disorder suggests a need for programs to educate parents, teachers, physicians, and other caretakers and professionals about sensory processing disorders, and for a rigorous program of research characterizing the phenotypes and clarifying the underlying mechanisms of disorders in sensory processing. ▲

Acknowledgments

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