Sensory abnormalities in autism
A brief report

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ABSTRACT

Sensory abnormalities were assessed in a population-based group of 208 20–54-month-old children, diagnosed with autism spectrum disorder (ASD) and referred to a specialized habilitation centre for early intervention. The children were subgrouped based upon degree of autistic symptoms and cognitive level by a research team at the centre. Parents were interviewed systematically about any abnormal sensory reactions in the child. In the whole group, pain and hearing were the most commonly affected modalities. Children in the most typical autism subgroup (nuclear autism with no learning disability) had the highest number of affected modalities. The children who were classified in an “autistic features” subgroup had the lowest number of affected modalities. There were no group differences in number of affected sensory modalities between groups of different cognitive levels or level of expressive speech. The findings provide support for the notion that sensory abnormality is very common in young children with autism. This symptom has been proposed for inclusion among the diagnostic criteria for ASD in the upcoming DSM-V.

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1. Introduction

In a study of children with autism (Dahlgren & Gillberg, 1989) abnormal response to sensory stimuli in the first two years of life was the class of symptoms that most clearly separated autism from learning disability (LD)/mental retardation (MR). These symptoms have also been reported to distinguish autism spectrum disorder (ASD)/pervasive developmental disorders (PDD) from other developmental delays (Wiggins, Robins, Bakeman, & Adamson, 2009). They are among the most consistently impairing problems from childhood to adulthood and affect almost all individuals diagnosed with “classic” autism (Billstedt, Gillberg, & Gillberg, 2007; Leekam, Nieto, Libby, Wing, & Gould, 2007). Although such symptoms may constitute a marker of ASD they have not been included in the Diagnostic and Statistical Manual of mental disorders (DSM-5).
diagnostic criteria for autism (American Psychiatric Association (APA); APA, 1980, 1987, 1994, 2000). However, in the proposed criteria for the DSM-V (dsm5.org) they have been included as a symptom that can substitute for repetitive verbal and non-verbal behaviors as a qualifying diagnostic criterion for autism.

The underlying brain pathology in autism has been the focus of many studies. The brainstem has long been suggested to be a key region of importance for autistic symptomatology and also for sensory modulation (Ornitz, 1983). A recent study found brainstem volumetric reductions of grey and white matter volumes in children with autism (Jou, Minshew, Melhem, Keshavan, & Hardan, 2009). The findings were taken to support the existence of a disturbance in the brainstem circuitry associated with the sensory dysfunction observed in autism. The possible involvement of the thalamus in the pathophysiology of autism and the sensory abnormalities observed in this patient group was supported in a study using MRI and proton spectroscopy (Hardan et al., 2008). The authors emphasized that sensory abnormalities are very disabling, and have received little attention, but that insight into their neurobiologic basis may open the way to effective treatments. In a recent review (Kostovic´ & Judas, 2010) the development of the thalamocortical connectivity in the fetal brain and its significance for cognitive disorders and also for various sensory experiences was outlined. There are also studies supporting the role of the cerebellum (Schmahmann, Weilburg, & Sherman, 2007) and the superior temporal sulcus (Brunelle, Boddaert, & Zilbovicius, 2009) for the development of sensory abnormalities.

2. Aim

The aim of the present study was to describe sensory abnormalities in preschool children with an ASD diagnosis, compare to different subgroups within the autism spectrum with respect to the presence of sensory abnormalities, and relate the findings to other clinically relevant symptom domains.

3. Material and methods

3.1. Study area and procedure

In the county of Stockholm the vast majority of preschool children with diagnosed ASD are referred to a specialized habilitation centre, the Autism Centre for Young Children (ACYC), for intervention. The county has approximately 1.9 million inhabitants and currently about 27,000 births per year. In an ongoing study (Fernell et al., 2010), children with ASD, referred to the centre before the age of 4.5 years, were given a structured assessment at the centre by a research team. The overall aim of the study was to follow the children's development over a two-year-period during which they received different types of intervention.

3.2. Participants

On December 31, 2008, a total of 313 Stockholm county children under age 4.5 years (birth years 2002–2006) had received a diagnosis of ASD. Of these, 27 had been referred to a regular habilitation centre, due to very complex needs. Parents of 37 children did not have time to participate, 15 families did not participate due to parent Swedish language skills problems, and 2 children moved from Sweden. Another 24 children had been referred during the first months of the study and could not be included due to limited project resources at that time.

3.2.1. Study group

Thus, a total of 208 children with ASD (176 boys and 32 girls) constituted the study group. They all received intervention from the ACYC.

The primary assessment, leading to an ASD diagnosis, had been performed at a child and adolescent mental health service (CAMHS) or at a neuropaediatric clinic. On admission to the ACYC, all 208 children were observed and re-assessed and at least one of the parents was interviewed by one of the physicians in the research team.

3.2.2. ASD clinical characterisation and subgrouping

The research team autism assessment included a detailed interview regarding the symptoms listed in the PDD section of the DSM-IV, interview using the Autistic Behavior Checklist (ABC) (Krug, Arick, & Almond, 1980), Vineland interview (Sparrow, Cicchetti, & Balla, 2005), and a general and individualised assessment of all reported and observed symptoms. The research team also made a new assessment with respect to type of ASD based upon the DSM-IV autistic disorder criteria, observation of the child and collection of information according to different rating scales (see Fernell et al., 2010 for details). In the majority of cases, this assessment agreed with the primary assessment, performed at the CAMHS or neuropaediatric clinic, but in some children (n = 17) the research team found the autistic features to be of a subclinical character, and other neurodevelopmental diagnoses (such as attention-deficit/hyperactivity disorder (ADHD), and LD) were considered more appropriate/more impairing.

The 208 children referred to the ACYC were divided into eight subgroups: (1) 28 children with “classic autism” (with aloofness and elaborate repetitive routines) and LD (nuclear autism LD), (2) 15 children with “classic autism” without LD (nuclear autism no LD), (3) 47 children with autistic disorder/ataypical autism and LD (non-nuclear autism LD), (4) 63 children...
with autistic disorder/atypical autism and developmental delay/borderline intellectual functioning but no clear diagnosis of LD (non-nuclear autism borderline IQ), (5) 27 children with autistic disorder/atypical autism and normal intelligence (non-nuclear autism normal IQ), (6) 9 children with Asperger syndrome (Asperger syndrome), (7) 2 children with childhood disintegrative disorder (CDD), and (8) 17 children referred to the centre with a diagnosis of ASD, but not meeting full criteria for ASD at the re-assessment at the ACYC (autistic features).

3.2.3. Cognitive subgroups

Each child’s general cognitive level at referral to the ACYC was assessed by the psychologists in the research team and based upon all available information from previous tests and observations of the child. General cognitive level was classified as being (a) clear learning disability (LD), (b) delayed but not clear LD (borderline IQ), or (c) clearly not LD (normal IQ).

3.2.4. Expressive language subgroups

The expressive language level was classified as (a) no words at all, (b) a few words, (c) a few communicative sentences, (d) speech with communicative sentences but mostly echolalia, or (e) fluent communicative speech.

3.3. Sensory abnormality assessment

An interview according to the PARIS schedule (developed by C. Gillberg, M. Coleman, and colleagues within the “Paris Autism Research In Sib-pairs” study, see Fernell et al., 2010) was performed with one of the parents. This interview included structured questions about the child’s sensory reactions: (i) overreactivity to sound, (ii) abnormal reactions to visual stimuli (including flickering) and/or overreactivity to light, (iii) overreactivity to smell, (iv) overreactivity to touch, (v) underreactivity to pain, (vi) underreactivity to heat and (vii) underreactivity to cold. Only clinically significant sensory abnormalities were scored as “present” in the study.

3.4. Data analysis and statistical methods used

Mean number of modalities affected by sensory abnormalities was considered in relation to subgroup of ASD, general cognitive level and expressive language level. One-way repeated-measures analysis of variance (ANOVA) was used to compare mean number of affected sensory modalities in these three different groupings of the sample. When comparing the different ASD subgroups, the group with CDD was excluded from analysis since this group comprised only 2 children. Mean number of affected sensory modalities was also analysed in relation to the following specific symptoms: food selectivity, toe-walking, sleep problems after the first year of life, severe tantrums, stereotypic behavior, self-injurious behavior and muscular hypotonia. These symptoms were coded as either present or not present, and data were analysed using unpaired t-tests. All data analyses were made using SPSS 16.0 for Windows.

4. Results

4.1. Total group data

When looking at the total group of 208 children, at least one type of major sensory abnormality was registered in 158 individuals (76%). The most commonly reported individual types of abnormality were over-reactivity to sound (44%) and under-reactivity to pain (40%). Under-reactivity to cold and heat were reported for 22% and 7% respectively. Over-reactivity to touch had been noted in 19%. Abnormal reactions to visual stimuli were seen in 19%. Oversensitivity to smell was reported in 5% (Fig. 1).

4.2. Sensory abnormalities and ASD subgroups

The number of sensory abnormalities differed significantly across ASD subgroups (Fig. 1). There was a significant effect of subtype on mean number of sensory abnormalities [F(6, 199) = 4.258; p < 0.001] (Fig. 2). A LSD post-hoc analysis showed that the autistic features subgroup differed significantly from all the other groups. The nuclear autism no LD group differed significantly from all the other groups except from that with Asperger syndrome. The other groups did not differ significantly from each other.

4.3. Sensory abnormalities and general cognitive level

The number of affected sensory modalities did not vary with cognitive level [F(2, 204) = 0.405, p = 0.638] (Fig. 3).

4.4. Sensory abnormalities and expressive language level

There were no significant differences across language groups related to the number of sensory abnormalities [F(4, 203) = 0.976, p = 0.422] (Fig. 4).
4.5. Sensory abnormalities related to specific symptoms

4.5.1. Food selectivity
The children with food selectivity had more affected modalities ($M = 1.8$, $SD = 1.4$, $n = 81$) than the children with no such problems ($M = 1.4$, $SD = 1.3$, $n = 119$); $t(198) = 2.209$, $p = 0.028$.

4.5.2. Toe-walking
Toe-walking children had more affected modalities ($M = 1.9$, $SD = 1.5$, $n = 69$) than children who were not reported to engage in toe-walking ($M = 1.4$, $SD = 1.3$, $n = 139$); $t(206) = 2.237$, $p = 0.026$.

4.5.3. Sleep problems
Children with sleep problems had significantly more sensory abnormalities affected ($M = 1.9$, $SD = 1.6$, $n = 85$) compared to those without ($M = 1.3$, $SD = 1.1$, $n = 123$); $t(206) = 3.220$, $p = 0.001$.

4.5.4. Tantrums
Children with tantrums had more sensory abnormalities affected ($M = 1.8$, $SD = 1.5$, $n = 101$) than children without ($M = 1.3$, $SD = 1.1$, $n = 107$); $t(206) = 2.700$, $p = 0.008$.

4.5.5. Stereotypic behavior
There was no clearly significant difference between the group with stereotypic behaviors ($M = 1.7$, $SD = 1.4$, $n = 106$) and the group without ($M = 1.4$, $SD = 1.3$, $n = 101$); $t(205) = 1.614$, $p = 0.108$.
4.5.6. Self-injurious behavior

Children with self-injurious behaviors had more sensory abnormalities affected ($M = 2.0, SD = 1.5, n = 61$) than children with no such behaviors ($M = 1.3, SD = 1.2, n = 147$); $t(206) = 2.791, p = 0.006$.

4.5.7. Muscular hypotonia

There was no significant difference between the group with muscular hypotonia ($M = 1.6, SD = 1.3, n = 62$) and the group without ($M = 1.6, SD = 1.3, n = 146$); $t(206) = 0.364, p = 0.716$.

5. Discussion

This study demonstrated that about three quarters (76%) of a population-based group of preschool children diagnosed with ASD and referred for intervention before age 4.5 years had been noted by their parents to have at least one sensory modality affected by major abnormality. The number of modalities affected by sensory abnormalities was related to ASD subgroup. Children with nuclear autism and no LD had significantly more affected modalities than the other groups, and the children who were considered by the research team to have symptoms not definitely reaching the threshold for ASD (autistic features) exhibited much lower levels of sensory abnormalities than the other groups. The group of children with nuclear autism and no LD, exhibiting the highest mean number of affected sensory abnormalities, may be more exposed to different sensory stimuli in their daily life and have a greater ability to express their sensory reactions compared with those with nuclear autism and LD.
Our findings that cognitive level and degree of expressive speech did not affect the number of sensory abnormalities accord with findings from a study by Rogers and collaborators (Rogers, Hepburn, & Wehner, 2003) demonstrating that neither overall developmental level nor IQ was related to abnormal sensory reactivity in children with autism or general developmental disorders. Nor did muscular hypotonia, a more general neurological symptom, correlate to the presence of sensory abnormalities.

Symptom categories that are commonly associated with autism, including food selectivity, toe-walking, sleep problems, severe tantrums and self-injurious behavior were all significantly related to the presence of sensory abnormalities. The findings correspond to the idea that sensory abnormalities constitute an important and valid symptom category of autism.

However, in our study group those with and without stereotypies did not differ with respect to the number of reported sensory abnormalities. This is difficult to explain – one factor may be the young age of our study group. There is clearly a risk of underreporting sensory abnormalities in very young children, given that many of them are yet unable to describe their sensory reactions.

There is a very small literature addressing treatment or intervention for children with ASD and sensory abnormalities. In a review by Dawson and Watling (2000) only four objective outcome studies of sensory integration therapy were identified. However, these did not allow conclusions regarding efficacy.

Within applied behavior analysis (ABA), it is generally assumed that the sensory abnormalities in children with autism contribute to autistic symptoms (Lovva, Newsome, & Hickman, 1987) and that specific sensory input may influence and change the child’s behavior. A stimulus that is experienced as neutral by most children may be either highly rewarding or aversive for some children with autism. It can be hypothesized that the altered sensory modalities explain why children with autism, in trying to either gain access or avoid unusual stimuli, develop unusual behavioral repertoires. To change the rewarding or aversive properties of such stimuli might be one of the effective components of ABA-treatment.

Until we know more about how to alleviate sensory/perceptual symptoms that cause problems for the patient it is of utmost importance that families and staff receive information about how to create an environment that takes these problems into consideration. Abnormal sensory responses cause daily problems in any individual. In somebody with autism it can cause major havoc all the time unless the environment is adapted and “autism friendly”.

6. Conclusion

Our main conclusion from this study is that sensory abnormalities differed among children with autism spectrum disorders according to autistic subgroups and that sensory/perceptual abnormalities were most frequent in the subgroups with nuclear autism without LD and in the Asperger syndrome group. The children who were classified in an “autistic features” subgroup had the lowest number of affected modalities. No group differences in number of affected sensory modalities were found between groups of different cognitive levels or levels of expressive speech.

References