

Original Article

Sensory processing in children with attention deficit hyperactivity disorder and high-functioning autism

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Abstract

Introduction: We aimed to assess the status of sensory processing in children with attention deficit and hyperactivity disorder, high-functioning autism and typical peers.

Methods: Participants in this study are children 7 to 10 years old with attention deficit hyperactivity disorder (n = 30), autistic children with high cognitive function (n = 28) and 30 matched typical children. Parents of children in all the groups have completed the Dunn sensory profile questionnaire (SP).

Results: The results of the present study showed that children in high-functioning autism and normal sensory processes act different. The autistic children differ in sensory seeking, emotional reactivity, low muscle tone and endurance, oral sensory sensitive, inattention and distractibility, poor sensory registration, sensory sensitivity, fine movement/perception. Children with attention deficit and hyperactivity disorder differ in seven factors of the nine factors. These factors were sensory seeking, emotional reactivity, low muscle tone and endurance, inattention and distractibility, poor sensory registration, sensory sensitivity, fine movement/perception.

Conclusion: Different sensory processing function in these children may explain their abnormal behaviors. This sensory processing dysfunction affects on child's daily life in areas such as play, academic skills, peer relationships, and self-help activities. Therapists should consider the child's sensory processing functions when they set therapeutic planes.

Declaration of Interest: None.

Keywords: Attention deficit hyperactivity disorder, Autism high function, Sensory processing.

Introduction

Attention deficit hyperactivity disorder (ADHD) is characterized by and developmentally inappropriate hyper activity, inattention, and impulsivity, which can cause varying degrees of difficulty in daily functioning. (1) Prevalence of ADHD is between 3 to6percent of the school-aged children (2). ADHD is a risk factor in academic performance, psychological adjustment, and mental illness in the future (3).

Autistic disorder (Autism) is a developmental disorder, characterized by difficulties in social interaction and communication and restricted and repetitive interests and behaviors (4). Although sensory symptoms are not part of the diagnostic criteria, but most autistic children show this symptoms (5).

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Sensory processing is defined as registration, modulation, integration and organizing sensory inputs (6). Sensory processing disorder is defining difficulties in regulation and organizing the variety and intensity of responses to sensory input for compliance with environmental requirements (7).

Children, who have sensory processing disorder, show abnormal sensory responses, such as under or over responsively, to sensory stimuli (8). Sensory processing disorder in children with autistic disorder is in a rangebetween 42-95% based on case studies have been reported (8,9). ADHD children compared to normal children show more abnormalities in the sensory modulation in both the physiological assessment and parents reporting (10). From the perspective of sensory processing, children with ADHD may not properly receive and process sensory information. Therefore, they have difficulties in creating adaptive responses in home or social settings (11). Neu (1997) suggested that more activity, less adaptive abilities and low sensory threshold in infancy is associated with higher rate of ADHD in later ages (12).

Empirical evidence and assumptions are highlighted with sensory processing and dysfunction among children with ADHD (13). Both sensory modulation disorder and ADHD include hyperactivity and impulsive behaviors and a high percentage of children with ADHD haves sensory processing disorders (14).

ADHD in children is reported too sensitive to sensory stimuli in infancy and can be easily dismayed by environmental changes (15). Further, children with ADHD behavioral show behavioral evidence of difficulties in sensory modulation response to sensory inputs and particularly show over responsivity compared to normal children (16). Another study of children with ADHD and their siblings' show that children with ADHD, girls with ADHD show tactile defensiveness more than boys with ADHD, but ADHD boys didn't show any significant difference compare with normal croups (17). Another study suggests that ADHD children show under responsively in auditory system (18). Yochman et al. (2004) suggested that ADHD children respond to sensory stimuliare significantly different from healthy children. These differences are evident in the six-factor of 9sensory scale factor and emotional responses. Behavioral and sensory processing is sensory modulation based on 11ofthe14 sections sensory profile questioner different from healthy children (19).

Several studies in response to sensory stimuli in the ASD population are done (20,21,9). This response include over responsivity, under responsivity, Sensory seeking. All seven sensory domains specially auditory, visual, tactile and proprioceptive may indicate dysfunctions. These abnormal sensory processing patterns recognized as sensory modulation disorder, which is related to arousal level. Studies used parental questioners; suggest that rate of sensory processing dysfunction in autistic children than other psychological disorders (8,22). Baranek et al. (2005) observed 3 sensory processing patterns in autistic children. These patterns pare wise incompatible and often have a coincidence (23). Although ASD diagnostic criteria do not include sensory processing deficits, many articles have reported sensory processing abnormalities in children with ASD. Several research groups have reported sensory modulation problems, which include both under and over responsiveness to sensory stimuli in autistic children (23,24,25). Pfeiffer et al. (2005) reported a strong relationship between the tactile defensive and anxiety in children with Asperger (26).

Wouter et al. (2012) study on autism and their normal sibling showed that autistic children significantly differ in sensory seeking and sensory avoidance domains (27). A review of14researchstudies, which involves sensory processing signs in children with ASD showed sensory behaviors are common (28). Roger et al. (2005) reviewed 48 empirical and 27 rhetorical studies, and found that intensity frequency and topography of these abnormal sensory behaviors are different in different ASD samples. In addition, they have reported evidence that is insufficient for considering sensory behavior as differential diagnosis between autism and other developmental disabilities (29). Study of 281 autistic children (3-6 year old) suggest that 95% of autistic children show some degree of sensory processing dysfunction short form in sensory profile questioner (9).

Walting et al. (2001) compared sensory processing behavior in autistic children (3-6 year old) by using long form of sensory profile questioner. Result showed that these children are different in 8 factors. These factors included sensory seeking, emotional reactivity, low muscle tone and endurance, oral sensory, sensitive inattention and distractibility, poor sensory registration, sensory sensitivity, fine movement/ perception (30).

New theories about autism express these sensory processing dysfunctions are the core symptoms of autism and have downstream effects on the development of conceptual system in people with autism (31).

The first aim of the present study was evaluation of sensory processing function between high functioning autistic children and normal peers. Another objective of the present study was to answer the question whether the sensory characteristics of the two disorders were different.

Methods

Thirty children clinically diagnosed with an attention-deficit–hyperactivity disorder (ADHD) and 30 typically developing Twenty-eight children clinically diagnosed with ASDHF and 30 control children of similar ages, participated in this study. The age range in all groups was between 7 to 10 year old. Children with ADHD and ASDHF groups had not used any psychiatric medicines or occupational therapy services yet. A child and adolescent psychiatrists diagnosed all by considering *DSM-IV-TR* characteristics. All children‘s parent completed long form of sensory profile questioner.

To determine cognitive functioning autistic children asanentry criteria (overall IQ score of 90) from the Wechsler intelligence test was used. The Wechsler intelligence scale for children (WISC), developed by David Wechsler, is an individually administered intelligence test for children between the ages of 6 and 16 inclusive that can be completed without reading or writing (33). The WISC takes 65–80 minutes to administer and generates an IQ score, which represents a child's general cognitive ability. Since, psychological tests are culturally dependent iodine be made on the basis of the prevailing culture. Wechsler Memory Scale (1371) in translation has been prepared on the population in the age group 9 (n =1007) with the liability of 85/0 is a normal issue (34).

Data collection included demographic questionnaire and sensory profile questionnaire. Sensory profile questionnaire that published in 1999 by Wayne Dunn, focuses on evaluation of the sensory profile of children aged 3 to 10 (Dunn, 1999). This questionnaire consists of 125 items. The questionnaire results can be classified in 9 factors:

Factor 1 (sensory seeking): the child shows a need to a variety of sensory stimuli. Based on questionnaire standard scoring, children whose scores are low on this factor need lots of different sensory stimuli.

Factor 2 (emotional reactivity): shows children's reactions to emotional-social issues. Based on questionnaire standard scoring, children whose scores are low on this factor, shows severe reaction on emotional issues like failure, fear and anxiety.

Factor 3 (low muscle tone and endurance): shows muscle endurance of the child on different activities. Based on questionnaire standard scoring, children whose scores are low on this factor, indicating that the child has little tolerance in everyday activities and gets tired easily.

Factor 4 (oral sensory sensitive): oral sensory processing in children's shows. Based on questionnaire standard scoring, children whose scores are low on this factor, indicating the child has a high sensitivity to the taste, smell and temperature of the food.

Factor 5 (inattention and distractibility): represents the focus of the child's daily activities. Based on questionnaire standard scoring, children whose scores are low on this factor, indicate that the child quickly loses its focus because of environmental factors and is not able to continue activities.

Factor 6 (poor sensory registration): child doesn't register sensory stimuli enough. Based on questionnaire standard scoring, children whose scores are low on this factor, indicating that the child does not understand sensory stimuli enough.

Factor 7 (sensory sensitivity): children register high sensory stimuli. Based on questionnaire standard scoring, children, whose scores are low on this factor, indicating that children record high intensity vestibular and proprioceptive sensory stimuli and show sever reaction on it.

Factor 8 (sedentary): indicates the preference of the child is the type of activity. Based on questionnaire standard scoring, children whose scores are low on this factor, indicating that the child prefers quiet and sitting activities.

Factor 9 (fine movement/perception): indicates the fine baby status. Based on questionnaire standard scoring, children whose scores are low on this factor, indicating poor eye and hand coordination for children.

The questionnaire filling and completion time by the childcare provider is 15 to 20 minutes and score time for specialist is 30 minutes. Cronbach's alpha coefficient for all of the parts is obtained between 47 to 91 (32).

Results

Test the hypothesis, given the number of variable sand data obtained from measurement to multivariate analysis of variance (MANOVA) was used. The first hypothesis: there is a difference of 9-factors between normal and ASDHF children (table 1).

The second hypothesis: there is a difference of 9 factors between normal and ASDHF children (table 2). The third hypothesis: between children with autism and ADHD sensory, there is a difference in terms of factors 9 (table 3).

Conclusion

The first research question was whether the two ASDHF and ADHD have different sensory processing from normal children. As the results have shown, children with ADHD and ASDHF have different sensory processing from normal children. The results of this study showed that children in the ASDHF and normal group act different in sensory processing. These children were different at the components of sensory seeking, emotional reactivity, low muscle tone and endurance, oral sensory sensitivity, inattention

Table 1. Summary of effects of test subjects

Sources	Dependent variables	SS	Df	MS	F	Square
GROPS	Sensory seeking	910.597	1	910.597	13.197**	0.194
	emotional reactivity	4828.937	1	4828.937	38.868**	0.414
	low muscle tone and endurance	749.039	1	749.039	12.107**	0.180
	oral sensory sensitivity	667.431	1	667.431	9.816**	.0.151
	inattention and distractibility	668.632	1	668.632	32.027**	0.368
	poor sensory registration	197.183	1	197.183	8.684**	0.136
	Sensory sensitivity	57.475	1	57.475	3.900	0.066
	Sedentary	58.608	1	2.467	.043	0.043
	Fine movement and perception	74.989	1	74.989	13.735**	0.200

Table 2. Chi Square across age and positioning

	Value	**df**	**P**
Pearson Chi-Square	5.625[a]	1	.044
Likelihood Ratio	6.194	1	.044
Fisher's Exact Test	4.0	4	.56
Linear-by-Linear	5.484[c]	1	.044
Association			

Table 3. Summary of effects of test subjects

Sources	Dependent variables	SS	Df	MS	F	Square
GROPS	Sensory seeking	1048.725	1	1048.725	7.977**	0.125
	Emotional reactivity	43.274	1	43.274	0.224	0.004
	Low muscle tone and endurance	42.562	1	42.562	0.505	0.004
	Oral sensory sensitivity	17.524	1	17.524	0.185	0.009
	Inattention and distractibility	61.147	1	61.147	1.853	0.032
	Poor sensory registration	19.472	1	19.472	0.590	0.136
	Sensory sensitivity	6.119	1	6.119	0.355	0.006
	Sedentary	33.524	1	33.524	1.368	0.024
	Fine movement and perception	40. 115	1	74.989	4.209*	0.070

and distractibility, poor sensory registration and fine motor sensory perceptions.

A similar pattern in other studies of children with autism is expressed (8,30,35). However, the results are inconsistent with studies of Ermerand Dunn (1998), which have reported the incidence of low sensation-seeking behavior in a small sample of children with autism (36).

ADHD children showed different functions in seven factors of SP questionnaire nine factors. These factors are emotional reactivity, low muscle tone and endurance, inattention and distractibility, poor sensory registration, sensory sensitivity and sedentary.

The results are consistent with the study of Yachmn et al. 2004. The sensory systems processed in, affect the child's ability to respond compliant. A child will not absorb every sense that is received passively. A child chose sensory stimulus that needs to achieve his purpose in that time and place. This is sensory integration and when this process is successful, the child can organize a successful and purposeful action on the environment that is called adapted response (37).

Based on the Dunn pattern if a child has impairment in sensory registration, he will need more intensive stimuli to participate and respond to it. Children who are in a low arousal state and have inadequate emotional records they do not capture changes in environment and so, accommodative response will not occur (38). These children require more sensory stimulation in certain sensory modalities such as proprioception and balance. For instance, in a deep sense, these children usually seek for active resistance to muscle stimulation, deep palpation, or joint push and pull. For example, hitting legs instead of walking, intentional failure, collision with objects or other people, or pushing big objects. They may do some serious throwing like throwing things tight. Some of these children do not understand the situation of their body organs except with severe proprioceptive stimuli. These behaviors may be interpreted as aggressive behavior. These children go up the high places, running and are stirring to receive stimuli equilibrium. These behaviors together interferes children sit to learn in school, playing with peers, self-care activities and may increase child's environmental failure (39).

ASDHF samples children showed oral sensory sensitivity. This means that these children are sensitive to food flavor and texture of foods (hardness and softness). This makes these children do not have a good diet and eat only a limited variety of foods (40).

However, what is important for clinical work correlate these findings with the daily challenges of these children. Weakness of sensory processing, causing a mismatch between environmental needs of the child and his inner emotional needs (41) and can cause weakness in the child's ability to work with others and engage in related activities in a sustainable basis.

The second research question was whether children with ADHD and ASDHF show different sensory performance in sensory profile questionnaire? The results show the performance of these two groups differs from each other in the sensory situation. The differences are significant in sensation seeking and fine components/perception.

ADHD children have lower performance in seeking sensory component (mean score 57.63) than ASDHF children (mean score 66.14) and level of sensation-seeking behaviors is higher in these children.

One of the characteristics of ADHD children is impulsivity. Impulsivity in ADHD often explained as incorrect executive functions (EFs). In general

terms, impulsivity means act without thinking and inability for planning. In the literature impulsivity is a heterogeneous concept that is described with terms such as quick response, sensation seeking, risk seeking, freshness seeking, boldness, and errantry (42). Sensation-seeking behaviors in children with ADHD can be aggravated by impulsivity.

Fine movement/perception factor in Dunn questionnaire just has 3-question about matching puzzle and hand fine movement. Results show that children with ADHD (mean 9.80) have lower performance than the children of ASDHF (mean 11.64). Due to low number of queries of this component we cannot accurately judge the fine movement/perception and understanding of this group based on this questionnaire. The results of this study suggest that occupational therapists consider emotional needs of children in developing treatment protocols for children with ADHD and ASD. To inform families about their children's emotional state can provide a better understanding of why children behave like this. Adapting and modifying the child's living environment by taking the functional status of the child can lead to better performance. Obviously, the outcome of the status of children's behavior, sensory processing, cognitive skills, psychological factors, parenting styles, and other factors are effective. Therefore, therapists must be detailed and comprehensive compilation of various therapeutic approaches such as sensory integration, perceptual-motor activities, behavioral therapy and etc. to be used.

References

1. Barkley RA. Attention Deficit Hyperactivity Disorder: a handbook for diagnosis and treatment, 2nd ed. New York: Guilford Press1998.
2. Khoshabi K, Puretemad H, Homan A, Biglariyan A, Tofigh. Prevalence of attention deficit and hyperactivity disorder and comorbid disorders in primary school students in Tehran. University of welfare and rehabilitation science 2003.
3. Mannuzza S, Klein RG, Bessler A, Malloy P, LaPadula M. Adult psychiatric status of hyperactive boys grown up. American Journal of Psychiatry 1998; 155: 493–8.
4. American Psychiatric Association. Diagnostic and statistical manual of mental disorders (4th ed., Text revision). Washington DC: American Psychiatric Association 2000.
5. Crane L, Goddard L, &Pring L. Sensory processing in adults with autism spectrum disorders. Autism, 2009; 13:215–228.
6. Miller LJ, Lane SJ. Towards a consensus in terminology in sensory integration theory and practice: Part 1: Taxonomy of neurophysiological processes. Sensory Integration Special Interest Section Quarterly 2000; 23:1–4.
7. Miller LJ, Anzalone ME, Lane SJ, Cermak SA, &Osten ET. Concept evolution in sensory integration: A proposed nosology for diagnosis. American Journal of Occupational Therapy, 2007; 61(2),135–140.
8. Kientz MA, & Dunn WA comparison of the performance of children with and without autism on the Sensory Profile. American Journal of Occupational Therapy 1997; 51(7),530–537.
9. Tomchek SD, & Dunn W. Sensory processing in children with and without autism: A comparative study using the Short Sensory

Profile. American Journal of Occupational Therapy 2007; 61(2),190–200.

10. Mangeot SD, Miller LJ, McIntosh DN, McGrath-Clarke J, Simon J, Hagerman RJ, et al. Sensory modulation dysfunction in children with attention-deficit–hyperactivity disorder. Developmental Medicine and Child Neurology 2001; 43,399–406.
11. Dunn W, & Bennett D. Patterns of sensory processing in children with attention deficit hyperactivity disorder. Occupational Therapy Journal of Research 2002; 22,4–15.
12. Neu M. Irritable infants: Their childhood characteristics. Dissertation Abstracts International 1997; 58(4B),1805.
13. Greenspan SI, Wieder S. Regulatory disorders. In: Zeanah CH, editor. Handbook of Infant Mental Health. New York: Guilford Press 1993; 280–90.
14. Parush S, Sohmer H, Steinberg A, Kaitz M. Somatosensory functioning in children with attention deficit hyperactivity disorder. Developmental Medicine & Child Neurology 1997; 39:464–8.
15. Kaplan and Sadock's Synopsis of Psychiatry: Behavioral Sciences/Clinical Psychiatry, North American Edition by Virginia A. Sadock. Lippincott Williams & Wilkins; Tenth Edition 2007.
16. Dunn W, & Bennett D. Patterns of sensory processing in children with attention deficit hyperactivity disorder. Occupational Therapy Journal of Research 2002; 22:4–15.
17. Bröring T, Rommelse N, Sergeant J, Scherder E. Sex differences in tactile defensiveness in children with ADHD and their siblings. Developmental Medical Child Neuroogyl 2008; 50:1.
18. Ghanizadeh A. Screening signs of auditory processing problem: does it distinguish attention deficit hyperactivity disorder subtypes in a clinical sample of children? International Journal of Pediatric Otorhinolaryngol 2009; 73:81–87.
19. Yochman A, Parush S, OrnoyA. Responses of preschool children with and without ADHD to sensory events in daily life. American Journal of Occupational Therapy 2004; 58(3):294-302.
20. Gal E, Dyck, MJ, &Passmore A. Sensory differences and stereotyped movements in children with autism. Behaviour Change 2002; 4,207–219.
21. Kern JK, Trivedi MH, Garver, CR, Grannemann BD, Andrews AA, Savla JS, et al. The pattern ofsensory processing abnormalities in autism. Autism 2006; 10(5),480–494.
22. Baranek GT, David FJ, Poe MD, Stone WL., & Watson LR. Sensory Experiences Questionnaire: Discriminating sensory features in young children with autism, developmental delays, and typical development. Journal of Child Psychology and Psychiatry 2005a; 47(6),591–601.
23. Dunn W, Myles BS, & Orr S. Sensory processing issues associated with Asperger syndrome: Apreliminary investigation. The American Journal of Occupational Therapy 2002a; 56:97–102.

24. Liss M, Saulnier C, Fein D, Kinsbourne M. Sensory and attention abnormalities in autistic spectrum disorders. Autism 2006; 10(2):155–172.
25. Myles BS, Hagiwara T, Dunn W, Rinner L, Reese M, Huggins A, & Becker S. Sensory issues inchildren with Asperger syndrome and autism. Education and Training in Developmental Disabilities 2004; 39,283–290.
26. Pfeiffer B, Kinnealey M, Reed C, & Herzberg G. Sensory modulation and affective disorders in children and adolescents with Asperger's disorder. American Journal of Occupational Therapy, 2005; 59,335–345.
27. De la MarcheW, SteyaertJ, NoensI. Atypical sensory processing in adolescents with an autism spectrum disorder and their non-affected siblings. Research in Autism Spectrum Disorders 2012; 639–645.
28. Ben-Sasson AS, Carter MJ, Briggs-Gowan. Sensory Over-Responsivity in Elementary school: Prevalence and Social-Emotional Correlates. Journal of Abnormal Child Psychology 2009; 37:705–716.
29. Rogers SJ, Ozonoff S. Annotation: what do we know about sensory dysfunction in autism? A critical review of the empirical evidence. Journal of Child Psychology Psychiatry 2005; 46(12):1255-68.
30. Watling RL, Deitz J, White O. Comparison of Sensory Profile scores of young children with and without autism spectrum disorders. American Journal of Occupational Therapy 2001; 55,416–423.
31. Just MA. Cortical activation and synchronization during sentence comprehension in high-functioning autism: Evidence of under connectivity. Brain 2004; 127,1811–1821.
32. Dunn W.The Sensory Profile: examiner's manual. San Antonio, TX: Psychological Corporation 1999.
33. Wechsler Memory Scale Normalization of the population living in Tehran. Master's thesis in psychology. TarbiatModarres University, Tehran 1383.
34. Kaplan, Robert M, Saccuzzo, Dennis P. Psychological Testing: Principles, Applications, and Issues fof Adult Intelligence) 2009.
35. Rogers SJ, Hepburn S, & Wehner E. Parent reportsof sensory symptoms in toddlers with autism and those withother developmental disorders. Journal of Autism and Developmental Disorders 2003; 33:631–642.
36. Ermer, J., & Dunn, W. The Sensory Profile: A discriminantan alysis of children with and without disabilities. American Journal of Occupational Therapy 1998; 52,283–290.
37. Case-Smith j. Clifford O'Brien.J Occupational Therapy for Children, 6e (OCCUPATIONAL THERAPY FOR CHILDREN (CASE-SMITH)) Mosby; 6 edition 2009. Chapter 13.
38. Hern KL, Hynd GW. Clinical differentiation of the attention deficit disorder subtypes: do sensorimotor deficits characterize children with ADD/WO? Arch Clin Neuropsy-chology 1992; 7:77–83.

39. Cheatum B, Hammond A, Physical Activities for Improving Children's Learning and Behavior 1999. Human Kinetics; 1 edition (November 5,1999) CHAPTER 5-6.
40. Linda G. Bandini, Sarah E. Anderson,, Carol Curtin,, Sharon Cermak E. Whitney Evans,, Renee Scampini, , Melissa Maslin, Aviva Must (2010) Food Selectivity in Children with Autism Spectrum Disorders and Typically Developing Children. Journal of Pediatric. 2010 August; 157(2):259–264.
41. Miller L J, Reisman J, McIntosh D, & Simon J. Anecological model of sensory modulation. In S. Smith-RoleyE. Blanche, & R. C. Schaaf (Eds.), Understanding the nature of sensory integration with diverse populations (2001). (pp. 57–82). LosAngeles: Harcourt.
42. Terje S, Espenborgå J, Vivienneann R, Heidi A. A dynamic developmental theory of attention-deficit/hyperactivity disorder (ADHD) predominantly hyperactive/impulsive and combined subtypes. Behavioral and Brain Sciences 2005; 28(3):397-419.