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The sensory profile of children with asthma

Batya Engel-Yeger, PhD¹, Meital Almog MD², Aharon Kessel, MD²

Occupational Therapy Department, Faculty of Social Welfare and Health Sciences, University
of Haifa, Israel¹Division of Allergy and Clinical Immunology, Bnai Zion Medical Center, Haifa,
Israel²

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Corresponding Author and reprint requests: Dr Aharon Kessel
Division of allergy and clinical Immunology and Allergy
Bnai Zion Medical Center, 47 Golomb Street, PO Box 4940
Haifa 31048, Israel. Tel/Fax: 97248359659
E. mail: aharon.kessel@b-zion.org.il

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Abstract

Aim: Sensory hypersensitivity is one expression of sensory processing disorders (SPD) and results from the inability to regulate an appropriate response to a sensory input in an adaptive manner. We explored the sensory processing profile of children with asthma, based on reports from parents.

Methods: We studied 86 children between the ages of four and 11 years: 37 diagnosed with asthma and 49 healthy controls. The parents of all participants filled out the Short Sensory Profile (SSP) that measures the child's behavioural reactions to sensory stimuli in daily environments.

Results: SPD were more prevalent among children with asthma ($F_{7,71} = 4.16$, $p = 0.001$; $\eta^2 = .29$) than among healthy controls and were mainly reflected by hypersensitivity. While about 90% of the healthy children were reported to actively seek sensory stimuli, only 53% of the asthmatic children showed this trend. In the study group, 25.7% of the children's scores reflected abnormal sensory performance, compared to 0% of the controls ($\chi^2 = 21.93$; $p < .001$).

Conclusions: Children with asthma may suffer from SPD. Our finding supports previous reports that suggest that the central nervous system is involved in the pathogenesis of atopic conditions. The sensory profile of children with asthma should be evaluated and treated as required.

Keywords: Asthma; Sensory hypersensitivity; Short Sensory Profile.

Key Notes

- Sensory hypersensitivity results from a dysfunction in the ability to regulate an appropriate response to a sensory input in an adaptive manner.
- Our study of 86 children between the ages of four and 11 found that sensory hypersensitivity was prevalent among children with asthma and may reflect central nervous system involvement in atopy.
- The sensory profile of children with asthma should be evaluated and addressed accordingly.

Introduction: Asthma is the most prevalent chronic medical illness in childhood (1). It is a heterogeneous disease characterised by inflammation of the small airways, bronchial hyper-responsiveness, intermittent airway obstruction, smooth muscle hypertrophy and mucus hypersecretion (2). The fact that atopic diseases such as asthma, allergic rhinitis and atopic dermatitis often occur in the same family suggests that they might share a common genetic susceptibility (3, 4). Moreover, recent studies suggest that atopic conditions, including atopic dermatitis and allergic rhinitis, may share the same phenotype expressed in sensory hypersensitivity (5, 6).

Sensory hypersensitivity is one expression of sensory processing disorders (SPD) and it results from a dysfunction in the ability to regulate and organise the degree, intensity and nature of a response to sensory input in a graded and adaptive manner (7). SPD are characterised by intense reactions to sensory stimuli. These may be expressed in sensory hypersensitivity resulting from a low neurological threshold to sensory stimuli, or in hyposensitivity resulting from a high neurological threshold to sensory stimuli. These intense reactions can occur in some or all sensory systems (8).

Clinical evidence and previous studies raise the possibility that genes may be involved in inducing SPD (9).

The literature also emphasises the negative impacts of SPD, mainly by referring to sensory hypersensitivity that was related to emotional problems, including anxiety, need for control and depression (10). As a result, SPD is reported to negatively impact on behaviour and mental health, reduce optimal participation in daily life activities and impair quality of life.

It has also been suggested that the genetic aetiology of SPD contributes to the emotional reactions that are characteristic of individuals with sensory hypersensitivity (11).

Interestingly, children with atopic conditions such as asthma may also suffer from psychological problems that are expressed mainly through anxiety, depression and somatic complaints (12). The severity of the asthma has been associated with children's fears related to the illness (13).

Both SPD sufferers and asthmatic children express hypersensitivity to sensory stimuli in their immediate environs. Both groups demonstrate common stressful and controlling behavioural patterns and tend to display negative impacts on their performance and participation at home, at school and in the community. These similarities point to a need to further explore whether SPD exist in asthma (14, 15).

The aim of this study was to explore the profile of sensory processing of children with asthma, as expressed in daily life. This information may strengthen the results of previous studies about SPD in atopic conditions and, more important, contribute to the evaluation and intervention of children with asthma (13). Our hypothesis was that SPD would be significantly more prevalent among children with asthma than among healthy controls and that the probability of SPD among children with asthma would be similar to that found in other atopic conditions, approximately 30%, such as atopic dermatitis and rhinitis.

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Patients and Methods

This study included 86 children, between the ages of four and 11. The study group included 37 children diagnosed with asthma (23 boys and 14 girls, mean age 8.37 ± 1.81 years). The control group included 49 healthy children (27 boys and 22 girls, mean age 6.97 ± 1.67 years). The study group was recruited from our outpatient allergy clinic and included children suffering from controlled mild to moderate persistent asthma according to the American Thoracic Society diagnoses (16). These children had no past medical history of any other atopic diseases, such as allergic rhinitis or atopic dermatitis. This was further confirmed by medical records and a complete physical examination, including allergy evaluation. Further exclusion criteria included chronic or severe health conditions, such as depression, cerebral palsy and autism. Only 30% of the screened children with asthma were deemed suitable to participate in the study.

Healthy children who did not suffer from allergies or other chronic diseases or conditions were included in the control group. They were recruited through an advertisement posted in several neighbourhoods in northern Israel inviting children and parents to participate in a study about children's reactivity to sensory stimulation in their daily environments. The study included 90% of all those who responded. Parents' education levels ranged from high school to university education, with 65% holding university degrees. The families had medium to high socioeconomic status. The study was approved by the ethics committee of Bnai Zion Medical Center.

The children's sensory profiles were assessed by the Short Sensory Profile (SSP), which is the shorter version of the Sensory Profile, and has been found to be suitable for research and for screening children with sensory modulation disorders (17). The SSP is filled in by the child's main caregiver. It measures the child's sensory reactivity to sensory stimuli in daily life environment.

The SSP comprises 38 items divided into seven sections: seven items of Tactile Sensitivity (for example: "Avoids going barefoot, especially on sand or grass"); four items of Taste/Smell Sensitivity (for example: "Will only eat certain tastes"); three items of Movement Sensitivity (for example: "Fears falling or heights"); seven items of Under-responsive/Seeks Sensation (for example: "Touches people and objects"); six items of Auditory Filtering (for example: "Has difficulty paying attention"); six items of low energy/weak (for example: "Has a weak grasp") and five items of Visual/Auditory Sensitivity (for example: "Holds hands over ears to protect ears from sound"). Items are scored on a five-point scale. SSP records include both section scores and a total score. The possible range of raw scores on the total scale is 38 to 190, with higher scores (155-190) representing normal performance. A score of 142-154 represents a probable difference in performance, while a score of 38-141 represents a definite difference in performance (10). Internal consistency of the sections within the scale ranged from 0.70 to 0.90 (10). Internal validity correlations for the sections ranged from 0.25 to 0.76 and were all significant at $p < .01$. The SSP demonstrated discriminate validity of >95% in identifying children with and without sensory modulation difficulties.

Method

In the study group, the parent who accompanied the child to the meeting in the clinic was asked to fill out the demographic questionnaire. Parents of children who answered the inclusion criteria were asked to complete the SSP.

A home meeting was arranged with the parents of the control participants who responded to the advertisement. The parents of children suitable for the study according to the demographic questionnaire filled in the SSP.

Statistical analysis

The significance of the differences in the SSP sections between the groups and genders were examined through a Multivariate Analysis of Variance (MANCOVA). The same tool also examined the significance of group X gender interaction on SSP sections scores. Significant differences were found between the groups in the variable of child's age. Therefore this variable was used as a covariate. A T-test was performed to examine the differences between the groups in the total SSP score. Chi square analyses examined whether significant differences exist between groups regarding the percentage of children found in each of the SSP performance range. Probabilities below .05 were considered significant.

Results

Differences in SSP scores between groups

The MANCOVA revealed significant differences between both groups in all SSP sections ($F_{7, 71} = 4.16$, $p = 0.001$; $\eta^2 = .29$). ANCOVAs found that compared to members of the control group, the children with asthma had significantly lower mean scores in all SSP sections, thus reflecting abnormal sensory processing abilities. The only exception was in for "Visual/Auditory sensitivity" where difference was nearly significant ($p = .06$) (see Table 1). The SSP total score also differed significantly between the groups (151.01 ± 26.77 versus 172.53 ± 10.87 ; $t_{82} = 4.49$, $p \leq .0001$).

The percentage of children in each sensory performance range – typical performance, probable difference or definite difference in performance – was calculated for each group. As presented in Figure 1, Chi square analyses yielded significant differences between groups in all SSP scales except for Visual/Auditory sensitivity. A higher percentage of children in the control group received scores indicating typical sensory performance, while a higher percentage of children

with asthma (about 20-30%) received scores reflecting definite differences in sensory performance.

Group X Gender effect on SSP scores

No significant group X gender interaction was found regarding SSP scores.

Group X Age effect on SSP scores

All participants were divided into two age groups: four to eight and eight to 11. In the study group, no significant differences in SSP scores were found between the age groups. Moreover, group X age interaction was not found to be significant in any of the SSP sections.

Discussion:

In accordance with previous studies documenting SPD among children with atopic conditions such as atopic dermatitis and allergic rhinitis, this study also confirmed the existence of SPD among children with asthma (5, 6).

The results of the present study found more sensory processing difficulties among children with asthma than among healthy controls. This was expressed on most SSP scales and in various modalities. This suggests that further studies should examine gene involvement in SPD characterising atopic conditions. This may also support the findings suggesting that the central nervous system is involved in the pathogenesis of atopic conditions, as expressed in difficulties to process sensory information in the best possible way (18). Interestingly, Rosenkranz et al argued that it was reasonable to postulate that neural signalling between the brain and lung at

least partially modulates the inflammatory response and lung function since psychological stress, as well as mood and anxiety disorders, increases the expression of asthma symptoms (19). They used the term "neurophenotype" to describe symptoms that result from an interaction between immune responses that regulate inflammation and the neural "context" (19). Earlier reports showing previously present neural regulation of inflammation in asthma highlighted that the brain transduces stress related and emotion related stimuli from the environment. It then activates inflammatory mechanisms in the lung to further exacerbate any underlying disease (19, 20). In their study, Rosenkranz et al. used functional magnetic resonance imaging to measure neural signals in response to asthma specific emotional cues, following allergen exposure in asthmatics with a dual response to allergen challenge (19). Their findings indicate that neurophenotypes for asthma may be identifiable by neural reactivity of brain circuits that are known to be involved in processing emotional information. The anterior insula was found to be related appreciably to greater inflammatory signals in the lung and increased severity of disease.

The anterior insula was also associated to sensory sensitivity, mainly in relation to the sensation of pain (21). It is well established that a person's subjective pain threshold can change when certain emotions are recognised. Interestingly, a recent study found that pain catastrophising level was enhanced among people with sensory hypersensitivity (22).

Results indicate that if children with asthma are found in the probable/definite range of sensory performance, their prevalence is five to six times higher than that of healthy controls. It may be suggested that the general sensory hypersensitivity expressed by children with asthma causes them to avoid daily experiences, which include a lot of sensory input. Such experiences include, for example, eating in restaurants, working out in gyms and others social activities.

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Interestingly, while about 90% of the healthy children were reported to seek sensory stimuli, only 53% of the children with asthma showed this trend. The literature indicates that sensory seekers crave large amounts of sensory input. They energetically engage in actions that add more intense sensations to their bodies, such as physical activity (23). Sensation seeking is considered a positive and important trend in childhood by which children explore the environment. Yet, some children use sensation seeking as a coping strategy to overcome their hypersensitivity or for relaxation (5, 10).

Specific differences were noted between the groups in certain items in the SSP Under responsive/Seek Sensation scale. The differences were most meaningful in items expressing excitable behaviour ("Becomes overly excitable during movement activity"; "Jumps from one activity to another so that it interferes with play"). This supports the result of a previous study about the sensory profile of children with atopic conditions such as atopic dermatitis (5).

The findings of our present study support our previous results about atopic dermatitis and rhinitis, and suggest that the irritability expressed by children with atopic conditions may result from their sensory hypersensitivity.

Similar to previous reports, group X gender interaction was not found to be significant. Although allergies are more prevalent among boys, the existence of sensory processing difficulties among children with atopic conditions such as asthma was found to be similar in both genders (6, 24).

Another important aspect that should be taken into account when referring to SPD among children with asthma is that their frequent emotional problems, expressed through stress, anxiety and depression, are similar to those of children with SPD in general. The fact that

emotional or psychological stimuli may trigger attacks among children with asthma highlights the importance of referring to SPD in this population (25, 26).

The SSP may serve as an appropriate tool for screening SPD among children with asthma. Health providers who are in continual contact with the child and its parents should consider the child's sensory profile during the evaluation stage. Consequently, the patient can be referred to psychological intervention to reduce their emotional burden and negative behavioural implications, if necessary.

Moreover, the literature emphasises that parental assessments are associated with asthma management (27), and that including the sensory profile in the evaluation may increase the parents' awareness to the possible involvement of SPD in asthma and, specifically, in their own child's behaviour. This may help the parents and the child to control sensory stimuli in the child's daily environment, thus implementing environmental adaptations that will allow optimal performance. The child's involvement in choosing clothes made of comfortable materials, in defining the kind of food they prefer and setting the light in the room according to their sensory abilities will enable the child and their family to better keep to daily routines that children with allergies are often unable to follow (28, 29).

In conclusion, extreme sensory processing patterns mainly indicated by sensory hypersensitivity may characterise children with asthma, as they do with children with other atopic conditions. Since functional sensory processing abilities are essential for a child's development and optimal performance in daily life, physicians should refer to the child's sensory profile in the evaluation and intervention process. Studies should further explore the sensory profiles of individuals suffering from other allergies in various age groups and, more important, explore the relationships between the sensory profiles, daily life and quality of life among individuals with

allergies. This knowledge may contribute to the focussing of the intervention process upon the specific needs of individuals suffering from atopic diseases and thus elevate their quality of life.

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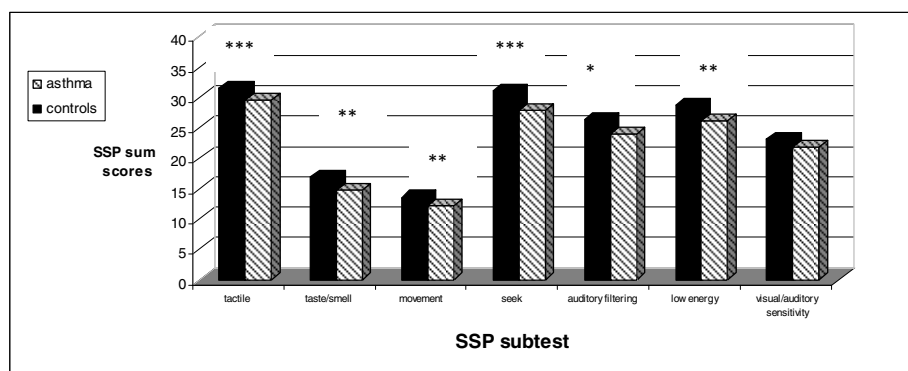
Table 1: Comparison of SSP scales scores between both groups

SSP scales	Children with asthma (N=37)			Healthy controls (N=49)			F, t
	Mean	SD	Range	Mean	SD	Range	
Tactile sensitivity	29.17	4.81	16-35	31.83	3.09	23-35	13.136***
Taste/smell sensitivity	14.28	4.54	1-20	16.87	3.33	8-20	7.862**
Movement sensitivity	12.25	3.35	5-15	13.89	1.81	5-18	7.344**
Under responsive/seek	27.67	4.96	16-35	31.48	3.36	21-37	14.472***
Auditory filtering	24.05	4.24	13-30	26.51	2.94	20-30	4.690*
Low energy/weak	26.03	4.61	11-30	28.75	1.84	23-30	9.263**
Visual/auditory sensitivity	21.72	4.62	7-25	23.16	2.26	15-25	3.554
Total	151.01	26.77	68-187	172.53	10.87	143-191	t=4.49***

p ≤ 0.01**

p ≤ 0.001***

Figure 1 - SSP scales scores in both groups:



$p \leq 0.05^*$, $p \leq 0.01^{**}$, $p \leq 0.001^{***}$