

THE RELATIONSHIP BETWEEN SENSORY PROCESSING AND ANXIETY ON CARS SCALE IN AUTISM SPECTRUM DISORDER

**Neda Novakovic¹, Milica Pejovic Milovancevic^{2,3},
Slavica Đukic Dejanovic^{4,5}, Nikola Paunovic¹,
Petar Jordanov¹, Milica Vukovic¹**

¹Day Care Center for Children and Adolescents with
Developmental Disorders, Belgrade, Serbia

²School of Medicine, University of Belgrade, Belgrade Serbia

³Institute of Mental Health, Belgrade, Serbia

⁴Faculty of Medical Sciences, University of Kragujevac,

⁵Clinic for Psychiatric Diseases „Dr Laza Lazarevic“, Belgrade, Serbia

Abstract: Autism Spectrum Disorder is a neurodevelopmental disorder, characterized by deficits in social interactions, social communication, stereotyped behavior associated with sensory disorders occurring before the age of 3. There has been a growing trend of this neurodevelopmental disorder in recent years. Although the sensory processing problems have been noticed since the first descriptions of autism spectrum disorders, it is only the DSM-5, diagnostic and statistical manual of mental disorders, that includes sensory problems, as the crucial symptom in diagnostic profile of autism spectrum disorder. **Objective:** To establish the relationship between functional areas related to sensory processing and anxiety, as well as to determine the degree of autistic disorder in adolescents and adults with autism spectrum disorder. **Method:** 42 participants, adolescents and adults with severe autism disorder and intellectual disability, aged 15-35, of both sexes from Belgrade were evaluated by Childhood Autism Rating Scale (CARS) used to determine the degree of autistic disorder. The following functional areas were compared: sensory interests and anxiety in adolescents and adults with autistic spectrum of both sexes. **Results:** The results indicated the existence of the relationship between anxiety and unusual sensory interests and the severity of autism spectrum disorder. The results showed that there was a correlation between visual perception and the level of intellectual functioning, especially of the severity of autistic disorder and visual perception. **Conclusion:** These results indicate the reasons of the problems and difficulties in the field of general adaptation of the individuals with autism spectrum disorder.

Key words: *sensory processing, sensory integration, anxiety, severity, autism spectrum disorder*

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder, characterized by deficits in social interactions, social communication, stereotyped behavior associated with sensory disorders, that occurs before the age of 3 [1]. High frequency of comorbidity conditions is present, such as intellectual disability, epilepsy, eating and sleeping disorders. The first noticed deviations from the regular development are manifested by delayed speech and language skills, difficulty with developing symbolic play and the absence of reciprocal social interactions.

ASD within the international classification ICD-10 (International classification of diseases, WHO) belongs to Pervasive Developmental Disorders: F84.0-84.9. In the latest classification of diseases of American Psychiatric Association (APA) DSM-5, the term ASD has been introduced [1], the triad of disorders has been replaced by the dyad: social communication deficits and stereotyped, repetitive behaviors and activities along with sensory integration disorders. The difference represents the merging of the first two diagnostic criteria into one – social interaction disorder and social communication disorder being merged into one entity – social communication disorder [2].

New studies have shown that ASD is one of the most frequent neurodevelopmental disorders. Nowadays, we talk about the prevalence of 60-70 in 10.000 children, with the rising tendency [1] in recent years, in 1980-1:2500, while the Centers for Disease Control and Prevention (CDC) in the USA have significantly revised the estimated prevalence of autism, showing the following growth: 2007-1:150, 2009-1:110, 2012-1:88, 2014-1:68 [3]. This growing trend is attributed to improved diagnostic procedures and their increased reliability. Studies also show that autism is four to five times more common in males than in females, although females often have a more severe cognitive disability [4].

Although the sensory processing challenges have been noticed since the first descriptions of autism spectrum disorders (Kanner, 1943), it is only the classification system – DSM-5 (2013) that includes sensory problems, as a crucial symptom. The previous absence of sensory disorders in diagnostic procedures was due to difficulties in characterizing sensory dysfunction empirically, and the focus was on obvious social and cognitive symptoms [5].

Sensory integration in regular individuals is spontaneous and imperceptible. Sensory processing is a complex and fluid process that includes the entire sensory system (auditory, visual, gustatory, olfactory and tactile, proprioceptive and vestibular) which refers to the individual ability to register sensory information, make it meaningful and respond to it.

It is typical for the individuals with ASD to use peripheral sight, not central, the auditory sense is hypersensitive to certain sounds, they can identify long distance frequencies, certain stimuli accepted and processed easily by regular population may cause unpleasant, even painful sensations.

Tactile receptors are hypersensitive; olfactory perceptions are often altered and they are attracted to strong smells. Gustatory receptors are also often altered, and in the context of oral tactility it is not a rare case that some food texture is not suitable while swallowing. Sensory integration problems affect motor planning and coordination.

The Embedded Figure Test [6], designed to assess visual perception, has shown that children with autism spectrum disorder are better at counting simple geometrical shapes within a more complex image than being able to identify the whole image [5]. Furthermore, the studies have also shown that children with autism spectrum disorder may have no reaction while processing simple auditory signals – loudness, the similar results were found with low tones [7]. Sensory processing with autism spectrum disorder can have more forms with three main models: sensory hypersensitivity (negative reactions to low threshold stimuli, considered as harmless), sensory hyposensitivity (no response to stimuli, including pain), sensory searching – mixed type (a strong desire for certain types of sensory experience) [8]. The hypersensitive type will externalize the problem, often manifested in aggression, while the hyposensitive type will internalize the problem manifested in self-stimulation and/or self-aggression.

The objective of this study was to establish the relationship between functional areas related to sensory processing and anxiety, as well as the degree of autistic disorder in adolescents and adults with ASD. This study, unlike others, included the population of adolescence and adults with autism spectrum disorder (15-35 years of age), when the severity of this neurodevelopmental disorder becomes intense.

Method

The study was conducted on 63 potential participants, out of which 48 were selected, while the results were produced on the sample of 42 subjects.

The population examined involved adolescents and adults with severe forms of autism spectrum disorder, with intellectual disability, aged 15 to 35, of both sexes, from Belgrade. The research was being conducted in the day care branch centres of the Day Care Centre for Children and Adolescents with Developmental Disorders, Belgrade.

The research was based on good clinical practices with respect to all relevant ethical standards, protecting the identity of each participant, as well as taking care of the personal data. Since the subjects in the institutes are the individuals with severe autism spectrum disorders, they are all taken care of by their caregivers, usually parents. Prior to the beginning of investigation, the written consent was obtained from the parents and caregivers. In addition, the consent was also obtained from the institution – Day Care Centre for Children and Adolescents with Developmental Disorders. After obtaining the consents and the approval of Ethic Committee of the Faculty of Medical

Sciences, University of Kragujevac, all the conditions for the research were fulfilled.

In order to select the sample in this stage, the diagnostic criteria ICD-10 designed for pervasive developmental disorders was used. The diagnosis data were collected from the participants' documentation. The data on the intellectual functioning were collected from the medical documentation (all participants were categorized which was recorded in their files).

The participants' inclusion criteria were: autism spectrum disorder diagnosis, 15-35 years of age, beneficiaries of the Centre (Day care), written parents'/caregivers' consents obtained.

The following functional areas were compared: sensory interests and anxiety of adolescents and adults with autism spectrum disorder of both sexes, using the scale for assessing the degree of autistic disorder (Childhood Autism Rating Scale – CARS). Total scale score measuring the degree and severity of autistic disorder was compared to the above mentioned functional areas, related to sensory interests and anxiety.

Measurement instruments

The scale for assessing the degree of autistic disorder (Childhood Autism Rating Scale – CARS) [9] was applied determine the severity of autistic symptoms. The assessment was performed by direct observations for the subjects older than 2 years of age. The scale containing 15 items was completed by a parent, caregiver or therapist. The evaluated areas were: social, emotional, communication skills, repetitive behavior, play organizational behavior and everyday activities (routines) and unusual sensory interests.

Correlation and standard deviations were statistically processed. The correlation of two numerical characteristics was examined by Pearson coefficient of correlation.

In the later stage of wider investigation, the data following the normal distribution were processed by parametric tests T-Test, and the data not following the normal distribution were processed by equivalent nonparametric tests.

All the data were processed in corresponding statistical programme-SPSS.

Results

The CARS scale results were processed on the sample of 42 participants belonging to the group of pervasive developmental disorders, according to ICD-10 classification (with diagnosed autism or mixed developmental disorder with autism elements), out of which 32 were males (74.4%) and 10 females (23.3%).

The average age of the participants was 23.81 (± 4.15) years of age; the youngest was 16, while the oldest was 35.

The level of intellectual abilities ranged from mild to profound mental retardation. The categorization of the intellectual functioning level was taken from the subjects' documentation based on previous testing and assessment by standardized scales.

Out of 42 subjects in the mild category (F70), there were 3 subjects (7%), then in the category of moderate (F71) were 9 subjects (20.9%), in the category of severe (F72) were 17 subject (39.5%) and in the category of profound (F73) were 8 subjects (18.6%). The level of intellectual functioning was not determined for 5 subjects (14%).

The mean score value of the Scale which determines the degree of autistic disorder (Childhood Autism Rating Scale – CARS) was 45.93 (± 5.86 ; the range from 36 to 56.50) which indicated more severe degree of autistic disorder.

The mean CARS score values according to the gender were higher in female population than in male population. The lowest score in male population reached the boundary value of moderate autism degree-36 (Table 1).

Table 1. CARS score values according to the gender

	Mean value	SD	95% CI		Min.	Max.
			Lower Bound	Upper Bound		
Males	44.3281	5.54834	42.3277	46.3285	36.00	56.50
Females	47.3000	6.55829	42.6085	51.9915	37.00	56.00

SD – Standard deviation; CI – Confidence Interval

The positive, statistically significant correlation was confirmed between total CARS score, that is the degree of autistic disorder and the items rating functional areas of unusual sensory interests, such as: visual perception ($r=0.738$; $p<0.001$), auditory perception ($r=0.497$; $p<0.001$) and receptor responsiveness at near distance ($r=0.627$; $p<0.001$). In addition, there was a statistically significant positive correlation between Total score and items referring to anxiety level assessment (Table 2).

Table 2. Correlation total CARS score and functional areas of unusual sensory interests and anxiety

	Degree of autistic disorder	Visual perception	Auditory perception	Near distance responsiveness	Anxious reactions
Degree of autistic disorder	1	.738**	.497**	.627**	.606**
Visual perception					.477**
Auditory perception					.462**
Near distance responsiveness					.483**
Anxious reactions					1

* - $p < 0.05$; ** - $p < 0.01$

Furthermore, the relationship between the items regarding sensory perception and the level of anxiety showed that there was also a positive significant correlation (Table 2), while there was no correlation between the age and Total score ($r=0.032$; $p>0.05$), or relative to the items assessing anxiety ($r=0.055$; $p>0.05$).

Total CARS score value followed normal distribution. As the sample was less than 50, the significant value of Shapiro-Wilk test was used ($N=0.55$; $p=0.099$), which was higher than 0.05 and consequently CARS score followed normal distribution.

Through establishing of the correlations between the level of intellectual functioning and total CARS score (the level of autistic disorder) it was found that there was a strong, significantly positive correlation ($r=0.525$, $p=0.001$), as well as the positive correlation of moderate degree between intellectual functioning and items evaluating visual perception ($r=0.382$, $p=0.019$). There was no correlation between the level of intellectual functioning and items related to auditory perception ($r=0.273$, $p=0.103$) and near distance responsiveness ($r=0.264$, $p=0.114$). (Table 3)

Table 3. Correlation between the level of intellectual functioning and total CARS score and functional areas of unusual sensory interests

	Intellectual functioning level	Visual perception	Auditory perception	Near distance responsiveness	Degree of autistic disorder
Intellectual functioning level	1	.382*	.264	.273	.525**
Visual perception					.738**
Auditory perception					.497**
Near distance responsiveness					.627**
Degree of autistic disorder					1

* - $p < 0.05$; ** - $p < 0.01$

Discussion

The results of the data processing have indicated that there is a correlation of the total CARS score, that is the degree of autistic disorder, and functional areas of sensory interests. Moreover, the strong correlation between the anxiety levels and unusual sensory interests has been confirmed.

Significantly, there has been no correlation between the age and the total CARS score, or relative to the items assessing anxiety. Previous research has indicated that affective symptoms are severe and serious in each age group and the results showed that in each age group the prevalence of the autism spectrum anxiety disorder surpassed the prevalence in general population [10].

The results have indicated that there is a relation between visual perception and the level of intellectual functioning, as well as that the severity of autistic disorder is connected to the lower level of intellectual functioning. The severity of autistic disorder and visual perception are in a positive relation compared to all other relations of sensory processing, while the intellectual level of functioning is not connected to auditory perception and responsiveness at near distance. All that distinguishes the visual perception disorder as a particularly significant symptom in autism spectrum (eye contact avoidance, staring at objects at unusual angles, staring at light stimuli and other characteristic interests).

Children with ASD are often described as being under chronic stress due to difficulties in understanding, and giving social responses as well as adapting to changes in their environment [10].

Neurobiological basis of sensory integration disorder in individuals with autism spectrum disorder has not been explained yet, but there are several theories which connect the possible etiology of sensory deficits [11]. The individuals with autism spectrum disorder are hypersensitive to vibratory stimuli of 200 Hz, relative to the control group [12] while no group

differences are found for vibrotactile stimulus of 33Hz (at low frequencies of vibration) [13]. These two frequencies were chosen because they are known to stimulate different mechanoreceptors in the skin [12].

The Swedish study conducted on a sample of 915 subjects with intellectual disabilities, out of which 143 were adults with autism spectrum disorder, has demonstrated that hyper-responsiveness to touch in persons with autism spectrum disorder was indicative for their social dysfunction [14]. It has also been stated that there is a relationship between hyper-responsiveness to touch and social impairment in both groups – typically developed children and children with autism spectrum disorder, but it is much more common among those with autism spectrum disorder [15]. Prevalence of sensory features is high in children with autism spectrum disorder, where 69% perform hyper sensory response in relation to typically developing children [8]. Some studies have investigated the issues related to the functions of the parietal cortex responsible for the integration of different stimuli, especially focused on neurodevelopmental disorders and autism as the most dominant neurodevelopmental disorder. By electrocortical screening of parietal cortex, the peaks of brain impulses were measured and some deviations were found in individuals with autism spectrum disorder who failed to recognize, react to familiar and unfamiliar faces compared with regular population [16].

It has been found that multisensory tasks engage a wider cortical structure in neurotypical population [5]. Stimulating the patterns of sensory processing the range of individual's reactions is enhanced.

The application of multisensory methods gives hope to improve sensory functions in ASD. The treatment of sensory integration, one of the most common approaches in autism spectrum treatment, is mostly based on subjective evaluation of occupational therapists. Although this approach is practical, it often excludes the ability of making strong empirical conclusions [5].

The provided activities are directed to improve neuroplasticity, modulation, organization and the integration of information from the environment, enabling further adaptive responses.

The goals of the sensory integration treatment are to improve sensory modulation in terms of behavior and attention, and also to increase the social ability interaction and independence through better sensory integration. Stimulating the sensory processing patterns the range of the individual reaction has been enhanced. The up-to-date research has mostly been done on pre-school and school age children with autism and included sensory integration treatment, such as: in Japan "Pilot study: Efficacy of Sensory Integration Therapy for Japanese children with High-Functioning Autism Spectrum Disorder" [17], in Croatia, the study titled "Sensory Integration in Working with Pupils with Autism" [18], then "Sensory symptoms in autism spectrum disorders" [11], "The effect of a psycho-educational program on CARS scores and short sensory profile in autistic children" [19].

Conclusion

Sensory processing might be related to other important features of autism spectrum. Multisensory approach is important in autism spectrum disorder in order to move focus from the deficit in functioning of one sensor, sense to neurobiological connections regulating higher integrative functions: executive, attention, time orientation [5].

Research of sensory symptoms related to ASD has the potential to indicate, in a more comprehensive way, the nature and psychopathology of this disorder and to enable new method of more efficient treatment [11].

The obtained results of the determined relationship between aggressiveness and unusual sensory interests, as well as severity of autism spectrum disorder confirm that individuals with autism spectrum disorder react in inappropriate manner to the stimuli they find unpleasant, trying to establish self-regulation to the stimuli.

Our results are an incentive to continue searching and investigating of this issue and thus get a better insight of the problem and understanding of the difficulties these individuals have in general adaptation. The final goal of the professionals is to adapt the approach and treatment for these individuals in order to achieve better self-regulation as well as the level of adaptation and the wider range of activities and help them socialize into the society.

ODNOS SENZORNOG PROCESUIRANJA I ANKSIOZNOSTI NA CARS SKALI KOD POREMEĆAJA AUTISTIČNOG SPEKTRA

Neda Novaković¹, Milica Pejović Milovančević^{2,3},
Slavica Đukić Dejanović^{4,5}, Nikola Paunović¹,
Petar Jordanov¹, Milica Vuković¹

¹Centar za smeštaj i dnevni boravak dece i omladine ometene u razvoju,
Beograd, Srbija

²Medicinski fakultet, Univerzitet u Beogradu, Srbija

³Institut za mentalno zdravlje, Beograd, Srbija

⁴Fakultet medicinskih nauka, Univerzitet u Kragujevcu, Srbija

⁵Klinika za psihijatrijske bolesti „dr Laza Lazarević“, Beograd, Srbija

Apstrakt: Poremećaj autističnog spektra je neurorazvojni poremećaj koji se javlja pre treće godine i koga karakterišu teškoće u socijalnim interakcijama, socijalnoj komunikaciji i prisustvu stereotipnih i repetitivnih obrazaca ponašanja uz senzorne poremećaje. Uočava se da je prisutan porast prevalence ovog poremećaja poslednjih godina. Iako su problemi senzornog procesuiranja primećeni kod ove dece još od prvih opisa poremećaja tek DSM-5 klasifikacioni sistem uključuje senzorne probleme kao bitan simptom koji je uveden u dijagnostički profil poremećaja autističnog spektra. **Cilj:** Da se ustanovi veza između funkcionalnih oblasti koje se odnose na senzorno procesuiranje i anksioznost kao i stepen autističnog poremećaja adolescenata i odraslih osoba sa poremećajem iz autističnog spektra. **Metod:** 42 ispitanika, adolescenti i odrasle osobe sa teškim oblicima poremećaja iz autističnog spektra, sa intelektualnom ometenošću, uzrasta od 15 do 35 godina, oba pola, iz Beograda evaluirani su Skalom za utvrđivanje stepena autističnog poremećaja (*Childhood Autism Rating Scale – CARS*). Vršilo se poređenje sledećih funkcionalnih oblasti: senzornih interesovanja i anksioznosti adolescenata i odraslih osoba sa poremećajem autističnog spektra oba pola. **Rezultati:** Dobijeni rezultati ukazuju na postojanje veze između anksioznosti, neobičnih senzornih interesovanja i težine poremećaja autističnog spektra. Rezultati su pokazali da postoji veza između vizuelne percepcije i nivoa intelektualnog funkcionisanja, i posebno težine autističnog poremećaja i vizuelne percepcije. **Zaključak:** Ovi rezultati ukazuju na razloge problema i teškoće na polju opšte adaptacije osoba s poremećajem autističnog spektra.

Ključne reči: senzorno procesuiranje, senzorna integracija, anksioznost, težina poremećaja autističnog spektra.

References:

1. Rybakowski F, Bialek A, Chojnicka I, Dziechciarz P, Horvath A, Janas-Kozik M, et al. Autism spectrum disorders – epidemiology, symptoms, comorbidity and diagnosis. *Psychiatr Pol.* 2014;48(4):653-65.
2. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders: DSM-5.* Washington, D.C: American Psychiatric Association, 2013.
3. Community Report from the Autism and Developmental Disabilities Monitoring (ADDM) Network CDC. Prevalence of Autism Spectrum Disorder and Developmental Disabilities Monitoring Network, 11 sites, United States, 2010. *MMWR* 2014;63(No. SS2):1-21.
4. Kenneth LD, Dennis C, Joseph TC, Charles N. *Neuropsychopharmacology: 5th Generation of Progress Editors: Lippincott, Williams, & Wilkins,* Philadelphia, Pennsylvania; 2002;42:566-70.
5. Sarah H-B, Ryan A-S, Mark T-W. Behavioral, perceptual, and neural alterations in sensory and multisensory function in autism spectrum disorder. *Prog Neurobiol.* 2015;1394:1-21.
6. Bertone A, Mottron L, Jelenic P, Faubert J. Enhanced and diminished visuo-spatial information processing in autism depends on stimulus complexity. *Brain.* 2005; 128:2430-41.
7. Bonnel A, McAdams S, Smith B, Berthiaume C, Bertone A, Ciocca V, et al. Enhanced pure-tone pitch discrimination among persons with autism but not Asperger syndrome. *Neuropsychologia.* 2010; 48:2465-75.
8. Baranek G-T, David F-J, Poe M-D, Stone W-L, Watson L-R. Sensory experiences questionnaire: Discriminating sensory features in young children with autism, developmental delays, and typical development. *J Child Psychol Psychiatry.* 2006;47(6):591-01.
9. Schopler E, Van Bourgondien ME, Wellman GJ, Love SR. *Childhood Autism Rating Scale, Second Edition (CARS2): Practice Administration, Standard Version Rating Booklet (CARS2-ST), [Electronic resource].* 2010 Available from: <http://www.wpspublish.com/store/search?Q=CARS>.
10. Roma AV, Luther K, Micah M, Stephen K, Brian F, Amy K. et al. Age-related differences in the prevalence and correlates of anxiety in youth with autism spectrum disorders. *Res Autism Spectr Disord.* 2013; 7:1358-69.
11. Hazen EP, Stornelli JL, O'Rourke JA, Koesterer K, McDougle CJ. Sensory symptoms in autism spectrum disorders. *Harv Rev Psychiatry.* 2014;22(2):112-24.
12. Blakemore SJ, Tavassoli T, Calo S, Thomas RM, Catmur C, Frith U, et al. Tactile sensitivity in Asperger syndrome. *Brain Cogn.* 2006;61:5-13.
13. Cascio C, McGlone F, Folger S, Tannan V, Baranek G, Pelphrey KA, et al. Tactile perception in adults with autism: a multidimensional psycho-physical study. *J Autism Dev Disord.* 2008;38:127-37.
14. Lars-Olov Lundqvist, Hyper-responsiveness to touch mediates social dysfunction in adults with autism spectrum disorders. *Res Autism Spectr Disord.* 2015; 9:13-20.
15. Hilton CL, Harper JD, Kueker RH, Lang AR, Abbacchi AM, Todorov A. Sensory responsiveness as a predictor of social severity in children with high functioning autism spectrum disorders. *J Autism Dev Disord.* 2010;40(8):937-45.

16. Silmar T, Sergio M, Bruna V, Antonio S, Daniel M. Integrative parietal cortex processes: neurological and psychiatric aspects. *J Neurol Sci.* 2014;15:338(1-2):12-22.
17. Ryoichiro I, Sumihisa H, Hideyuki N, Koji T. Pilot Study: Efficacy of Sensory Integration Therapy for Japanese Children with High-Functioning Autism Spectrum Disorder. *Occup Ther Int.* 2014;21(1):4-11.
18. Mamić D, Fulgosi-Masnjak R, Pintarić-Mlinar Lj. Senzorna integracija u radu s učenicima s autizmom. *Napredak, Časopis za pedagojsku teoriju i praksu.* 2010;151(1):69-84.
19. Antigone SP, Nikaina I, Rizou J, Alexandrou S. The effect of a psycho-educational program on CARS scores and short sensory profile in autistic children. *Eur J Paediatr Neurol.* 2011;338-44.

Neda NOVAKOVIC, special educator – oligophrenologist, Day Care Center for Children and Adolescents with Developmental Disorders, Belgrade

Neda NOVAKOVIĆ, diplomirani defektolog – oligofrenolog, Centar za smeštaj i dnevni boravak dece i omladine ometene u razvoju, Beograd

E-mail: nedanovak@gmail.com