

Comparative Systematic Review of Korea Domestic and International Studies on Sensory Integration Therapy in Patients with Autism Spectrum Disorder

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ABSTRACT

This systematic review compared Korean and international researches on sensory integration therapy in patients with autism spectrum disorder (ASD). We targeted studies on sensory integration therapy for patients with ASD published from January 2000 through July 2016. Specifically, we analyzed the papers that used the phrase 'sensory integration, autism' as keywords. There were fewer Korean studies of sensory integration therapy, and the diversity of research topics were limited, focusing mainly on case studies. There was no difference between the internal/external validity of Korean and those of international studies targeting the clinical environment and patients. Further study of a variety of aspects of sensory integration therapy is needed to gain high internal/external validity.

Key words: Autism Spectrum Disorder (ASD), Sensory Integration Intervention, Qualitative Level, Comparative Systematic Review, Internal/external Validity.

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1. INTRODUCTION

Autism spectrum disorder (ASD) is a lifelong developmental disability defined by diagnostic criteria that include deficits in social communication and social interaction and restricted, repetitive patterns of behavior, interests, or activities [1]. The estimated incidence of ASD is about 2.64% in Korea [2], and 1.69% in US [3]. Although many studies have explored the causes and treatment of autism in infancy and childhood since autism was first described by Kanner [4], it still induces a severe disability. ASD constitutes a neurological process that makes it difficult for affected individuals to use their bodies effectively [5], [6]. In children, problems in motor performance, behavior, self-control, and social development may influence activities of daily living (ADLs), and the ability to learn [7].

Most commonly, individuals with ASD are characterized as sensory modulation disorders and/or sensory processing disorders such as decreased tactile sensitivity which are linked to stereotypical behaviors, disturbed emotional and social responses [8]-[10]. The diminished sensory integration occurs when CNS dysregulates the neural messages about sensory stimuli from body, as well as environment.

Sensory integration therapy is a one of intervention that involves child-centered activities and play and that manages the child's sensory experiences in a therapeutic environment [11]. Moreover, this intervention facilitates sensory processing and stimulates abilities that are fundamental to ADLs in children: playing, learning, life skills, and social participation [6], [12]. Several international studies have reported that autism involves difficulty with tactile, auditory, or visual processing [13]-[19]. The studies of the sense sensory experiences of children with autism showed deficits in sensory processing including tactile, oral, auditory, visual, kinesthetic (speed), and other major modalities in 95% of subjects [20], [21]. The results of these studies suggest that developmental disorders in children with autism reflect difficulty with sensory processing in multiple modalities.

Sensory integration therapy is a one of the neurophysiological approaches being applied to children with autism [22]. It provides controlled sensory stimulation in domains such as proprioception, vestibular sensation, and tactile sensation in an environment that fosters appropriate adaptive responses, ultimately improving the ability to process sensory information [23]. Sensory integration therapy facilitates interaction with the environment, focusing on neurological processes to organize the sensory stimuli effectively [11], [24], [25] and induces responses appropriate to the given environment [26], [27]. Furthermore, the process of handling sensation effectively improves children's sensory capacity and their ability to organize their behaviors [28]. The technique of sensory integration for children with autism is based on the framework of sensory integration theory [29], [30].

Sensory integration therapy is considered as an effective therapeutic strategy for patient with ASD. However, Korean research on autism and sensory integration therapy has mainly analyzed stereotyped behavior, motor skills, development, sociability, and sensory responses, whereas international research has focused more broadly on the domains of play,

social interaction, communication, and adaptive behavior. Since children with autism differ in their characteristics, case studies are also important [31], not only for determining the values and priorities of clients but also to attain therapeutic goals and improve task performance, which helps the therapist to make clinical decisions [32]. Additionally, applying sensory integration therapy based on practical clinical evidence can produce objective results and lead to qualitative improvement in sensory integration therapy [33]. Many recent Korean and international studies have systematically studied sensory integration therapy [33]-[35].

However, no systematic review of these studies and no comparative study of international and Korean sensory integration therapy has been conducted. Therefore, the present study examined the research trends through a systematic review of Korean and international studies of sensory integration therapy with autism patients. The review focused on those two questions. First, is there a difference of trends between Korean and international research trends in the application of sensory integration therapy in autism patients? Second, is there a difference between intervention methods, intervention effects, and the qualitative level of sensory integration therapy for patients with autism in Korean compared with international research?

2. METHODS

2.1 Study design

This study was a descriptive systematic review of Korean and international research on the application of sensory integration therapy in patients with ASD.

2.2 Hypotheses

We hypothesized that there is a difference in research trends between Korean and international studies of sensory integration therapy in ASD patients. Furthermore, the methods, effects, and level of qualitative evidence reflected in studies of sensory integration therapy for ASD patients differ between Korean and international studies.

2.3 Subjects

Korean and international studies of sensory integration therapy in ASD published from January 2000 to July 2016 were analyzed. Inclusion/exclusion criteria were set up in accordance with the purpose of the study. The specific criteria for including and excluding studies were as follows:

2.3.1 Inclusion criteria:

- 1) Research applying sensory integration intervention in pediatric ASD patients;
- 2) Availability of the full text of the study;
- 3) Research targeting patients with ASD; and
- 4) Research applied in clinical occupational therapy.

2.3.2 Exclusion criteria:

- 1) Conference papers or presentations;
- 2) Theses; and
- 3) Systematic reviews.

2.4 Study methods

2.4.1 Data collection: To collect data, we have searched for papers using the keyword phrase and study period; Term=(sensory integration) AND ASD AND (“2000/01/01” [PDat] : “2016/07/31” [PDat])). The MEDLINE/PubMed and Korea National Scholar search engines were used as sources of information. We found 48 international and 21 Korean studies. The citations for reviews and the abstract or full text of these papers were obtained using the Inje University Library Google search engines. Ultimately, five Korean studies and 15 international studies were selected with inclusion/exclusion criteria for this review.

2.4.2 Qualitative evaluation of methods: Two researchers independently evaluated the selected studies in terms of the qualitative level of research based on the level of evidence as defined by the American Occupational Therapy Association (AOTA). The AOTA level of evidence is shown in a Table 1 that provides objective criteria for each study based on the study design, sample size, and internal and external validity [36]. The two researchers reviewed the level of evidence individually, and cases of disagreement were resolved by discussion.

Table 1. Level of evidence for AOTA evidence-based practice project

Step	Category	Definition
Design	I	Randomized trial The random assignment or a series of repeated measurements of group In the design, the two groups or more than two group of comparative study Randomized Assignment of group, same condition, Sequential measurements
	II	Non-RCT That do not satisfy the two groups in quasi-experimental designs, or more groups and the comparison of treatment
	III	Non-subject design A single group pre-post comparison study of treatment
	IV	Single-subject design The measurement of a single target through therapeutic interventions
	V	Case studies Description and example research
Sample size	A	n≥50 Observations per group n more than 50
	B	n≥20 Observations per group n more than 20
	C	n<20 Observations per group n less than 20
Internal validity	1	High Attrition, non-blind, in equivalent intervention,

External validity	2	Intermediate	Control the validity simultaneous recovery Validity threats or strong control of the factors affecting result such as concurrent recovery No apparent factors affecting the progress, but The presence of one or two elements that threaten the validity
	3	Low	No satisfied of 1, 2 requirement Subjects representing the population and therapeutic interventions in the natural environment, (at home or clinical) is running on the present results also show or get a strong theoretical background
	a	High	Satisfied two in the criteria presented in a
	b	Intermediate	Satisfied one or less in the criteria presented in a
	c	Low	

ATO = American Occupational Therapy Association; RCT = randomized control trial.

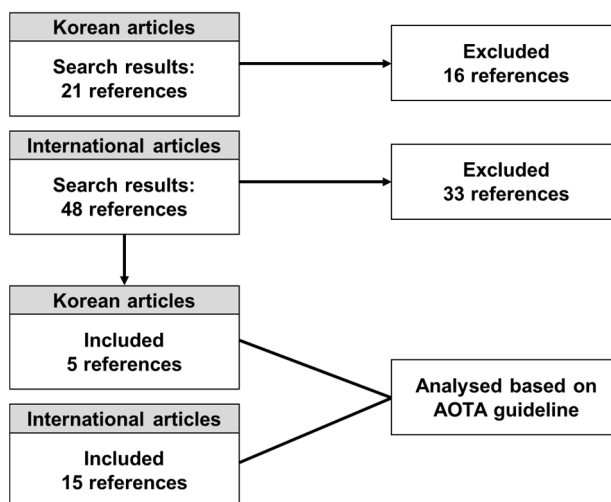


Fig. 1. Study flow diagram

3. RESULTS

Based on the inclusion and exclusion criteria, we have investigated five Korean and 15 international studies (see Tables 2 and 3). Few Korean studies were appropriated and matched to inclusion criteria (see Table 2). Two of Korean papers were consisted to single-subject design using therapeutic intervention and were therefore not rated as having a high level of evidence [33], [37]. And two of Korean studies were comprised of non-subject design studies, and showed level III of evidence [38], [39]. Rest of one Korean study was non-

randomized trial, and showed level II [40]. In addition, almost of Korean studies had small sample size ($n \leq 20$), except one study [40], which included 30 participants. Both internal and external validity of all Korean studies were evaluated three times. The internal and external validity had many shortcomings, such as poor representation, non-blind evaluation, the lack of items for simultaneous recovery, short duration of treatment, and a small number of subjects. Because the short-term therapeutic effect was insufficient, the internal and external validity of the assessment in all five studies are questionable. Although there were some limitations in Korean studies, we found that sensory integration therapy reduced stereotyped behaviors and persistent preoccupied behavior and improved attention in ASD children through those of studies.

Table 2. Characteristics of Korean domestic researches

Study	Sample size (person)		Level of evidence*	Result
	Test group	Control group		
Jeong and Chung (2009)	1	-	IVC3c	Stereotype behavior reduced
Lee et al (2009)	1	-	IVC3c	Persistent preoccupied behavior reduced
Kim et al (2010)	2	-	IIIC3c	Attention increased
Jung (2013)	15	15	IIB2c	Improvement of sense of control and adaptive behavior in ASD Significant recovery in proprioception-vestibular, auditory-visual, revolution-vestibular, and tactile after SIT
Kim (2014)	2	-	IIIC3c	

*Level of evidence is based on AOTA guideline.

Among the 15 international studies, one study enrolled the most subjects, with 93 children in the test group [41] and Foxe et al [42] enrolled 84 children in the test group and 142 children in the control group. Most of the remaining studies had small sample sizes of fewer than 20 participants. Regarding the study designs, there were two randomized trials (level I), seven comparative non-randomized trials with more than two groups (level II), four non-subject design studies (level III), one single-subject design studies (level IV), and one case study (level V).

Regarding the internal and external validity, only short-term treatment effects could be determined due to the small sizes of the study groups, non-blinded nature of the studies, lack of an item for simultaneous recovery, and short duration of treatment. Consequently, the internal validity was between 2 and 3 level, the external validity also showed between b and c level (see Table 3). The Korean studies evaluated only general therapeutic effects of sensory integration therapy, whereas there were numerous studies including therapeutic equipment [43], efficacy of therapy [44]-[46], the appropriateness of treatment protocols [47], and treatment factors that might affect outcomes [41], and the link between multisensory temporal integration in ASD [48].

4. DISCUSSION

This study reviewed the results of Korean and international studies of sensory integration therapy in patients with ASD and compared Korean with international trends in sensory integration therapy in ASD patients, examining the status of sensory integration therapy and providing basic data.

It has been known that ASD is marked by impairments in reciprocal social interaction and communications due to limited, repetitive, and stereotyped behaviors [49]-[51]. ASD is the main target of sensory integration therapy [52], which can discover the early symptoms of sensory integration disorder in autistic children and can be used to alleviate symptoms and to provide the necessary foundation for treatment [53], [54]. There were far fewer Korean studies (five articles) than international studies (15 articles). Moreover, the international studies had a variety of designs, including two randomized trials, seven non-randomized trials, four non-subject design studies, one single-subject design studies, and one of case study. In comparison with five Korean studies, two studies were single-subject design studies and two studies were non-subject design studies and rest of one study was non-randomized trial. The reviewed Korean and international studies had internal validity of 2-3 level and external validity of b-c level (see Tables 2 and 3). The clinical nature of these human studies raises issues concerning the small sample size, short treatment duration, and difficulty excluding the effects of comprehensive rehabilitation therapy. In terms of the diversity of the study results, the international studies showed the effects of traditional sensory integration intervention and provided various suggestions, such as coordination, social skills, stereotyped behavior, task performance, arousal level, activity levels involving home/school/family, participation in family activities, play behavior, and aggression [55]-[60]. Particularly, present international studies have investigated the need for validation of new assessment/treatment equipment [43], the importance of examining the adequacy of treatment protocols [47], the requirement that sensory integration treatment factors that might affect outcomes be considered [41], and modified application of sensory integration in ASD [48]. The Korean research also demonstrated reduction of obsessive behaviors [61], improvement in attention [38], decreased stereotyped behavior [37], recovery of sensory control [40], and progress in proprioception-vestibular, auditory-visual, revolution-vestibular,

Table 3. Characteristics of the international researches

Study	Sample size (person)		Level of evidence	Result
	Test group	Control group		
Jung et al (2006)	12	20	IIB2c	Significant difference in coordination ability and social skill • Found that VR-SIT is possible to apply our system
Watling and Dietz (2007)	4	-	IIIC3c	• No clear change in undesired behavior or task management • Subjective positive change
Fazlıođlu and Baran (2008)	15	15	IIB2b	• Significant difference in sensory problem
Wei et al (2009)	93	-	IIIA2b	• Influential factors for the SIT effects (Sex and age)
Pfeiffer et al (2011)	20	17	IB2b	• More significant positive changes occurred in the SI group
Hodgetts et al (2011)	6	-	IIIC3c	• Did not decrease motoric stereotyped behaviors • Did not decrease heart rate
Schaaf et al (2012a)	10	-	IIIC3c	• Intervention is safe and feasible to implement, acceptable to parents and therapist • Able to implement protocol with adequate fidelity
Schaaf et al (2012b)	1	-	VC3c	• Improvement in sensory processing • Enhanced participation in home, school, and family activities
Dunbar et al (2012)	3	4	IC2c	• Positive differences in play behavior for both groups
Davis et al (2013)	1	-	IVC3c	• No marked effect on levels of aggression and self-injurious behavior
Stevenson et al (2014)	32	32	IIA3b	• ASD showed a speech-specific deficit in multisensory temporal processing. • SIT group showed more improvement in motor coordination, non-verbal cognitive abilities and combined abilities of sensory motor and cognition when compared with group therapy
Iwanaga et al (2014)	8	12	IIB2c	• Severe integration deficits were uncovered in ASD, which were increasingly pronounced as background noise increased. These deficits were fully ameliorated in ASD children entering adolescence.
Foxe et al (2015)	84	142	IIA2b	• Hyperreactivity in posture-related sensory information, which reflects a general, rather than channel-specific sensory integration impairment in ASD.
Doumas et al (2016)	15	15	IIB3c	• Significant improvement in sensory processing functions of preterm infants
Pekçetin et al (2016)	34	34	IIA3c	

and tactile [39] in ASD after sensory integration therapy. However, few studies exist for ASD and sensory integration therapy in Korea therefore, additional and various studies on sensory integration therapy in ASD are required. Furthermore, the studies are needed to establish basic information on sensory integration therapy by comparing Korean and international research. Eventually, this review may contribute to improving the quality of life of autistic children through therapeutic intervention using sensory integration therapy.

One limitation of this study is that it analyzed the Korean and international studies at the same level, and there were insufficient subjects in the studies. Future Korean and international studies should examine the assessment tools and intervention methods used.

5. CONCLUSION

This study examined Korean and international studies of sensory integration therapy in ASD patients published from January 2000 to July 2016 and compared the results. The Korean research on sensory integration treatment was very

limited, and its qualitative level of evidence was very low. Furthermore, this research lacked diversity compared with international studies. The Korean and international studies had low internal/external validity due to the focus of the studies on children in their natural environments. Additional studies with appropriate study designs are needed to obtain high internal and external validity. Korean studies of sensory integration therapy should be more diverse.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to this study.

REFERENCES

- [1] American Psychiatric Association, *Diagnostic and statistical manual of mental disorders. 5th ed.*, 2013.
- [2] Y. S. Kim, B. L. Leventhal, Y. J. Koh, E. Fombonne, E. Laska, E. C. Lim, K. A. Cheon, S. J. Kim, Y. K. Kim, H. Lee, D. H. Song, and R. R. Grinker, "Prevalence of autism spectrum disorder in a total population sample," *The American journal of psychiatry*, vol. 168, 2011, pp. 904-912. doi : 10.1176/appi.ajp.2011.10101532
- [3] J. Baio, L. Wiggins, D. L. Christensen, M. J. Maenner, J. Daniels, Z. Warren, M. Kurzius-Spencer, W. Zahorodny, C. Robinson Rosenberg, T. White, M. S. Durkin, P. Imm, L. Nikolaou, M. Yeargin-Allsopp, L. C. Lee, R. Harrington, M. Lopez, R. T. Fitzgerald, A. Hewitt, S. Pettygrove, J. N. Constantino, A. Verhorn, J. Shenouda, J. Hall-Lande, K. Van Naarden Braun, and N. F. Dowling, "Prevalence of autism spectrum disorder among children aged 8 years – autism and developmental disabilities monitoring network, 11 sites, United states, 2014," *Morbidity and mortality weekly report, Surveillance summaries (Washington, D. C. : 2002)*, vol. 67, 2018, pp. 1-23. doi : 10.15585/mmwr.ss6706a1
- [4] L. Kanner, "Autistic disturbance of affective contact," *Nervous Child*, vol. 2, 1943, pp. 217-250.
- [5] A. J. Ayres and L. S. Tickle, "Hyper-responsibility to touch and vestibular stimuli as a predictor of positive response to sensory integration procedures by autistic children," *American Journal of Occupational Therapy*, vol. 34, 1980, pp. 375-380. doi : 10.5014/ajot.34.6.375
- [6] A. J. Ayres, *Sensory integration and praxis tests manual*, Western Psychological Services, 1989.
- [7] A. J. Ayres, *Sensory integration and the child*, Western Psychological Services, 1979.
- [8] J. Ashburner, L. Bennett, S. Rodger, and J. Ziviani, "Understanding the sensory experiences of young people with autism spectrum disorder: a preliminary investigation," *Australian Occupational Therapy Journal*, vol. 60, 2013, pp. 171-180. doi : 10.1111/1440-1630.12025
- [9] A. V. Joosten and A. C. Bundy, "Sensory processing and stereotypical and repetitive behaviour in children with autism and intellectual disability," *Australian Occupational Therapy Journal*, vol. 57, 2010, pp. 366-372. doi : 10.1111/j.1440-1630.2009.00835.x
- [10] L. Wing, *The Autistic Spectrum: A parents' guide to understanding and helping your child*, Ulysses Press, 2001, pp. 65-92.
- [11] A. C. Bundy, S. J. Lane, and E. A. Murray, *Sensory integration: Theory and practice*, F.A. Davis Company, 2002.
- [12] L. D. Parham and Z. Mailloux, "Sensory Integration," In J. Case-Smith, A.S. Allen, and P. Nuse Pratt (Eds.), *Occupational therapy for children 3rd ed.*, St. Louis, MO: Mosby, 1996.
- [13] G. T. Baranek, L. G. Foster, and G. Berkson, "Tactile defensiveness and stereotyped behaviors," *American Journal of Occupational Therapy*, vol. 51, 1997, pp. 91-95. doi : 10.5014/ajot.51.2.91
- [14] G. T. Baranek, "Autism during infancy: A retrospective video analysis of sensory-motor and social behaviors at 9-12 months of age," *Journal of Autism and Developmental Disorders*, vol. 29, 1999, pp. 213-224. doi : 10.1023/A:1023080005650
- [15] T. Grandin, *Thinking in pictures: My life with autism*, Random House Audio, 1995.
- [16] C. Gillberg and M. Coleman, "Autism and medical disorders: A review of the literature," *Developmental Medicine and Child Neurology*, vol. 38, 1996, pp. 191-202. doi : 10.1111/j.1469-8749.1996.tb15081.x
- [17] C. Gillberg and M. Coleman, *The biology of autistic syndromes*, Mac Keith Press, 2000.
- [18] S. I. Greenspan and S. Weider, "Developmental patterns and outcomes in infants and children with disorders relating and communicating: A chart review of 200 cases of children with autistic spectrum diagnoses," *Journal of Developmental and Learning Disorders*, vol. 1, 1997, pp. 87-142.
- [19] C. Lord, M. Rutter, and A. Le Couteur, "Autism Diagnostic Interview-Revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders," *Journal of Autism and Developmental Disorders*, vol. 24, 1994, pp. 659-685. PMID : 7814313
- [20] J. K. Kern, M. H. Trivedi, B. D. Grannemann, C. R. Garver, D. G. Johnson, A. A. Andrews, J. S. Savla, J. A. Mehta, and J. L. Schroeder, "Sensory correlations in autism," *Autism*, vol. 11, 2007, pp. 123-134. doi : 10.1177/1362361307075702
- [21] S. D. Tomchek and W. Dunn, "Sensory processing in children with and without autism: A comparative study using the Short Sensory Profile," *American Journal of Occupational Therapy*, vol. 61, 2007, pp. 190-200. doi : 10.5014/ajot.61.2.190
- [22] G. T. Baranek, "Efficacy of sensory and motor interventions for children with autism," *Journal of Autism and Developmental Disorders*, vol. 32, 2002, pp. 397-422. PMID : 12463517
- [23] A. J. Ayres, *Sensory integration and learning disorders*, Western Psychological Services, 1972.
- [24] A. R. Deris, E. M. Hagelman, K. Schilling, and C. F. DiCarlo, *Using a weighted or pressure vest for a child with autistic spectrum disorder*, Education Resources Information Center, 2006.
- [25] A. Kane, J. K. Luiselli, S. Dearborn, and N. Young, "Wearing a weighted vest as an intervention for children with autism/pervasive developmental disorder," *The Scientific Review of Mental Health Practice*, vol. 3, 2004, pp. 19-24.
- [26] J. G. Kimball, "The issue is integration not sensory," *American Journal of Mental Retardation*, vol. 92, 1988, pp. 435-437.
- [27] P. Wilbarger and J. L. Wilbarger, *Sensory Defensiveness in child age 2-12*, Avanti Educational Programs, 1991.
- [28] K. M. Kim, "Sensory integration approach for a child with autism," *Journal of Korean Society of Occupational Therapy*, vol. 4, 1996, pp. 51-58.
- [29] L. J. Olson and H. J. Moulton, "Use of weighted vests in pediatric occupational therapy practice," *Physical and*

- Occupational Therapy in Pediatrics, vol. 24, 2004, pp. 45-60. doi : 10.1300/J006v24n03_04
- [30] L. Zissermann, "The effects of deep pressure on self-stimulating behaviors in a child with autism and other disabilities," *American Journal of Occupational Therapy*, vol. 46, 1992, pp. 547-551. doi : 10.5014/ajot.46.6.547
- [31] E. K. Kim, "Literature review on the sensitive characteristics and sensory integration intervention of children with autistic disorders," *Busan presbyterian theological college and seminary*, vol. 5, 2005, pp. 247-273.
- [32] C. J. Lee and L. T. Miller, "The Process of Evidence-Based Clinical Decision Making in Occupational Therapy," *American Journal of Occupational Therapy*, vol. 57, 2003, pp. 473-477. doi : 10.5014/ajot.57.4.473
- [33] K. M. Kim, "The effectiveness of sensory integrative intervention: a systematic review," *Journal of Korean Society of Sensory Integration Therapists*, vol. 7, 2009, pp. 77-90.
- [34] T. A. May-Benson, J. A. Koomar, and A. Teasdale, "Incidence of pre-, peri-, and post-natal birth and developmental problems of children with sensory processing disorder and children with autism spectrum disorder," *Frontiers in Integrative Neuroscience*, vol. 3, 2009, pp. 1-12. doi : 10.3389/neuro.07.031.2009
- [35] L. D. Parham, E. S. Cohn, S. Spitzer, J. A. Koomar, L. J. Miller, J. P. Burke, B. Brett-Green, Z. Mailloux, T. A. May-Benson, S. S. Roley, R. C. Schaaf, S. A. Schoen, and C. A. Summers, "Fidelity in sensory integration intervention research," *American Journal of Occupational Therapy*, vol. 61, 2007, pp. 216-227. doi : 10.5014/ajot.61.2.216
- [36] C. A. Trombly and H. I. Ma, "A synthesis of the effects of occupational therapy for persons with stroke, Part I: Restoration of roles, tasks, and activities," *American Journal of Occupational Therapy*, vol. 56, 2002, pp. 250-259. doi : 10.5014/ajot.56.3.250
- [37] B. L. Jeong and B. I. Chung, "The compare of effects on sensory integration therapy and applied behavior analysis on the decreasing stereotypic behaviors in a child with autism," *Journal of Korean Society of Occupational Therapy*, vol. 17, 2009, pp. 17-27.
- [38] B. K. Kim, S. H. Park, H. S. Bang, S. H. Chun, J. H. Han, and B. J. Jeon, "The effects of sensory integration intervention on the attention capabilities of children with autism spectrum disorder (ASD)," *Journal of Korean Society of Occupational Therapy*, vol. 8, 2010, pp. 113-125.
- [39] Y. M. Kim, "The Development and Application of Sensory Integration Program Model Based on Characteristics of children with disabilities," *Korean Council of Physical, Multiple & Health Disabilities*, vol. 57, 2014, pp. 1-24. doi : 10.20971/kcpmd.2014.57.1.1
- [40] H. S. Jung, "The effects of sensory integration therapy program on sensory modulation function and adaptive behavior for children with autism spectrum disorder," *The Journal of Play Therapy*, vol. 17, 2013, pp. 83-98.
- [41] B. Y. Wei, Y. Y. Wei, and F. Huang, "Influential factors for the sensory integration training effects in children with autism," *Chinese journal of contemporary pediatrics*, vol. 11, 2009, pp. 124-127. PMID : 19222950
- [42] J. J. Foxe, S. Molholm, V. A. Del Bene, H. P. Frey, N. N. Russo, D. Blanco, D. Saint-Amour, and L. A. Ross, "Severe multisensory speech integration deficits in high-functioning school-aged children with Autism Spectrum Disorder (ASD) and their resolution during early adolescence," *Cerebral cortex*, vol. 25, 2015, pp. 298-312. doi : 10.1093/cercor/bht213
- [43] K. E. Jung, H. J. Lee, Y. S. Lee, S. S. Cheong, M. Y. Choi, D. S. Suh, S. Oah, S. H. Lee, and J. H. Lee, "The application of a Sensory Integration Treatment Based on virtual Reality-Tangible Interaction for Children with Autistic Spectrum Disorder," *Psychology Journal*, vol. 4, 2006, pp. 145-149.
- [44] R. Iwanaga, S. Honda, H. Nakane, K. Tanaka, H. Toeda, and G. Tanaka, "Pilot study: efficacy of sensory integration therapy for Japanese children with high-functioning autism spectrum disorder," *Occupational Therapy International*, vol. 21, 2014, pp. 4-11. doi : 10.1002/oti.1357
- [45] S. Pekçetin, E. Akı, Z. Üstünyurt, and H. Kayihan, "The Efficiency of Sensory Integration Interventions in Preterm Infants," *Perceptual and motor skills*, vol. 123, 2016, pp. 411-423. doi : 10.1177/0031512516662895
- [46] M. Dumas, R. McKenna, and B. Murphy, "Postural Control Deficits in Autism Spectrum Disorder: The Role of Sensory Integration," *Journal of Autism and Developmental Disorders*, vol. 46, 2016, pp. 853-861. doi : 10.1007/s10803-015-2621-4
- [47] R. C. Schaaf, T. W. Benevides, D. Kelly, and Z. Mailloux-Maggio, "Occupational therapy and sensoryintegration for children with autism: a feasibility, safety, acceptability and fidelity study," *Autism*, vol. 16, 2012, pp. 321-327. doi : 10.1177/1362361311435157
- [48] R. A. Stevenson, J. K. Siemann, B. C. Schneider, H. E. Eberly, T. G. Woynaroski, S. M. Camarata, and M. T. Wallace, "Multisensory temporal integration in autism spectrum disorders," *The Journal of neuroscience*, vol. 34, 2014, pp. 691-697. doi : 10.1523/JNEUROSCI.3615-13.2014
- [49] B. Henning, R. Cordier, S. Wilkes-Gillan, and T. Falkmer, "A pilot play-based intervention to improve the social play interactions of children with autism spectrum disorder and their typically developing playmates," *Australian Occupational Therapy Journal*, vol. 63, 2016, pp. 223-232. doi : 10.1111/1440-1630.12285
- [50] American Psychiatric Association, *Diagnostic and statistical manual of mental disorders (DSM-IV)*. 4th ed., American Psychiatric Association, 1994.
- [51] World Health Organization, *The International Classification of Diseases and Disorders-10 (ICD-10) Classification of Mental and Behavioural Disorders: Diagnostic Criteria for Research*, 1993.
- [52] V. A. Green, K. A. Pituch, J. Itchon, A. Choi, M. O'Reilly, and J. Sigafos, "Internet survey of treatments used by parents of children with autism," *Research in developmental disabilities*, vol. 27, 2006, pp. 70-84. doi : 10.1016/j.ridd.2004.12.002

- [53] S. S. Roley, E. I. Blanche, and R. C. Schaaf, *Understanding the nature of sensory integration with diverse populations*, Communication Skill Builders, 2007.
- [54] Y. Fazlioglu and G. Baran, "A sensory integration therapy program on sensory problems for children with autism," *Perceptual and motor skills*, vol. 106, 2008, pp. 415-422. doi : 10.2466/pms.106.2.415-422
- [55] T. N. Davis, S. Dacus, E. Strickland, D. Copeland, J. M. Chan, K. Blenden, R. Scalzo, S. Osborn, K. Wells, and K. Christian, "The effects of a weighted vest on aggressive and self-injurious behavior in a child with autism," *Developmental Neurorehabilitation*, vol. 16, 2013, pp. 210-215. doi : 10.3109/17518423.2012.753955
- [56] S. B. Dunbar, J. Carr-Hertel, H. A. Lieberman, B. Perez, and K. Ricks, "A pilot study comparison of sensory integration treatment and integrated preschool activities for children with autism," *The Internet Journal of Allied Health Sciences and Practice*, vol. 10, 2012, pp. 1540-1580.
- [57] S. Hodgetts, J. Magill-Evans, and J. E. Misiasek, "Weighted vests, stereotyped behaviors and arousal in children with autism," *Journal of autism and developmental disorders*, vol. 41, 2011, pp. 805-814. doi : 10.1007/s10803-010-1104-x
- [58] B. A. Pfeiffer, K. Koenig, M. Kinnealey, M. Sheppard, and L. Henderson, "Effectiveness of sensoryintegration interventions in children with autism spectrum disorders: a pilot study," *American Journal of Occupational Therapy*, vol. 65, 2011, pp. 76-85. doi : 10.5014/ajot.2011.09205
- [59] R. C. Schaaf, J. Hunt, and T. Benevides, "Occupational therapy using sensory integration to improve participation of a child with autism: a case report," *American Journal of Occupational Therapy*, vol. 66, 2012, pp. 547-555. doi : 10.5014/ajot.2012.004473
- [60] R. L. Watling and J. Dietz, "Immediate effect of Ayres's sensoryintegration-based occupational therapy intervention on children with autism spectrum disorders," *American Journal of Occupational Therapy*, vol. 61, 2007, pp. 574-583. doi : 10.5014/ajot.61.5.574
- [61] N. H. Lee, S. H. Lee, and W. S. Park, "The effects of sensory integration theory on the persistent preoccupation in a child with autism spectrum disorder," *Journal of Korean Society of Occupational Therapy*, vol. 17, 2009, pp. 55-64.



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