The Relationship between Sensory Processing Disorder and Quality of Sleep in Children with Autism Spectrum Disorder and Learning Disorder from 6 to 14 Years' Old

Ebrahim Mahmoudi[a*], Navid Mirzakhani[b], Seyyed Mehdi Tabatabaee[b], Samaneh Fallah[a], Marjan Shahbazi[a]

a Department of Occupational Therapy, Faculty of Rehabilitation Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran; ***b*** Faculty of Rehabilitation Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran

Corresponding Author:** Ebrahim Mahmoudi. Department of Occupational Therapy, Faculty of Rehabilitation Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran; ***E-mail:emc181376@gmail.com

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Abstract

Introduction: Sensory problems can affect the functioning of individuals in a variety of daily activities in different aspects. One of these aspects of daily activity is the quality and quantity of sleep. Sensory processing perhaps is the most basic psychological element that determine how individuals perceive and respond to environmental stimuli. Given this, this study aimed to investigate the effect of sensory processing disorder on sleep quality of children with autism spectrum disorder and learning disorder. **Materials and Methods:** The present study was a descriptive cross-sectional study. The study was performed on 23 children with autism spectrum disorder and 20 children with learning disorder from 6 to 14 years' old. Two Child Sleep Habits Quality (CSHQ) and Sensory profile 2 questionnaires were used for data collection. Data were analyzed by Mann-Whitney U test in SPSS 22 software. **Results:** The results of data analysis showed that children with ASD have lower sleep quality than children with specific learning disorder (P=0/033). Children with autism also received higher scores on sensory profile 2 subtests except visual and olfactory processing than children with specific learning disorders. In children with ASD the highest scores are related to Sensory Sensitivity (45.83) and sensory registration (45.17) and lowest score is related to visual processing (10.96). However, children with specific learning disorders have highest score in sensory registration (43.40) and lowest score in body position processing (8.55). **Conclusion:** The findings of the study emphasized children with poor sleep quality had sensory processing disorder and sleep quality were reduced. There was a significant relationship between sensory registration (P=0.005) and sensory sensitivity (P=0.012) with sleep quality. Therefore, it seems necessary to support children in considering proper sensory diet and taking measures to resolve their sensory problems and thus improve their sleep patterns.

Keywords: Autism Spectrum Disorder; Learning Disorder; Quality of Sleep; Sensory Processing Disorder

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Introduction

Sleep is one of the most important factors in daytime cycles that is associated with the renewal of physical and mental power (1-2). Almost a third of our lives are spent asleep. Quality sleep plays an important role in health and improving life (3). This active, repetitive and reversible behavior helps to several important functions in the body, including growth and repair, learning and memory strength (4). On the other hand, sleep disorders can directly and indirectly consider a serious risk to people's lives and in addition to the person's own life; it can affect the family, colleagues and ultimately society. In fact, human health is related to the quantity and quality of sleep (5). Irritability, aggressive behaviors, and decreasing social communication are among the cases that are significantly higher in people with sleep deprivation compared to other people (6). Sleep disorders are often an early sign of psychiatric illness. Among sleep disorders, insomnia and drowsiness during the day are the most common complaints. Insomnia is also a risk factor for developing depression, which reduces the response to depression treatment and increases the likelihood of depression recurrence (7-8). Sleep disorders in the general population have a prevalence of between 15% and 42%,

and these disorders have negative effects on the quality of life and performance of individuals (9). And according to international statistics, 60% of all people in any society suffer from some type of sleep-related disorders (10).

Some studies have considered factors such as age, gender, socioeconomic status, lifestyle habits and psychological factors as factors affecting sleep quality (11). Sensory problems in various areas can affect people's functioning in a variety of daily activities. One of these areas of daily activity is the quality and quantity of sleep (12). The number of synapses throughout the cerebral cortex increases during slow sleep fluctuations (13), and teta fluctuations during the sleep phase play a key role in the process of retention in the hippocampus (14). In addition, structural neuroplasticity in hippocampus is created caused by sleep (15). The structure of the visual cortex is modulated during sleep (16) and the activity of the olfactory cortex is modulated during sleep and the olfactory experience that is perceived during the day reorganizes the olfactory cortex and stabilizes olfactory memory during sleep, such as the hippocampus (17)

Sensory processing is perhaps the most fundamental psychological element that forms the underlying of how individuals perceive and react to environmental stimuli (18). Sensory processing refers to receiving, adjusting, and integrating sensory information sequentially and producing adaptive response. Researchers' effort to develop the study of sensory processing date back to the theory of sensory integration, first proposed by Iers in 1972 (12). New evidence shows that individual processes sensory information in different ways, it means that a group of people are more sensitive to sensory information compared to others (18). Dan (2008) in his sensory processing model (2001) has placed sensory processing in the form of four variables: sensory seeking, sensory avoiding, sensory sensitivity, and low registration. He assumed that sensory processing depended on two main factors: A person's sensory threshold that can be high or low (how much of the stimulus is needed for the person to react to the stimulus), 2. The person's response strategy which can be active or passive (19). Defect in the sensory processing process lead to sensory processing disorders. Sensory processing disorder is defined as a problem in regulating and organizing the type and severity of responses to sensory input to adopt environmental needs. People with this disorder typically give exaggerated responses (avoidance and defense) or inappropriate responses to sensory inputs (20). This disorder is a long-term problem that affects the child's participation in the family, school, and community (21). Studies have shown that different aspects of sensory processing are associated with clinical outcomes. A correlation between sensory sensitivity and introversion and excitability was obtained in a study conducted by Aaron and Aaron (1997) (18). Benham also reported in 2006 that there was a direct relationship between sensory processing and health indicators (such as more stress experience) (22). In 2005, Liz, Timmel, Boxley, and Killingsworth examined sensitivity in sensory processing, parental restraint, anxiety, and depression (23). Don has proposed a four-factor model of sensory processing, according to which Dan has classified sensory processing patterns into four types: 1. Low sensory registration: A person who is in the weakness of sensory registration (a person who has a weakness in sensory registration) has a high stimulus threshold and less responsive to sensory stimuli, and therefore he needs stronger sensory stimuli to participate and respond to daily life activities and this person is passively responding to stimuli. 2. Sensation seeking: A person who is in the sensation seeking field also has a high threshold of stimulation and low response, but his strategy to deal with this situation is active behavior of seeking intense sensory stimuli. 3. Sensory sensitivity: People are sensitive to sensory stimuli, due to the low threshold of stimulation, have a strong awareness to sensory stimuli and in facing with sensory stimuli, they are confused but they are trying to cope with these sensations inactively. 4. Avoidance or Sensory Avoiding: These people also have a low threshold for sensory stimuli. Not only they have a strong awareness to sensory stimuli, but they also actively try to avoid the usual stimuli that are annoying to them (24).

Sleep disorders such as night waking, sleep onset delay, sleep duration with law quality are debilitating conditions and can affect the quality of life and education (6). Sensory processing disorder as one of the most important sensory problems can affect a variety of aspects, including sleep. According to this issue, this study was conducted to investigate the relationship between sensory processing disorders and sleep quality in children with autism and specific learning disorder based on children's sleep habits questionnaire and children's sensory profile 2 questionnaires. Given that no similar research has been done in this area, it is hoped that the results of this study can be used to provide solutions to improve the quality of children's sleep.

Materials and Methods

This study is a cross-sectional study which was conducted in the winter of 2009 to investigate the relationship between sensory processing and sleep quality in children with autism and special learning disabilities based on sensory profile 2 tests and children's sleep habits questionnaire. Initially, by referring to one of the children's mental therapy clinics in Tehran and studying the

Table 1. Average and standard deviation scores of nine scales and total score of sleep quality in terms of disorder

Variable	Mean(SD)	
	Learning disability	Autism
Sleep resistance	11.56(2.80)	9.75(2.98)
Sleep onset delay	1.73(0.61)	1.15(0.48)
Sleep duration	5.08(1.39)	4.20(1.39)
Sleep anxiety	7.43(2.33)	6.15(2.43)
Night waking	4.56(1.47)	3.90(1.16)
parasomnia	9.17(0.98)	8.70(1.62)
Sleep disordered breathing	3.39(0.78)	3.50(0.88)
Daytime sleepiness	10.60(2.25)	11.60(2.18)
Quality of Sleep	53.39(6.59)	49.00(8.09)

Table 2. Average Statistics and Standard Deviation of Sensory Processing Status of Participants in the Study Based on 13 Parts of Children Sensory Profile 2

	Part	Mean(SD)	
		Autism	Learning disability
Sensory patterns	**Sensory seeking**	41.83(13.56)	33.45(16.42)
	Sensory avoiding	44.43(12.65)	43.40(14.85)
	Sensory sensitivity	45.83(13.36)	33.40(13.48)
	Sensory registration	45.17(13.14)	30.95(17.19)
Sensory sections	**Auditory**	19.30(5.31)	20.50(8.26)
	visual	10.96(5.05)	11.35(3.57)
	touch	21.30(8.89)	12.40(7.59)
	motion	18.13(5.10)	14.95(6.67)
	Body position	14.17(7.33)	8.55(7.77)
	oral	20.57(10.22)	16.65(10.60)
Behavioral sections	**Behavioral responses**	21.65(5.90)	16.75(7.89)
	Emotional-social responses	33.57(13.10)	30.05(11.66)
	Subjective responses	23.22(5.92)	17.80(9.70)

relevant files and referring to one of the schools of Tehran,23 children with autism and 20 children with special learning disorder who received a definitive diagnosis from a psychiatrist were selected and studied. Entry criteria for subjects included the following: 1. The child has been diagnosed with autism by a child psychiatrist and has a special learning disorder; 2. The child is in the age range of 6-14 years; 3. The child does not have problems with blindness, deafness, epilepsy and other chronic neurological problems such as cerebral palsy. The exclusion criterion of the study was dissatisfaction for participating in the study.

After inviting the parents and informing them about the subject and purpose of the research, obtaining consent and also reassuring the parents that the information was confidential, the children's sensory profile 2 questionnaire and children's sleep habits questionnaire was provided to them. Also, during the entire time of completing the questionnaire, the examiner was available to guide the parents in case of need for further explanation or help.

Children Sensory Profile 2 is a standardized measurement tool for measuring children's sensory processing capabilities at home and in the community, designed and developed by Dan in 2014 (25). This questionnaire can be used for ages 3 to 14. The score of the questionnaire is in the six-point Likert scale (almost always, often, sometimes, rarely, almost never, and not true). How to calculate the parts (sensory seeking, sensory avoiding, sensory sensitivity, sensory registration, hearing, vision, touch, motion, body position, oral, behavioral responses, emotional-social responses and subjective responses) of this questionnaire is measurable using five cutting points that include much less than others, less than others, more like others, and more than others and much more than others. These scores are calculated for each section separately, and each section has its own cut points. To calculate the reliability of this test, two statistical analysis methods were used: internal consistency (Cronbach's alpha coefficient) and retesting. The alpha coefficient for different parts of this test is in the range of 0.60 to 0.90. To investigate the retest after the first execution, the second execution was performed between 7 and 121 days. To calculate the reliability, the inter-class correlation coefficient was used; this coefficient was in the range of 0.87 to 0.97 and showed a very good stability of the scores in the first and second executions. Content validation methods and factor analysis were used to calculate the validity (25).

The Children's Sleep Habits Questionnaire was developed by Owens et al., Sprito et al. in 2000 in 45 articles to measure the quality and sleep habits of children aged 4-12 years which is completed by the parents (26). Owens et al grouped females into eight subscales conceptually: 1) sleep resistance, 2) sleep onset delay, 3) sleep duration, 4) sleep anxiety, 5) night wakening, and 6) Parasomnia, 7) sleep disorders breathing, 8) Daily sleepiness. The questionnaire is graded in the form of a five-point Likert scale. The questionnaire consists of 45 questions, some of which have only diagnostic and therapeutic value and not research, so only 33 of the questions are included in the grading. Each article has a value between 1-3 (rarely to usual) with the exception of articles (1-3, 10, 11, 26) that are scored in reverse. Estimates of internal consistency (Cronbach's alpha coefficient) for subscales were 0.70 in a sample (non-clinical) of children aged 4 to 10

Table 3. Percentage of relative frequency of sensory processing status in children with autism spectrum disorder in the study based on 13 parts of Children Sensory Profile 2

		Much less than others	Less than others	Like others	More than others	Much more than others	Individuals with sensory processing
Sensory patterns	**Sensory seeking**	0	0	56.5	39.1	4.4	43.5
	Sensory avoiding	0	4.4	47.8	34.7	13.1	52.2
	Sensory sensitivity	0	0	43.5	21.7	34.8	56.5
	Sensory registration	0	4.4	43.5	34.7	17.4	56.5
Sensory sections	**Auditory**	0	0	82.6	17.4	0	17.4
	visual	8.7	17.4	65.2	8.7	0	33.4
	touch	4.4	4.4	30.4	39.1	21.7	69.6
	motion	0	0	60.9	26.1	13.1	39.2
	Body position	4.4	4.4	47.8	17.4	26.1	52.2
	oral	0	8.7	60.9	21.7	8.7	39.1
Behavioral sections	**Behavioral responses**	0	4.4	47.8	39.1	8.7	52.2
	Emotional-social responses	4.4	4.4	26.1	39.1	26.1	73.9
	Subjective responses	0	0	52.2	39.1	8.7	47.8

Table 4. Percentage of Relative Frequency of Sensory Processing Status in Children with Specific Learning Disabilities in Studying based on the 13 Parts of Children Sensory Profile 2

		Much less than others	Less than others	Like others	More than others	Much more than others	Individuals with sensory processing
Sensory patterns	**Sensory seeking**	5	15	60	15	5	40
	Sensory avoiding	0	5	60	15	20	40
	Sensory sensitivity	0	15	60	15	10	40
	Sensory registration	0	30	45	15	10	55
Sensory sections	**Auditory**	0	15	50	30	5	50
	visual	5	20	75	0	0	25
	touch	0	35	55	0	10	45
	motion	5	10	50	35	0	50
	Body position	15	20	50	5	10	50
	oral	0	25	45	25	5	55
Behavioral sections	**Behavioral responses**	5	10	70	10	5	30
	Emotional-social responses	0	10	45	25	20	55
	Subjective responses	0	15	60	20	5	40

Based on the obtained results, there was a significant relationship between touch processing (p-value = 0.002), body position (p-value= 0.014), behavioral responses (p-value = 0.012), mental responses (p-value= 0.027), sensory sensitivity (p-value = 0.012) and sensory registration (p-value= 0.005) with sleep quality in two groups of children with autism spectrum disorder and specific learning disorder, which we will discuss in the discussion.

years. The revaluation estimate by retest method with a two-week interval was in the range of 0.62 to 0.79. In Iran, instrument validity in Shoghi, Khanjari, Farmani and Hosseini researches (2005) was evaluated by content validity method and its validity was determined 0.97 by retesting method with a two-week interval for 10 children aged 6-11 years. Cronbach's alpha coefficient of the questionnaire was obtained in two studies, 0.77 and 0.79 (27).

At the end, the data was analyzed by Mann-Whitney U in SPSS software version 22. One way to test statistical hypothesis between two independent communities or groups is the Mann-Whitney U, presented by Henry Mann and Donald Whitney in 1947. This test is a group of nonparametric methods and therefore, it has less power than its parametric counterpart when the data is normally distributed, but when the sample size is

small or if the distribution of data is high, it is better to use non-parametric tests such as this test to match the two distributions (28). In order to investigate the sensory processing status according to the 13 parts of the children's sensory profile 2, the questionnaire cutting line was used.

Results

The study included 23 children with autism and 20 children with special learning disabilities, ranging in age from 6 to 14 years old that 6 children were girls and 6 children were boys. In the group of children with special learning disabilities, all children were boys.

Table 1 shows the mean and standard deviation of score of each scale of Children's Sleep Habit Questionnaire separately. In the questionnaire of the quality of children's sleep habits, the higher the average score obtained in each scale, the more undesirable the situation is. According to Table 1, children with autism have gained higher scores than children with special learning disorders, except for daily sleepiness. The significant difference between the overall score of sleep quality in the two groups was that the overall score of sleep quality in children with autism was significantly higher than in children with specific learning disabilities, indicating lower sleep quality and more sleep problems in children with autism (p-value= 0.033).

Table 2 shows the average statistics and standard deviation of the scores of sensory profile 2 variables in children separately. The findings showed that children with autism received higher scores than children with special learning disabilities in all sensory processing variables except visual and olfactory processing.

In children with autism, the highest score was related to sensory sensitivity variables (45.83) and sensory registration (45.17) and the lowest score was related to visual processing (10.96); The highest score is assigned to the sensory registration (43.40) and the lowest score assigned to the body position variable (8.55) in children with special learning disabilities.

Tables 3 and 4 of the sensory processing distribution in two groups of children with autism spectrum disorder and specific learning disabilities based on the 13 parts shows Children Sensory Profile 2 in percentage. The results are reported in 5 categories of much less than others, less than others, similar to others, more than others, and much more than others in cutline of Sensory Profile 2 questionnaire. And the percentage of people with sensory processing disorder in each group is obtained by subtracting the percentage of relative frequency obtained in the group similar to others from the number 100, which indicates the relative frequency of any sensory processing disorder.

According to Table 3, the highest and lowest relative frequency of sensory processing disorder in children with autism was in the parts of emotional-social responses (73.9%) and auditor (17.4%). More details on the other parts are shown by separating the cut lines of Sensory Profile 2 in Table 3.

According to Table 4, the highest relative frequency of sensory processing disorder in children with special learning disabilities was in the parts of sensory registration, oral processing and socio-emotional responses (50%) and the lowest in the visual part (25%). More details on the other parts are shown in table 4 by separating the cut lines of sensory profile 2.

Discussion

The goal of this study was to investigate the relationship between sensory processing and sleep quality in children with autism and specific learning disabilities. The results of this study indicate the high frequency of sensory registration in children with autism as one of the four patterns in sensory processing model.

The findings of various studies about sensory processing patterns in children with autism spectrum disorders contain many contradictions, which are shown for all four patterns of sensory processing models; For example, Armer and Dan have introduced sensation seeking as a rare behavioral pattern in children with pervasive developmental disorders, especially autism (29). Watting *et al.* found sensory seeking as a common behavioral pattern in these children (30). In this regard, other research in Iran has been conducted in the field of sensory processing patterns of children with autism spectrum disorder. In this regard, the research of Dehghan et al., who in their study examined the relationship between sensory processing and behavior in children with autism disorder with high performance. The results of their research showed that the components of sensation seeking and inactivity are most related to the behavioral problems of children with autism (31). In another study, Ahmadi et al. examined the patterns of sensory processing in children with autism from the perspective of Winnie the Pooh model and concluded that sensory processing patterns in children with autism spectrum disorder and their normal peers were distinct and placed at the end of the continuum. (20).

The small sample size and the wide age range in the studied samples are the reasons for the observing difference in the research results. To compensate these cases, Ben Sassen and colleagues conducted studies on high-volume, low-age samples and used several evaluation scales to demonstrate a correlation between parental reports and clinical observations of sensory behaviors that

the results indicated the frequency of sensory registration patterns in children with autism spectrum disorder (32), which is consistent with the results of the present study. In another study, Mirzakhani *et al.* studied the sensory processing status in children with autism spectrum disorder aged 3 to 14 years that sensory registration and emotional-social responses had the most frequency in children with autism spectrum disorder (33), which is consistent with the results of the present study. Negative outcomes of high frequency of sensory registration as sensory processing disorder include the following cases.

Dan in his sensory processing model assumed that sensory modulation defects were not as more or less responsive only, but sensory behaviors were expressed in four patterns: sensory sensitivity, sensory avoiding, sensory registration, and sensory seeking, and the individual's behavioral aspect is dependent on coordination with his sensory threshold or attempting to compensate for this sensory threshold (19).

Children who have problems in their sensory registration experience a more fluctuating level of arousal than normal, i.e, there are sharp fluctuations between more arousal and low arousal in the normal range of sensory registration. Due to the fact that the level of arousal and alertness leads to the most adaptive response, so children who have a disorder in their sensory registration, have problems with the level of arousal and awareness, so that excessive registration increases the level of arousal and alertness compared to the normal state. These problems in sensory registration lead to dysfunction of the cortical and subclavian functions, as well as anxiety, depression, and aggressive behavior, so in people with sensory registration, alertness or varying levels of response is seen in the normal state which disrupts the sleep process disorder and thus reduces the quality of sleep of these people. Tzichensky et al. Found that touch hypersensitivity was most associated with sleep disorders in children with autism (34).

Children with sensory processing disorder of sensory sensitivity and sensory avoiding have intense alertness to sensory stimuli such as sound, smell, and touch due to low stimulation threshold; As a result, they suffer from confusion in facing with these sensory stimuli and show symptoms such as discomfort, avoidance, distraction, and anxiety. The child following more responding may experience frequent jumping following noise and show sensitivity to normal sounds in his or her sleeping environment. As a result, we may experience symptoms such as anxiety, restlessness, anger, fear, and distress in such children. Sensory registration disorder and disturbances in the level of consciousness, as an index of sensory processing disturbances, will lead to emotional instability. Therefore, it can be stated that this disturbance of sensory processing may impair the outputs of sensory processing systems, which are considered as inputs for the limbic emotional system and attention centers in temporal and parietal lobes. (35). Therefore, it can be expected that such sensory processing disorders will lead to emotional defects. Therefore, in examining the relationship between these two factors and sleep quality, these two factors can reduce the efficiency and sleep duration and increase the sleep delay, with the difference that the child suffering from passive sensory sensitivity only tries to cope with sleep stimuli, while the child suffering with sensory avoiding actively avoid disturbing sleep stimuli; As a result, in such children, we may experience symptoms such as anxiety, restlessness, anger, fear, and distress, all of which lead to a decrease in the quality of sleep in these children. A study conducted by Engel Yeger et al. to investigate the relationship between sensory processing and sleep quality in young people found that touch hypersensitivity had the greatest impact on sleep quality, while other sensory subcomponents such as vision and auditor affects sleep quality far less than touch (36).

Conclusion

Evidence and research theories show that sense is considered an introduction to high-level cognition. The learning model presented by William and Shellenberger shows how sensory processing affects high-level cognitive processes, academic achievement, coordination, and behavior (37). Therefore, determining sensory processing disorder in children with autism and special learning disabilities allows occupational therapists to reduce the incidence of behaviors caused by sensory processing problems and allow these children to participate better in different areas of life and increase the quality of sleep using their specialized knowledge in the field of sensory interventions by performing sensory integration interventions as well as training sensory relaxation techniques and matching activities and environment.

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