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Sensory symptoms in children with autism spectrum disorder, other developmental disorders and typical development: A longitudinal study

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Abstract

Sensory symptoms are prevalent in autism spectrum disorder but little is known about the early developmental patterns of these symptoms. This study examined the development of sensory symptoms and the relationship between sensory symptoms and adaptive functioning during early childhood. Three groups of children were followed across three time points from 2 to 8 years of age: autism spectrum disorder, developmental delay, and typical development. At each time point, parents filled out questionnaires regarding their child's sensory symptoms and adaptive functioning. At the initial time point, parents of children with autism spectrum disorder reported more sensory symptoms in their children than parents in the typical development group. Parents in the autism spectrum disorder group reported more sensory symptoms than parents in the developmental delay group within smell, taste, and auditory domains. While the typical development group decreased in reported sensory symptoms across the study period, the clinical groups demonstrated no significant change across assessment points. Sensory symptoms for all groups were not independently predictive of adaptive functioning when verbal mental age was also included in the model. The young age range at the initial assessment and pattern of results suggest that sensory symptoms are present early in the etiology of autism spectrum disorder and other developmental disorders and remain stable over time.

Keywords

adaptive behavior, autism spectrum disorder, longitudinal studies, sensory symptoms

Introduction

Sensory symptoms are a complex set of behavioral reactions to the sensory environment. Sensory symptoms can be broken down into three patterns: hyperresponsiveness, hyporesponsiveness, and sensory seeking (Miller et al., 2007). Hyperresponsiveness involves overreactions to the sensory environment (e.g. covering ears to the sound of someone singing). Hyporesponsive behaviors are underreactions to the sensory environment (e.g. not turning to a loud sound). Examples of sensory seeking behaviors include prolonged visual inspection of toys or repetitive touching of objects.

Recent estimates of prevalence of sensory symptoms of people with autism spectrum disorder (ASD) range from 69% to 93% in children and adults (Baranek et al., 2006; Billstedt et al., 2007; Klintwall et al., 2011; Leekam et al., 2007) and were recently added as a diagnostic criterion of ASD in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-V; American Psychiatric Association, 2013). Despite the high prevalence rates of symptoms and their centrality to ASD, little is known about the developmental trajectory of these symptoms. The main purpose of this study was to characterize the early developmental pattern of sensory symptoms in ASD.

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There has been debate about when sensory symptoms emerge (Baranek, 1999; Lord, 1995), as well as about their developmental trajectory (Baranek, 2002; Talay-Ongan and Wood, 2000). Lord (1995) suggested that sensory symptoms may not become clinically significant until the preschool years, but prospective studies of infant siblings at genetic risk of developing autism have found evidence of sensory symptoms present as early as social and communication symptoms (Ozonoff et al., 2010; Zwaigenbaum et al., 2005). From 2 years of age and beyond, there has been consistent documentation of significant sensory symptoms in children with autism when measured via parent report (Leekam et al., 2007; Rogers et al., 2003) and behavioral observations (Baranek et al., 2007; Leekam et al., 2007; Rogers et al., 2003).

Conflicting evidence exists about the relationship between sensory symptoms and chronological age. Some evidence suggests an increase in sensory symptoms over time (Ben-Sasson et al., 2009), compared to evidence that younger children have more sensory symptoms than older children (Leekam et al., 2007), and reports that symptoms are stable across childhood (Ausderau et al., 2014; Cheung and Siu, 2009; Green et al., 2012). Leekam et al. (2007) also found different relationships between sensory symptoms and age based on sensory domain.

There are several limitations with the extant research. First, very few studies have employed a longitudinal design. Most of the research on sensory symptoms uses cross-sectional groups of different ages or adds chronological age as a covariate to the primary analyses. The second difficulty is operationalizing sensory symptoms. Many studies use a total score or global measure that combines symptoms across response patterns and sensory domains. Other studies examine specific response patterns and/or specific sensory domains. Some researchers also combine sensory symptoms with other repetitive behaviors as part of the repetitive stereotyped behavior symptom set. Differences in how sensory symptoms are operationally defined may contribute to conflicting findings within the literature. Third, researchers often attempt to identify sensory behaviors from measures not designed to test these symptoms. For example, the autism diagnostic interview (ADI; Lord et al., 1994), while frequently used to measure sensory symptoms, combines sensory symptoms with repetitive behaviors, has a very restricted, skewed scoring range, and was not developed as a stand-alone measure of sensory symptoms.

Although sensory symptoms are not specific to ASD, as shown in studies that compare children with ASD to well-matched groups with other developmental delays (DDs; Leekam et al., 2007; Rogers et al., 2003; Wiggins et al., 2009), there may be certain patterns of response or sensory domains that are more prevalent in ASD than in other disorders. For example, Baranek et al. (2006) found that the under-responsive patterns of sensory behavior may be more prevalent in ASD. Differences found between groups may depend on whether they are matched on chronological or mental age (Kern et al., 2006). Differences in impairment between clinical groups may also be dependent on the classification of symptoms. The developmental pattern of sensory symptoms (i.e. when they emerge and whether they increase or decrease over time) may also be different in ASD compared to other populations, but has yet to be explored.

Unusual sensory behaviors have the potential to interfere with adaptive functioning, but the relationship between these constructs is currently unclear in ASD. Qualitative interviews with parents reveal that sensory symptoms limited participation in family routines and activities (Schaaf et al., 2011). Higher rates of sensory behaviors are also related to family and parent stress (Ben-Sasson et al., 2013). The relationship between sensory symptoms and adaptive functioning may depend on the age of participants, the domains of adaptive functioning and sensory processing being compared, and the inclusion of cognitive abilities as an additional covariate.

The aims of this study were threefold: (1) to describe the developmental trajectory of sensory symptoms in young children with ASD, (2) to test differences in the developmental trajectory of sensory symptoms among children with ASD, DD, and typical development (TD), and (3) to assess the effect of sensory symptoms on adaptive functioning over time.

Methods

Participants

Participants were seen as part of the National Institute of Child Health and Human Development/National Institute on Deafness and Other Communication Disorders (NICHD/NIDCD) Collaborative Programs of Excellence in Autism (CPEA) network site at University of Colorado Health Sciences Center, Denver, CO. Participants in the clinical groups were recruited from various health and early education agencies, as well as parent support groups. Children with TD were recruited from the University of Denver subject pool.

The participant groups consisted of 79 children in three diagnostic groups: ASD ($n = 29$), DD of mixed/unknown etiology ($n = 26$), and TD children ($n = 24$). See Table 1 for participant characteristics. Participants in the two clinical groups were matched on chronological and mental age, and the group with TD was matched on mental age. As a result, the typically developing group was significantly younger than the other two samples ($p < 0.01$). Mental ages were measured with the Mullen Scales of Early Learning (MSEL: Mullen, 1995). There were no significant differences between groups at the initial time point on nonverbal mental age ($F(2, 82) = 0.05$, $p = 0.95$) or overall

Table 1. Demographics at the first time point.

	ASD	DD	TD
CA			
Mean (SD)	33.75 (3.7)	33.40 (6.7)	19.57 (4.7)
Range	26–41	24–47	12–35
MA			
Mean (SD)	19.6 (6.4)	22.11 (6.3)	23.34 (6.2)
Range	9–42	14–36	14–41
NVMA			
Mean (SD)	23.26 (6.2)	22.63 (5.5)	22.64 (5.1)
Range	4–53	15–38	16–40
VMA			
Mean (SD)	16.05 (7.1)	21.81 (8.1)	24.06 (7.3)
Range	6–37	11–43	12–43
N	32	26	24

ASD: autism spectrum disorder group; DD: developmental delay group; TD: typically developing group; CA: chronological age in months; MA: overall mental age in months; NVMA: nonverbal mental age in months; VMA: verbal mental age in months.

mental age ($F(2, 82)=2.56$, $p=0.08$). However, the groups were significantly different on verbal mental age (VMA) ($F(2, 82)=8.79$, $p<0.001$); the ASD group had significantly lower verbal scores than the DD group ($p<0.05$) and the TD group ($p<0.01$).

The children in the ASD group had to meet the following inclusion criteria: (1) previous clinical diagnosis of autism, (2) current clinical diagnosis from expert clinician, (3) full criteria for autism on the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; DSM-IV) checklist, and either (4) scores above the cut-off for autism on the ADI (Lord et al., 1994) or (5) scores above cut-off on the autism diagnostic observation schedule (ADOS; Lord et al., 1999). Most children met all five criteria. Participants in the DD group had an overall standard score on the MSEL between 35 and 70, no past or current diagnosis of ASD or fragile X syndrome, and did not meet criteria for ASD on two or more of the autism diagnostic measures (e.g. ADOS, ADI, DSM-IV). The children in the TD group had average scores or higher on developmental measures and did not meet criteria for ASD. Data from a portion of the current sample at age 2–3 years were previously published (Rogers et al., 2003).

Procedures

This study was carried out under Institutional Review Board approval from the University of Colorado Health Sciences Center. Consent forms were reviewed with each family and all questions answered before consent was obtained and before any measures were gathered. Participants were seen at three time points. Ages of participants in each group are presented in the supplemental material (Table S1). The time interval between the first and second waves of assessment had a mean of 21 months, whereas the second interval between waves 2 and 3 was longer with a mean of 51 months. The short sensory profile (SSP) was completed by the mothers before the laboratory visit at all three points. All other measures were collected in the laboratory over several visits that included additional measures not reported here.

Measures

Short Sensory Profile (SSP). The SSP (McIntosh et al., 1999) is a sensory-specific parent report measure of abnormal behavioral reactions to the sensory environment frequently used in ASD research. It consists of 38 items from the longer sensory profile (Dunn, 1999), which was standardized on 1200 typically developing children. Items are scored for frequency on a scale of 0–4, with lower scores indicating more severe sensory abnormalities. In addition to a total score, there are also seven subscale scores: tactile sensitivity (e.g. withdrawal from water), taste/smell sensitivity (e.g. avoids certain tastes or food smells), movement sensitivity (e.g. distress when head is upside-down), under-responsive/seeks sensation (e.g. frequently touches people or objects), auditory filtering (e.g. distracted by a lot of noise), low energy/weak (e.g. poor endurance/tires easily), and visual/auditory sensitivity (e.g. covers ears to protect from sound). Parent report measures are especially useful to capture behaviors, like sensory symptoms, that can be infrequent or only occur in specific contexts that are difficult to recreate in the laboratory.

Mullen Scales of Early Learning (MSEL). The MSEL (Mullen, 1995) is a standardized developmental assessment for children ranging from 3 to 64 months of age. The MSEL was administered to all subjects according to standard instructions by raters with advanced degrees who were trained in assessing young children with autism and other DDs. Four subscale scores, visual reception, fine motor, receptive language, and expressive language, yield standard scores and age equivalence scores. These subscales were averaged to create separate verbal (receptive and expressive) and nonverbal (visual reception and fine motor) age equivalence scores. The verbal age equivalence score from the first assessment was used in the main analyses as a covariate.

Vineland Adaptive Behavior Scales (VABS). The VABS (Sparrow et al., 1984) is a standardized parent interview used to assess child adaptive functioning. The interview yields age equivalence and standard scores across four subdomains (communication, social, daily living skills, and motor skills) as well as an overall adaptive behavior composite (ABC). The interview was administered by a graduate student of psychology to the primary caregiver of the child during a laboratory visit.[1]

Autism Diagnostic Observation Schedule (ADOS). The ADOS (Lord et al., 1999) is a semi-structured standardized assessment using developmentally appropriate social and toy-based interactions in a 30- to 40-min session that elicits symptoms of autism in four areas: social interaction, communication, play, and repetitive behavior. The ADOS was administered to all subjects in the study as part of the diagnostic qualification process. There are four different modules of the ADOS tailored to the developmental level of the child. In this study, Modules 1, 2, and 3 were used across the different time points. To account for differences in the modules, autism severity scores were calculated (Gotham et al., 2009). Autism severity scores range from 1 to 10 and are based on the total raw score from the administered module and the age of the child.

Analytic plan

To answer the questions about developmental trajectory of sensory symptoms in ASD, multilevel models were fit with sensory symptoms as the dependent measure. All models were fit using the PROC MIXED procedure in SAS with the maximum-likelihood estimation method, to account for missing data due to participant drop out (Graham, 2009; Schafer and Graham, 2002). This procedure uses all available data to create estimates of effects, so all subjects are included regardless of missing values. The approach also allows flexibility in how time is treated within the model.

Models with the total score and seven subscale scores of the SSP as the dependent measures were run separately. Two models were tested for the total score and each subscale: no growth and linear slope. Two dummy coded variables were created to test differences between the three groups, one for the TD group and one for the DD group. The ASD group was the reference group. VMA at the initial assessment was also entered as a covariate. For the linear model, assessment time was measured as the number of months since the first assessment. This measure of time was used to account for differences in intervals between visits while still preserving chronological and mental age group comparisons. The random effect of time was also included in the linear model to test for variability in the slope. The addition of all main and interaction effects was tested for goodness of fit by a chi-square log-likelihood deviance test. Effects that did not significantly improve fit were not retained in the model.

To answer the question about the effect of sensory symptoms on adaptive behavior over time, multilevel models were fit using the SAS PROC MIXED procedure with maximum likelihood with the ABC from the VABS as the dependent measure. Group and VMA at the initial assessment point were entered as covariates, while the severity score from the ADOS and the SSP total score were time varying covariates. Two models were tested: no growth and linear slope. Time was treated in the same way as in the models described above. The addition of all main and interaction effects was tested for goodness of fit by a chi-square log-likelihood deviance test.

Results

Data description

The number of participants with SSP data at each time point is reported in Table S1. Of the 79 participants, 91.1%, 69.6%, and 53.2% had SSP scores across the three assessment waves, respectively. Rates of retention did not differ across diagnostic groups. Correlations were run with the SSP at the initial time point to examine relationships between subscale scores (Table S2). Of 21 correlations, 10 reached statistical significance. All correlations between subscale scores on the SSP were small to moderate (absolute range: 0.03–0.48).

Sensory symptoms

Sensory symptoms between groups. Table 2 presents the parameter estimates of the best fitting models for the total score and all subscale scores. For the model of SSP total score, the ASD group was not significantly different than the DD group ($p = 0.94$), but the ASD group had significantly more sensory symptoms overall than the TD group ($p < 0.001$). At the initial time point, the TD group scored an average of 21.24 (confidence interval (CI) = 12.14–30.34) points higher than the ASD group across multiple symptoms. For the tactile sensitivity subscale, there was no difference between the ASD and DD groups ($p = 0.52$), but the ASD group had significantly more symptoms than the TD group ($p < 0.05$). The TD group scored an average of 3.61 (CI = 1.4–5.82) points higher than the ASD group. For the taste/smell sensitivity subscale, the ASD group had more symptoms than both the DD ($p < 0.01$) and TD

Table 2. Parameter estimates for best fitting models of total and subscale scores.

Measure	Total score	Tactile sensitivity	Taste/smell sensitivity	Under-responsive/ seeks sensation	Movement sensitivity	Auditory filtering	Low energy/ weak	Visual/auditory Filtering
Fixed effects								
Intercept	132.79***	27.36***	10.41***	23.31***	12.72**	18.53***	23.16***	17.20***
Time	−0.06	−0.009	0.01	−0.03	0.01	−0.01	−0.02	0.002
DD	6.26	0.72	3.63**	1.46	−0.81	3.57**	−2.86***	0.79
TD	21.24***	3.61*	6.02***	2.19	0.73	5.57***	5.65*	0.49
Time × DD	−0.01			0.03		0.04		−0.02
Time × TD	0.35**			0.13***		−0.04		0.07*
Random effects								
Level 1								
Within-person	228.05**	12.65***	5.41***	15.35***	2.74***	12.07***	13.40***	11.59***
Level 2:								
Intercept	153.67***	11.55**	12.88***	9.64**	3.09**	7.06*	15.17***	5.15*
Slope	0	0.001	0.002*	0	0.001	0	0.003	0
Fit indices								
−2 log-likelihood	935.1	983.8	913.3	1009.7	700.9	945.8	1017.4	935.1
AIC	951.1	999.8	929.3	1027.7	716.9	963.8	1033.4	953.1
BIC	970.1	1018.7	948.3	1049.0	735.9	985.1	1052.3	974.4

DD: developmental delay group; TD: typically developing group; AIC: Akaike's information criteria; BIC: Bayesian information criteria.
* $p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

($p < 0.001$) groups. The DD group scored an average of 3.63 (CI = 1.69–5.57) points higher and the TD group scored an average of 6.02 points higher (CI = 4.00–8.04) than the ASD group. For the auditory filtering subscale, the ASD group had more symptoms than both the DD ($p < 0.01$) and TD ($p < 0.001$) groups. The DD group scored an average of 3.57 (CI = 1.34–5.80) points higher and the TD group scored an average of 5.57 (CI = 3.34–7.80) points higher than the ASD group. For the low energy/weak subscale, the ASD group had more symptoms than the TD group ($p < 0.001$) but fewer symptoms than the DD group ($p < 0.05$). The TD group scored an average of 5.66 (CI = 3.14–8.19) points higher and the DD group scored an average of 2.86 (CI = −5.33 to −0.39) points lower than the ASD group. Although the addition of group significantly improved model fit for the under-responsive/seeks sensation, movement sensitivity, and visual/auditory filtering subscales, the parameter estimates for the main effect of group did not reach significance.

Sensory symptoms across time and between groups. The overall main effect for time was significant ($\chi^2 = 23.5$, $p < 0.0001$). To answer the question of differences in the developmental trajectory of sensory symptoms across time between groups, models were also tested for interactions between slope and diagnostic group. For the SSP total score, children in the ASD and DD groups demonstrated no significant change, but parameter estimate of the interaction between time and the TD group reached significance ($p < 0.01$). The scores on the SSP for the TD group increased an average of 0.29 (CI = 0.05–0.53) points for each month enrolled in the study. The under-responsive/seeks sensation and visual/auditory filtering subscales demonstrated the same pattern of results. The ASD group demonstrated no significant change, the DD group was not significantly different from the ASD group, and the parameter estimates of the interaction between time and the TD group reached significance in both models ($p < 0.001$, $p < 0.01$, respectively). For the under-responsive/seeks sensation subscale, scores of the children in the TD group increased an average of 0.10 (CI = 0.04–0.16) points every month. For the visual/auditory filtering subscale, scores of the children in the TD group increased an average of 0.07 (CI = 0.01–0.13) points every month. For the auditory filtering subscale, although the interaction term significantly improved model fit, the parameter estimates for slope within all groups did not reach significance. In a model with the TD group as the reference group, the TD group demonstrated no significant change, but the parameter estimate of the interaction between time and the DD group reached significance ($p < 0.01$). For the auditory filtering subscale, the DD group decreased an average of 0.06 (CI = −0.11 to −0.01) points every month. Adding the interaction between diagnostic group and slope did not improve model fit for the tactile sensitivity, taste/smell sensitivity, movement sensitivity, or low energy/weak subscales. The parameter estimates of linear slope on these subscales did not reach significance. Across all models, there were

Table 3. Parameter estimates of best fitting model for VABS.

Measure	Total score
Fixed effects	
Intercept	50.47***
Time	−0.04
DD	1.41
TD	41.09***
VMA	0.65***
ADOS	0.18
SSP	0.05
Random effects	
Level 1:	
Within-person	71.79***
Level 2:	
Intercept	33.65*
Slope	0.06**
Fit indices	
−2 log-likelihood	1089.1
AIC	1111.1
BIC	1136.5

DD: developmental delay group; TD: typically developing group; VMA: verbal mental age; ADOS: autism diagnostic observation schedule; SSP: short sensory profile; AIC: Akaike's information criteria; BIC: Bayesian information criteria.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

significant estimates of variance in the intercept. Only the taste/smell sensitivity model had a significant random slope; however, the effect was small. This suggests variability between subjects in their scores, but not variability in how those scores changed over time.

Sensory symptoms and adaptive behavior

For adaptive behavior, the best fitting model was the linear model with main effects of group, VMA, ADOS severity score, and SSP total score (see Table 3 for parameter estimates). The TD group scored an average of 41.09 (CI=31.43–50.75) points higher than the ASD group, but the ASD and DD groups did not differ in their overall scores. VMA, ADOS, and SSP all improved model fit and had significant parameter estimates when no other variables were in the model; however, with all of the predictors in the model, only the parameter estimate of the main effect of VMA reached significance ($p=0.00$). VMA scores were positively associated with VABS scores ($\beta=0.65$; CI=0.36–0.94). There were no significant interactions between slope and SSP or group and SSP. The variance terms for the intercept and slope were both significant; however, the slope estimate was small.

Discussion

Abnormal sensory behaviors are frequent and often severe symptoms in children with ASD; however, little is known about the developmental course of these symptoms. The specific aims of this study were to identify the developmental trajectory of sensory symptoms in children with ASD, to examine differences in the development of sensory symptoms between diagnostic groups, and to examine the effect of sensory symptoms on adaptive functioning. When compared to children with TD, children with ASD demonstrated significantly more sensory behaviors overall and also on most subscales. However, children with autism did not have more sensory symptoms than children with other DDs overall and on most subscales. On two subscales: Smell/Taste Sensitivity and Auditory Filtering, children with ASD demonstrated more severe symptoms than children with other types of DD, replicating findings from other studies using the SSP to compare autism with other types of disabilities (Schoen et al., 2009; Wiggins et al., 2009).

On the SSP, elevated scores on the auditory filtering subscale may reflect social deficits as well as sensory features, given that items address response to name and other aspects of speech. Similarly, elevated scores on the taste and smell domain may reflect significant eating problems often found in ASD (Nadon et al., 2011), which can cause specific nutrient deficits and effects on lifelong health (Sharp et al., 2013). Response to items in this subdomain on the SSP should alert clinicians to assess nutritional status and also highlight the need for empirically based feeding interventions.

Our second question concerned developmental trajectories of sensory symptoms. Across the age ranges tested (i.e. 2–8 years), children with ASD demonstrated no significant change on either total SSP score or subscale scores, their sensory symptoms are elevated at a very young age and remain elevated throughout this period of childhood. The early emergence of sensory symptoms highlights the importance of having an interdisciplinary early intervention team that includes an occupational therapist. These results conflict with meta-analysis findings of worsening of symptoms across childhood (Ben-Sasson et al., 2009), and we cannot rule out the possibility that there may be changes in sensory symptoms at different developmental stages or when measured and analyzed in alternative methods. For example, one cross-sectional study that analyzed sensory symptoms by response pattern found a negative relationship between sensory seeking and age (Lidstone et al., 2014). This conflict may result from using the specific subscales of the SSP versus describing sensory symptoms by response patterns. Future studies should carefully consider the choice of measurement tool in terms of how it categorizes sensory symptoms. The total score and the under-responsive/seeks sensation subscale models showed significant linear change across assessment points, driven by the group with TD, which had a reduction in sensory symptoms across assessments. The groups with ASD and DD demonstrated similar stable sensory symptoms across time as indicated by the nonsignificant variance in the estimate of slope.

Concerning effects of sensory symptoms on adaptive behavior functioning, our third question, we found no relationship between adaptive behavior and sensory symptoms either as a main effect or across time once we controlled for intellectual ability and other ASD symptoms. VMA was the only covariate with a significant positive effect on adaptive functioning. Children with higher VMA also had higher levels of adaptive functioning.

There were a number of strengths that support the validity of the present findings. First, sensory symptoms were quantified with the SSP, a psychometrically sound and a sensory-specific measure that provides scores for several domains of behavior. Second, a reasonably large group of children with ASD were compared to two other rigorously characterized diagnostic groups, with both mental and chronological age matches. Third, this study used a longitudinal design across three time points to answer questions about the development of sensory symptoms in autism. Fourth, the use of multilevel models fit with maximum likelihood is a well-established and recommended statistical procedure to account for missing data in longitudinal designs.

However, there were also some limitations. The sample size of this study, while large enough to examine group differences, was insufficient to investigate subgroups within the group with ASD. ASD is a complex disorder with varied presentations and there is some evidence for different subgroups of sensory symptoms within the autism spectrum (Lane et al., 2010). As with categorizations of restricted and repetitive behavior (Richler et al., 2010), there may be different developmental trajectories depending on the type of symptom or response pattern. Longitudinal studies will need larger samples to investigate individual differences or subgroups within ASD. Finally, a considerable portion of the sample was lost to follow-up. Although we were still able to include all participants within the analysis, attrition may have affected the estimation of model parameters.

Conclusion

This longitudinal study examined sensory symptoms in children with ASD across childhood. We found no significant evidence of change from 2 to 8 years of age in the frequency of parent-reported sensory symptoms in children with ASD. Children with ASD did not differ from children with other DDs in overall symptoms; both groups had more symptoms than children with TD. However, we replicated others' findings of more severe taste/smell sensitivity and auditory filtering symptoms in ASD than in other groups. Finally, the relationship between sensory symptoms and adaptive functioning appeared to be influenced more by language functioning than sensory impairment per se.

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Note

1. The Vineland Adaptive Behavior Scales-II (Sparrow et al., 2004) was administered at the third time point.

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