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ROLE OF SENSORY INTEGRATION IN REHABILITATION OF PATIENTS WITH DISABILITIES: A REVIEW ARTICLE

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ABSTRACT

Sensory integration (SI) theory was originally developed by A. Jean Ayres to focus on the neurological processing of sensory information. Sensory integrative therapy (SIT) or SI approach has been used for the treatment of challenged children since the 1970s. It is based on the understanding that interferences in neurological processing and integration of sensory information disrupt the construction of purposeful behaviors. According to Ayres, sensory information is not processed in isolation and, given this essential feature of the central nervous system, therapeutic intervention that incorporates sensation to affect multisensory perception will influence learning and behavior. **Ayres, (1972)** proposed that through the development of these sensorimotor functions and, specifically, by facilitating adaptive somatomotor responses, a person can develop learning, reading, math, visual and auditory perception, and skilled motor tasks. Treatment is designed to provide controlled sensory experiences so that an adaptive motor response is elicited. The goals of treatment are to improve sensory modulation related to behavior and attention and to increase abilities for social interactions, academic skills, and independence through better SI. The activities provided are meant to help the nervous system modulate, organize, and integrate information from the environment, resulting in future adaptive responses.

Key Words: Autism Spectrum Disorder, Cerebral palsy; Physical therapy, rehabilitation; Sensory Integration,

INTRODUCTION

Theory of Sensory Integration (SI)

In 1979, Ayres introduced the construct of (SI). She defined SI as "the neurological process that organizes sensation from one's own body and from the environment and makes it possible to use the body effectively within the environment". According to Ayres, SI occurs in the brain cortex, and it requires balance between the central and peripheral nervous systems, as well as between excitatory and inhibitory neurological systems. SI is viewed as necessary to maintain a personal " map" of one's body (i.e., being aware of the body and what it is doing) and to perform sophisticated cognitive activities (e.g., planning, attending to the environment, and using language) **(Bundy, 2002)**.

According to **Davies and Gavin (2007),** SI is the interaction and coordination of two or more functions or processes in a manner which enhances the addictiveness of the brain's response. It is the combining of signals from two or more senses in the central nervous system (CNS). Ayres and subsequent writers have pointed to SI problems in a variety of disorders, including physical disabilities such as cerebral palsy (CP) **(Anzalone and Murray, 2002),** learning disabilities, ADHD, and developmental disabilities such as autism spectrum disorder (ASD), **(Linderman and Stewart, 1999).** These writers refer to problems seen in some people as "sensory integration dysfunction," which is "the inefficient neurological processing of information received through the senses, causing problems with learning, development, and behavior" **(Kranowitz, 1998).**

SI dysfunction is thought to impair the vestibular, proprioceptive, and tactile systems. The vestibular system provides sensory input to the brain about the body's movement through space. Ostensible signs of vestibular impairment include poor posture and dyspraxia (difficulty planning or sequencing motor activities). The proprioceptive system provides sensory input from muscles and joints. Proprioceptive impairment is said to be revealed by the presence of stereotyped body movements, such as flapping one's hands or rocking one's body back and forth. Finally, in SI theory impairments in the tactile system, or one's sense of touch, are evidenced by over- or under-sensitivity to sensory stimuli **(Case-Smith *et al.*, 2015).**

Sensory processing involves perceiving, organizing and interpreting information received through sensory systems (e.g., taste, touch, smell, sight, auditory, vestibular) in order to produce an adaptive response. The term "sensory integration" as used by Ayres, refers to the ability to produce appropriate motor and behavioral responses to stimuli **(Ayres, 1979).**

Ayres observed that people with sensory integration deficits have problems in registration (signal detection and interpretation), in modulation (signal inhibition or propagation), in interacting with certain objects and in motivation **(Ayres, 1979).**

Components of impaired sensory integration according to Ayres:

Registration is the detection of sensory sensations within the central nervous system. Ayres used the term "registration of sensory information" which expands beyond the clinical definition of the initial detection of a stimulus to also include the recognition of significant meaning of sensory stimulation **(Smith *et al.*, 2005).**

Modulation: Modulation is the ability of the brain to regulate inhibition or propagation of neural signaling. Sensory modulation reflects adjustments made in response to continual physiological processes to ensure adaptation to new or changing sensory information. Ayres defined modulation as the "brain's regulation of its own activity" **(Watling and Dietz, 2007).**

Motivation: Ayres described motivation as the desire or willingness to respond to a stimulus that has been registered or to ignore it. Ayres suggested that a part of the brain that motivates a response has an "energizing effect" that initiates behavior when encountering a stimulus and triggers the desire to do something new or different **(Ayres, 1979).**

Assessment of sensory integrative dysfunction:

The three main methods for diagnosing sensory integrative dysfunction are direct assessments such as the Sensory Integration and Praxis Tests (SIPT), rating scales such as the Sensory Profile 1 and 2, and clinical observations **(Ayres, 1979; Dunn, 2014).**

(1) **The Sensory Integration and Praxis Tests (SIPT):** It was derived from factor analytic studies beginning with Ayres, and is a standardized instrument designed to assess vestibular, proprioceptive, tactile, and visual processing in children aged 4 through 8 years old. It has been described as "the most comprehensive and statistically sound means for assessing some important aspects of sensory integration, most notably praxis and tactile discrimination". However, research indicates that 5 of the 17 subtests are unstable, meaning that results are likely to vary each time they are given to the same individual **(Parham and Mailloux, 2001)**. Although Ayres reported that SIPT scores differed between children with and without learning disabilities, subsequent analyses of her studies showed that there were actually no reliable differences. As well, Ayres did little testing of the utility of this test for children with other disabilities. A more fundamental concern is that a key index of SI dysfunction in the SIPT is hyponystagmus, which is an especially long duration of involuntary eye rolling following a rapid rotation of the individual. Studies indicate that hypo nystagmus is unrelated to learning disabilities. Though some more recent data surest that SIPT demonstrates acceptable inter-rater reliability **(Asher *et al.*, 2008).**

(2) **Observation:** Another diagnostic practice involves observing behaviors and making inferences about sensory difficulties associated with those behaviors. However, operational definitions have not been developed for the behaviors that are observed, and the reliability and validity of inferences about underlying sensory difficulties have not been documented. Thus, there are currently no objective, validated methods for conducting observations of putative sensory integrative dysfunction **(Cook and Dunn, 1998)**.

(3) **Sensory Profile 2:** Another SI measure is the Sensory Profile 2 **(Dunn, 2014)**, which is a paper-and-pencil or online questionnaire completed by caregiver or teacher to characterize the child's unique sensory preferences and aversions. The first edition of the Sensory Profile discriminated among different clinical populations. It also correlated with another SI assessment instrument and with electroencephalogram recordings **(Davies and Gavin, 2007)**. However, the utility of the original Sensory Profile or Sensory Profile 2 for identifying dysfunction and planning treatment remains largely unsubstantiated **(Koziol *et al.*, 2011)**.

Treatment Outcome:

SIT is designed to restore effective neurological processing and increase the individual's ability to integrate sensory information by enhancing the vestibular, proprioceptive, and tactile systems **(Case-Smith *et al.*, 2015)**. For example, SIT often incorporates activities intended to stimulate the vestibular system such as swinging, rolling, jumping on a trampoline, or riding on scooter boards. Activities to stimulate the proprioceptive or tactile systems include "smooshing" the individual between gymnasium pads or pillows to provide "deep pressure," brushing a client's body, providing "joint compression" by repeatedly tightening the individual's joints, such as at the wrist or elbow, and playing with textured toys **(Bundy, 2002)**. Such activities are intended to provide a «just-right" challenge- requiring an individual to use her most advanced, adaptive skills and encouraging her to build on these skills in order to ameliorate- or compensate for--the underlying deficit **(Smith *et al.*, 2015)**.

The application of a "sensory diet," also called a sensory-based intervention, is a related clinical practice in which practitioners implement activity plans into an individual's daily routine to meet their presumed idiosyncratic sensory needs. Such a plan might include directing the individual to sit on a large ball, having her wear weighted or "pressure" vests, putting a body sock over her, conducting oral motor exercises, encouraging play with items that have specific tactile qualities (e.g., clay), negotiating an obstacle course, jumping into pillows, and modifying her environment (e.g., adjusting the lighting) in order to improve or alter arousal states and affect. A particularly influential sensory-based intervention is the Alert Program™N, which compares individuals' arousal levels to an engine that, in some cases, may run too fast or slow for optimal learning readiness **(Schaaf & Miller, 2005 ; Schaaf & Nightlinger 2007 and Smith *et al.*, 2015).**

SIT practitioners are usually occupational therapists (OT). These practitioners typically conduct 30- to 60-minute sessions one to three times per week and often direct parents and paraprofessionals such as classroom aides to carry out the intervention at other times throughout the day **(Bundy, 2002)**. Although SIT originated in clinical settings, it has subsequently been extended to a variety of other environments, including classrooms, homes, swimming pools, and even on horseback **(Case-Smith and Miller, 1999; Smith *et al.*, 2015)**.

SIT practitioners report three types of benefits **(Ayres, 1979; Reisman, 1993 ; Moore and Henry, 2002).**

(a) Enhanced ability to focus on relevant materials in educational, therapeutic, and social environments.
(b) Reduction in the rate of disruptive behaviors such as self-injury.
(c) Generalized improvements in nervous system functioning reflected in gains in high-level cognitive activity such as language and reading.

Because practitioners attribute these improvements to increased organization and functional efficiency in an impaired (CNS), they often describe SIT as a "process" therapy **(Cermak and Henderson, 1999).**

Successful SI should involve the following:

(1) Receiving the sensory information successfully.
(2) Interpreting the sensory information correctly.
(3) Combining information from different senses to create a complete picture.

(4) Deciding on a response based on information from all sources.
(5) Executing that response by sending electrical impulses back out to the muscles and limbs.

Sensory Integration for different cases:

SI for rehabilitation of children with (ASD):

Sensory integration is one of the most highly utilized interventions in autism. (ASD) are characterized by a combination of restrictive and repetitive behaviors and deficits in communication and social skills **(American Psychological Association, 2000).** Ayres suggested that some children with ASD do not register sensory inputs properly; and as a result, these children allocate attention differently from typically developing children. Although not part of the diagnostic criteria, individuals with ASD may also appear to seek or avoid ordinary auditory, visual, tactile, and oral stimuli. For example, individuals with ASD may perseverate on objects that have a specific texture or visual pattern, may cover their ears when they hear a specific noise (e.g., car horn), or may not respond to stimuli that should elicit their attention (e.g., someone calling their name). These unusual behaviors are sometimes described as ''sensory behaviors'' **(Rogers and Ozonoff, 2005; Kern *et al.,* 2008; Ben-Sasson *et al.,* 2009; Lane *et al.,* 2010).**

She also proposed that children with ASD not only fail to register sensory input properly but also have trouble modulating input that they do register. She suggested that over- or under-activity, especially in response to vestibular and tactile sensations, may manifest in gravitational insecurity (fear of movement, especially when not in the upright position), tactile defensiveness (fight, fright or flight reaction to light touch that most others would consider non-noxious) or a combination of both **(Ayres, 1979).**

ASDs represent an extensive category of conditions that had a variety of deficits. These deficits change considerably and vary from mild to severe. These children had problems with social communication, somatosensory, typical developmental patterns, mood and concentration. Perception, communication, sensory processing and neurological dysfunctions result in various functional behavior limitations **(Karim and Mohammed, 2015).** Sensory processing dysfunction is relatively familiar among children with ASD; ranging from 42% to 88%. Those children often have complexity in modifiable responses to sensations and specific stimuli. They may use self-stimulation to recompense for limited sensory input or to keep away from overstimulation **(Robert *et al.,* 2007).**

Many studies were conducted to determine the effectiveness of sensory integration program in children with autism in different aspects. Social interaction, sensory processing, functional motor skills, balance, and social–emotional factors improved after using SI interventions in children with ASD **(Pfeiffer *et al.,* 2011).** Other studies suggest that SIT might improve fundamental sensory-motor abilities, coordination abilities, nonverbal cognitive abilities, and visualmotor abilities. Also there is a marked improvement in communication and interaction skills **(Iwanaga *et al.,* 2014).**

Developmental delay among children with ASD can result in lack of physical activities. ASD makes it difficult to participate with peers due to behavior and social issues, so intervention programs must focus on this. There is a need that intervention programs must address not only muscle strength and functional activities but also must focus to minimize the child's stereotypical behaviors. The effects of different exercise and training programs have been studied to decrease stereotypic behavior among children with ASD **(Corvey *et al.*, 2016).**

Ferreira *et al.* (2018), evaluated that there is a decrease in symptoms of ASD after a physical exercise program and in stereotypic behavior following physical activities such as vigorous jogging **(Yeo and Teng, 2015).** The use of deep pressure is helpful in reducing symptoms of stress, and anxiety and improving the performance of school-going children. Other types of deep pressure comprise therapeutic brushing, weighted vest, hugging, squeezing, stroking, holding, and swaddling **(Bestbier and Williams, 2017).**

SI includes several activities as described by **Zhao *et al.*, (2005); Kashoo and Ahmad, (2019)** and **Chen *et al.*, (2020):**

(1) **Tactile perception**—e.g., experience with objects of different shapes, sizes and surfaces, tactile walkways and recognition of friends with eyes blindfolded.

(2) **Proprioceptive perception**—e.g., tracing of the body, "window game", pressure on body parts and identification of weight of known objects.

(3) **Vestibular perception**—e.g., activities on a gymnastic ball, balance board, swing, trampoline, climbing wall, rocking horse, practicing balance in various positions, standing on one leg, walking in sand or water or walking backwards.

(4) **Postural and ocular control and bilateral integration:** e.g., turning to the left and right, ball games, hitting a ball into a basket and target, training of head, neck and chest control in the central position.

(5) *Praxis*: e.g., ball games, for example throwing a ball with a leg, wheel barrow, swimming/drying, inchworm art, stick ball, stringing beads, touch boards, writing in different positions, tear art in the kneeling position, doing up buttons, tying knots, tracing and finger drawing.

Studies show that SIT has a major effect on behavioral problems in children with ASD.

Targeted behavioral problems in all studies and SIT intervention:

(1) Tactile-based:

- Hyperactivity, restless-impulsive, stereotypical and sleep problems (fussing, restlessness, crying, self-stimulating, number of time children left the bed) **(Escalona *et al.*, 2001)**.
- Emotional disturbances including depression, anxiety (fidgeting), muscle tensions, increase cortisol level and sleep disturbances **(Field *et al.*, 1997).**
- Inattentiveness (off-task behaviors), touch aversion, withdrawal, orienting to irrelevant sounds and stereotypical behaviors **(Field *et al.*, 1997).**

- Behavioral (restlessness, inattention and impulses ;) emotional (depress, mood changes) and physiological **(Khilnani *et al.*, 2003)**.
- Stereotypical behaviors, hyperactivity, inattention-passivity, anxiety, conduct problems and sleeping behaviors **(Piravej *et al.*, 2009).**
- Autistic behaviors, sensory and self-regulatory disturbances, digestion and sleep **(Silva *et al.*, 2009).**
- Stereotyped behavior; hand flapping, finger flicking and body rocking **(Davis *et al.*, 2011).**

(2) Proprioceptive based:

- Off tasks behaviors in the classroom; difficulties staying in own seat, difficulties staying in own seat, difficulty keeping eyes on teachers, boards or own work, needs frequent reminder to work on tasks and ask irrelevant questions or off topic questions **(Collins and Dworkin, 2011).**
- Stereotyped behaviors; Flicking objects, hand and finger mannerisms, echolalia, spinning objects, rocking and hand flapping **(Hodgetts *et al.*, 2011a).**
- Classroom off-tasks behaviors; looking away from the activity or not participating in the intended functional manipulation of materials related to activity, response appropriately to external prompts, difficulty sitting **(Hodgetts *et al.*, 2011b).**
- Attention to task (distractions of turning eyes or head away from tasks) and self-stimulatory behaviors (repetitive, stereotyped mannerisms such as rocking, spinning objects, twirling, arm flapping, gazing, tapping, hand biting, flickering ears, crossing eyes, rolling eyes, squinting or repetitive and monotonous vocalization) **(Fertel-Daly *et al.*, 2001).**

(3) Vestibular based:

- In-seat behaviors (participant’s buttocks in contact with the ball, the ball in contact with the floor) and engagement (oriented towards appropriate classroom activity or teacher and either interacting with materials, responding to speaker or looking at the speaker) **(Bagatell *et al.*, 2010).**
- Problem behaviors; aggression, pica, stereotypical (hand flapping, body rocking, finger posturing, noncontextual vocalizations), screaming or other inappropriate vocalization and property destruction (tearing, throwing, ripping) **(Jenkins and Reed 2013).**
- Out-of-seat behaviors; participants buttocks left contact with the seat and any chairs left contact with the floor **(Umeda and Deitz 2011).**
- Off-tasks-behavior; loss of visual orientation to activity or teacher, inappropriate manipulation of activity-related materials and failure to respond or provide verbal responses **(Umeda and Deitz 2011).**

SI for children with Cerebral Palsy:

CP refers to a group of non-progressive brain disorders. It is a group of permanent disorders of movement and posture causing activity limitation, which is attributed to non-progressive disturbances that occur in the developing fetal or infant's brain. It influences children's mobility, eyesight, learning, and reasoning. It can happen before, throughout, or within the first year of a child's life. It can occur up to the age of two years, as the maturation of the cortex occurs at the age of two years and CP affects the brain in an immature stage **(Gillani *et al.,* 2021).**

Clinical management of children with CP aims to promote efficiency and involvement in everyday activities while eliminating the impacts of a condition that might aggravate the illness, like seizures, eating difficulties, hip dislocation, and spinal deformity such as scoliosis. Some of the therapeutic methods include improving neurological functioning since the initial stages, reducing clinical co-morbidities, weakening, and hypertonicity, using rehabilitation techniques to restore functional ability, and minimizing subsequent muscular diseases **(Graham *et al.,* 2016).**

Several different approaches are used to treat cerebral palsy children like neurodevelopmental therapy (NDT), SIT, and hippotherapy. SIT is a clinical-based technique that emphasizes the therapist-child interaction and employs play-based sensory and motor exercises to promote sensation processing and integration. SIT appears to have significant potential as a treatment **(Randell *et al.,* 2019).** Occupational therapists use this technique to assist children to develop their sensory processing and integration so that they can respond appropriately to everyday stimuli **(Guardado and Sergent, 2022).**

Sensory processing is receiving, trying to organize, and interpreting data via sensory inputs (e.g., touch, smell, taste, sight, hearing, and vestibular) to create an appropriate reaction.

A study by **Mahaseth and Choudhary, (2021)** states that SIT improves a children's capacity to analyze and integrate sensory data by incorporating various visual processing, kinesthetic awareness, tactile awareness, visuomotor coordination development, and vestibular and proprioceptive activities.

Different interventions that are used in SIT are described by **Guardado and Sergent, (2022), Mahaseth and Choudhary, (2021),** and **Randell *et al.,* (2019)**:

(1) Visual processing tasks: Block designs, matching shapes in photographs, puzzles, identifying geometric forms and alphabets, numbers, and categorization.
(2) Body recognition: Indicating various body parts, life-size drawings, rolling right and left sides, and recognizing the body parts by touching.
(3) Tactile awareness: sense different textures, touch boards, and recognize shapes.
(4) Visual-motor coordination training Ocular-pursuit training, games using pegboards and moving balls.
(5) Proprioception Joint compression, ball squeezing, ball catching and throwing, wall push-ups.

SIT approach had also a considerable beneficial impact on gross motor functioning in children with CP. To enhance motor function, in each session, children were sustained on forearms and hands in sitting, quadruped, half-kneeling, and standing postures, with the OT (occupational therapist) assisting them unless tone attenuation was accomplished. After the child had achieved the ability to hold the training positions, a CP ball and tilt board were used to promote balancing and corrective reflexes. Ambulation practice (crawling, creeping, walking in a half-kneeling posture, and stepping on parallel bars) was provided at the appropriate motor stage of development **(Shamsoddini and Hollisaz, 2009).**

SIT had also effect on Balance and Gait by affecting the somatosensory, vestibular, and visual systems that are responsible for posture and mobility regulation. Children with C.P can develop their posture stability and motor abilities by getting specialized and appropriate sensory stimuli during therapy. As a result, their interaction might be improved with the environment and social participation **(Liao and Hwang, 2016).**

SI for rehabilitation of children with Down syndrome:

Down syndrome (DS) is the most widely recognized chromosomal abnormalities characterized by the presence of an additional duplicate of hereditary material on the 21st chromosome. DS composes the largest group in intellectual and developmental disabilities. Limitation in attention and motor skills is a common characteristic in children with intellectual disability. Intellectual disability is a condition of deficiency in brain development, which affects the attention as well as the motor skills. Children with DS have problems in attention and motor skills **(Nadkarni *et al.,* 2012).**

Attention is the first stage in information processing. It collects part of the environmental information for later processing. In fact, attention is an important component in learning and education. Children with DS have attention problems **(Hung *et al.,* 2016).** Motor skill development includes gross and fine motor skills and bilateral coordination. Delay in motor development is common in children with moderate to profound intellectual disabilities. These children usually have deficit or delay in motor skills that can lead to compelled immobility. This delay occurs in locomotion, balance, dexterity and practical skills such as working, playing games, and doing daily living activities. Furthermore, DS children have frequent problems in attention, motor activities, and sensory integration **(Gawali *et al.,* 2017).**

The SI is defined as the interpretation and organization of sensory information from the body and environment to make meaningful responses. When children with Down syndrome participate in sensory integration program, they show improvement in attention, motor skills & coordination, daily activities and quality of life **(Parhoon *et al.,* 2014).**

As described by **Sourtji *et al.,* (2009) ; Parhoon *et al.,* (2014) ; Karim and Mohammed; (2015)** and the content of sensory integration training program for Down syndrome:

- **Gross motor skills:** This activity or skill included big activities of body, like jumping, walking, catching and throwing, coordination among hands and feet, and going down and up the stairs.
- **Tactile:** This activity refers to information processing about body position, temperature and pain by the body skin. Essential sense material included finger painting and touchable materials.

- **Propriocetive:** This system processes information about the pressure of body and movements by receptors in ligaments, tendons, joints, tissues, muscles. Hand weight during walks, modeling clay, weighted blanket and stress ball are appropriate practices for this activity.
- **Vestibular:** This system processes data about mobility and balance through sensory receptors in the neck, eyes, inner ear and other receptors. Practices included spinet, tumbled, bouncing and rocking. Balancing board, swing, trampoline and therapy exercise ball are appropriate material for this activity.
- **Heavy work activities:** These activities included total body reactions such as moving, pulling, pushing, playing and lifting; using hands for pinching, squeezing and catching different materials, carrying objects like book and chair, twisting body, the use of balance board, bouncing and jumping, running and walking on soft or hard objects like sand, seesaw swing, sitting on a spinning chair and spinning toward right and left on low and high speed, playing with a heavy blanket at bedtime, ball play, rolling a ball on the floor at home **(Afrooz *et al.,* 2014).**

SI for rehabilitation of patients with Parkinsonism disease:

Postural instability is a key component of functional mobility, is often overlooked by both clinicians and their patients with Parkinson's disease (PD), who focus on gait impairments. However, balance problems and resulting falls are major factors determining quality of life, morbidity, and mortality in individuals with PD. All patients with idiopathic PD show progression of bradykinesia and rigidity that impairs postural control. However, later in the disease process, individual patients also show quite variable involvement of kinesthesia (proprioception), freezing of gait, decline of executive function and inflexible motor set that will result in a variety of types of mobility disorders among patients with PD **(Kerr *et al.,* 2010).**

Excessive, inflexible axial postural tone, called rigidity, results in many biomechanical impairments affecting postural control such as abnormally stooped (flexed) postural alignment, forward head, reduced joint range of motion, and low back pain. Stooped posture, due to excessive, static flexor muscle activity, is associated with increased velocity and jerkiness of postural sway in stance. Automatic postural responses to external displacements are also impaired by a stooped postural alignment **(Jacobs *et al.,* 2005).**

Automatic postural responses to unexpected external perturbations of the body's center of mass can be classified into feet-in-place and change-in-support strategies. In patients with PD, both types of postural response strategies are smaller and slower (bradykinetic) than normal. Patients with PD are also unable to quickly change postural muscle synergies with changes in initial support conditions, called inflexible "central set", for example, standing versus-sitting posture, holding versus-free stance, surface translation versus-rotation, and voluntary resist versus-relax **(Chong *et al.,* 2000).**

Central sensory integration involves active interpretation of visual, vestibular and somatosensory inputs for orientation of the body in space. When sensory information is unavailable or conflicting, a process of sensory reweighting occurs so the nervous system ignores ambiguous, unhelpful information and relies more on useful sensory information. For example, somatosensory input normally contributes 70% to postural stability when standing on a firm surface with eyes open but, but vestibular input contributes 100% to postural stability when standing on an unstable surface with eyes closed.30 Patients with advanced PD are often unable to stand on an unstable surface with eye closed, although their vestibular system is usually normal **(Jacobs *et al.*, 2009).**

Effective sensory integration training protocols and exercise-induced therapy improves postural stability for PD patients and benefits on overall brain health, including increased blood flow and trophic factors and a stronger immune system, also may help address the environmental need for neuroplasticity in the damaged brain **(Marxreiter *et al.*, 2013).**

REFERENCES:

Afrooz, G. ; S. Ghasemzadeh ; T. Taziki ; M. Mohajerani and M. Dalvand (2014). Effectiveness of sensorimotor interventions to increase the attention span of students with learning disabilities (Persian). J. Learning Disabilities. 4(1):23-37.

American Psychiatric Association.(2000). Diagnostic and Statistical Manual of Mental Disorders: DSM-IV (Vol.4). Washington, DC: American Psychiatric Association.

Anzalone, M.E. and E.A. Murray (2002). Integrating sensory integration with other approaches to intervention. Sensory integration: Theory and practice. 371-394.

Asher, A.V. ; L.D. Parham and S.Knox (2008). Interrater reliability of Sensory Integration and Praxis Tests (SIPT) score interpretation. Am. J. Occup. Ther., 62(3):308-319.

Ayres, A,J. (1972). Sensory Integration and Learning Disorders. Los Angeles: Western Psychological Services.

Ayres, A.J. (1979). Sensory Integration and the Child; Western Psychological Services: Los Angeles, CA, USA.

Bagatell, N. ; G. Mirigliani ; C. Patterson ; Y. Reyes and L. Test (2010). Effectiveness of therapy ball chairs on classroom participation in children with autism spectrum disorders. Am. J. Occup. Ther., 64(6):895-903.

Ben-Sasson, A. ; L. Hen ; R. Fluss ; S,A. Cermak ; B. Engel-Yeger and E. Gal (2009). A meta-analysis of sensory modulation symptoms in individuals with autism spectrum disorders. J. Autism and Developmental Disorders. 39:1–11.

Bestbier L, Williams TI.(2017). The immediate effects of deep pressure on young people with autism and severe intellectual difficulties: Demonstrating individual differences. Occup Ther Int. 1-7.

Bundy, A.(2002). Sensory integration: A. Jean Ayres' theory revisited. Sensory Integration: Theory and Practice (2):3-34. Philadelphia, PA: F. A Stephenson. Davis Company.

Case-Smith, J. and H. Miller (1999). Occupational therapy with children with pervasive developmental disorders. Am. J. Occup. Ther.,, 53(5):506-513.

Case-Smith, J. ; L.L. Weaver and M.A. Fristad (2015). A systematic review of sensory processing interventions for children with autism spectrum disorders. Autism. 19(2):133-148.

Cermak, S.A. and A. Henderson (1999). The efficacy of sensory integration procedures. Sensory Integration Quarterly. 18(1):1-5.

Chen, J. ; X.U. Chunxin ; L. Ding and S.R. Amp (2020). Effects of Different Patterns of Sensory Integration Training on Balance of Children with Cerebral Palsy. Chin. J. Rehabil. Med. 35:546–550.

Chong, R.K. ; F.B. Horak and M.H. Woollacott (2000). Parkinson's disease impairs the ability to change set quickly. J Neurol Sci 175(1):57-70.

Collins, A. and R.J. Dworkin (2011). Pilot study of the effectiveness of weighted vests. Am. J. Occup. Ther., 65(6):688–694.

Cook, D.G. and W. Dunn (1998). Sensory integration for students with autism. Educating children and youth with autism: Strategies for effective practice. 191-229.

Corvey, K. ; K.S. Menear ; J. Preskitt ; S. Goldfarb and N. Menachemi (2016). Obesity, physical activity and sedentary behaviors in children with an autism spectrum disorder. Maternal and Child Health J., 20: 466-476.

Davies, P.L. and W.J. Gavin (2007). Validating the diagnosis of sensory processing disorders using EEG technology. Am. J. Occup. Ther., 61(2):176-189.

Davis, T.N. ; S. Durand and J.M. Chan (2011). The effects of a brushing procedure on stereotypical behavior. Research in Autism Spectrum Disorders. 5(3):1053–1058.

Dunn, W. (2014). Sensory Profile 2: User's Manual-Strength Based Approach to Assessment and Planning. Psych Corporation.

Escalona, A. ; T. Field ; R. Singer-Strunck ; C. Cullen and K. Hartshorn (2001). Brief report: Improvements in the behavior of children with autism following massage therapy. J. Autism and Developmental Disorders, 31:513–516.

Ferreira, J.P. ; C.V. Andrade-Toscano ; A.M. Rodrigues ; G.E. Furtado ; M.G. Barros and R.S. Wanderley (2018). Effects of a physical exercise program (PEP-Aut) on autistic children's stereotyped behavior, metabolic and physical activity profiles, physical fitness, and health-related quality of life: A study protocol. Front Public Health. 6:47.

Fertel-Daly, D. ; G. Bedell and J. Hinojosa (2001). Effects of a weighted vest on attention to task and self-stimulatory behaviors in preschoolers with pervasive developmental disorders. Am. J. Occup. Ther., 55(6):629–640.

Field, T. ; D. Lasko ; P. Mundy ; T. Henteleff ; S. Kabat ; S. Talpins and M. Dowling (1997). Brief report: Autistic children's attentiveness and responsivity improve after touch therapy. J. Autism and Developmental Disorders, 27(3):333–338.

Gawali, P.P. ; S.S. Jain ; U. Yeole ; R. Adkitte and G. Gharote (2017). Gross motor deficits in cerebral palsy, autistic spectrum disorder, mental retardation, and Down syndrome children: A prevalence study. Saudi J. Health Sci., 6(1):19-22.

Gillani, S.F. ; A. Rafique ; M. Taqi ; M.A. Chatta ; F. Masood ; B.T. Ahmad and S.M. Awais (2021). Effectiveness of treatment in children with cerebral palsy. Cureus., 13(3): e13754.

Graham, H.K. ; P. Rosenbaum ; N. Paneth ; B. Dan ; J.P. Lin and D.L. Damiano (2016). Cerebral palsy. Nat Rev Dis Primers. 2(1):1-1.

Guardado, K.E. and S.R. Sergent (2022). Sensory Integration. StatPearls [Internet]. StatPearls Publishing, Treasure Island (FL). StatPearls Publishing.

Hodgetts, S. ; J. Magill-Evans and J.E. Misiaszek (2011a). Effects of weighted vests on classroom behavior for children with autism and cognitive impairments. Research in Autism Spectrum Disorders. 5(1):495–505.

Hodgetts, S. ; J. Magill-Evans and J.E. Misiaszek (2011b). Weighted vests, stereotyped behaviors and arousal in children with autism. J. Autism and Developmental Disorders. 41:805–814.

Hung, C.L. ; C,J. Huang ; Y.J. Tsai ; Y.K. Chang and T.M. Hung (2016). Neuroelectric and behavioral effects of acute exercise on task switching in children with attention-deficit/hyperactivity disorder. Frontiers in Psychol., 7: 1589.

Iwanaga, R. ; S. Honda ; H. Nakane ; K. Tanaka ; H. Toeda and G. Tanaka (2014). Pilot study: Efficacy of sensory integration therapy for Japanese children with high functioning autism spectrum disorder. Occup. Ther. Int., 21(1):4-11.

Jacobs, J.V. ; D.M. Dimitrova ; J.G. Nutt and F.B. Horak (2005). Can stooped posture explain multidirectional postural instability in patients with Parkinson's disease? Exp Brain Res 166:78- 88.

Jacobs, J.V. ; J.G. Nutt ; P. Carlson-Kuhta ; M. Stephens and F.B. Horak (2009). Knee trembling during freezing of gait represents multiple anticipatory postural adjustments. Exp. Neurol., 215(2): 334-341.

Jenkins, S.R. and F.D. Reed (2013). An experimental analysis of the effects of therapeutic horseback riding on the behavior of children with autism. Res. Autism Spectrum Disorders. 7(6):721–740.

Karim, A.E. and A.H. Mohammed (2015). Effectiveness of sensory integration program in motor skills in children with autism. Egyptian J. Med. Human Genetics, 16(4):375-380.

Kashoo, F.Z. and M. Ahmad (2019). Effect of Sensory Integration on Attention Span among Children with Infantile Hemiplegia. Int. J. Health Sci.13(3):29.

Kern, J.K. ; C.R. Garver ; T. Carmody ; A.A. Andrews ; J.A. Mehta and M.H. Trivedi (2008). Examining sensory modulation in individuals with autism as compared to community controls. Res. Autism Spectrum Disorders. 2(1):85–94.

Kerr, G.K. ; C.J. Worringham ; M.H. Cole ; P.F. Lacherez ; J.M. Wood and P.A. Silburn (2010). Predictors of future falls in Parkinson disease. Neurology 75(2):116-124.

Khilnani, S. ; T. Field ; M. Hernandez-Reif and S. Schanberg (2003). Massage therapy improves mood and behavior of students with attention-deficit/hyperactivity disorder. Adolescence. Adolescence-San Diego. 38:623–638.

Koziol, L.F. ; D.E. Budding and D. Chidekel (2011). Sensory integration, sensory processing, and sensory modulation disorders: Putative functional neuroanatomic underpinnings. The Cerebellum, 10(4):770-792.

Kranowitz, C.S. (1998). The out-of-sync child: Recognizing and coping with sensory integration dysfunction.

Lane, A.E. ; R.L. Young ; A.E.Z. Baker and M.T. Angley (2010). Sensory processing subtypes in autism: Association with adaptive behavior. J. Autism and Developmental Disorders. 40:112–122.

Liao, H.F. and A.W. Hwang (2016). Relations of balance function and gross motor ability for children with cerebral palsy. Percept Mot. Skills. 96(3):1173-1184.

Linderman, T.M. and K.B. Stewart (1999). Sensory integrative–based occupational therapy and functional outcomes in young children with pervasive developmental disorders: A single-subject study. Am. J. Occup. Ther., 53(2):207-213.

Mahaseth, P.K. and A. Choudhary (2021). Sensory integration therapy verses conventional physical therapy among children with cerebral palsy on gross motor function - a comparative randomized controlled trial. Ann. Romanian Soc. Cell. Biol., 17315:34.

Marxreiter, F. ; M. Regensburger and J. Winkler (2013). Adult neurogenesis in Parkinson's disease. Cell Mol Life Sci. 70:459–473.

Moore, K.M. and A.D. Henry (2002). Treatment of adult psychiatric patients using the Wilbarger protocol. J. Health Psychol. 18(1):43-63.

Nadkarni, S. ; S. Sumi and D. Ashok (2012). Enhancing eye-hand coordination with therapy intervention to improve visual-spatial abilities using 'The Retraining Approach in children with Down syndrome: Three case studies. Disability, CBR and Inclusive Development 23(2):107-120.

Parham, L.D. and Z. Mailloux (2001). Sensory Integration. Case-Smith J, editor. Occupational Therapy for Children. St. Louis Mosby. 329–81.

Parhoon, K. ; H. Parhoon and G. Movallali (2014). Effectiveness of training sensory stimulation on gross motor skills of 5-7 years old children with Down syndrome. Int. J. Acad. Res. Psychol., 1(1):18-27.
Pfeiffer, B.A. ; K. Koenig ; M. Kinnealey ; M. Sheppard and L. Henderson (2011). Effectiveness of sensory integration interventions in children with autism spectrum disorders. A pilot study. Am. J. Occup. Ther., 65(1):76-85.
Piravej, K. ; P. Tangtrongchitr ; P. Chandarasiri ; L. Paothong and S. Sukprasong (2009). Effects of Thai traditional massage on autistic children's behavior. J. Alternative Complementary Med., 15 (12): 1355–1361.
Randell, E. ; R. McNamara ; S. Delport ; M. Busse ; R.P. Hastings and D. Gillespie (2019). Sensory integration therapy versus usual care for sensory processing difficulties in autism spectrum disorder in children: Study protocol for a pragmatic randomised controlled trial. Trials. 20(1):113 doi: 10.1186/s13063-019-3205-y
Reisman, J.M. and S. Ribordy (1993). Principles of Psychotherapy with Children. Simon and Schuster. 312 pages.
Robert, J.E. ; T.L. King and M.L. Boccia (2007). Behavioral indexes of efficiency of sensory integration therapy. Am. J. Occup. Ther., 61(5):555–562.
Rogers, S.J. and S. Ozonoff (2005). What do we know about sensory dysfunction in autism: A critical review of the empirical evidence. J. Child Psychol. and Psychiatry. 46(12):1255–1268.
Schaaf, R.C. and L.J. Miller (2005). Occupational therapy using a sensory integrative approach for children with developmental disabilities. Mental Retardation and Developmental Disabilities Res. Rev., 11(2):143–148.
Schaaf, R.C. and K.M. Nightlinger (2007). Occupational therapy using a sensory integrative approach: a case study of effectiveness. Am. J. Occup. Ther., 61(2):239–46.
Shamsoddini, A.R. and M.T. Hollisaz (2009). Effect of sensory integration therapy on gross motor function in children with cerebral palsy. Iran J. Child Neurol. 03:43-8.
Silva, L.M. ; M. Schalock ; R. Ayres ; C. Bunse and S. Budden (2009). Qigong massage treatment for sensory and self-regulation problems in young children with autism: A randomized controlled trial. Am. J. Occup. Ther. 63(4):423–432.
Smith, S.A. ; B. Press ; K.P. Koenig and M. Kinnealey (2005). Effects of sensory integration intervention on self-stimulating and self-injurious behaviors. Am. J. Occup. Ther. 59(4):418–425.
Smith, T. ; D.W. Mruzek and D. Mozingo (2015). Sensory Integration Therapy. Controversial Therapies For Autism And Intellectual Disabilities: Fad, Fashion, And Science In Professional Practice. 247-269.

Sourtji, H. ; A.H. Sazmand ; A. Karbalaei-Nori and H. Jadidi (2009). [Effect of Sensory Integration Therapy on Gross and Fine Motor Skills of 5-7 Years Old Children with Down Syndrome. Archives of Rehabilitation. 9(2):35-41.

Umeda, C. and J. Deitz (2011). Effects of therapy cushions on classroom behaviors of children with autism spectrum disorder. Am. J. Occup. Ther., 65(2):152–159.

Watling, R.L. and J. Dietz (2007). Immediate effect of Ayres's sensory integration–based occupational therapy intervention on children with autism spectrum disorders. Am. J. Occup. Ther., 61(5):574–583.

Yeo, K.J. and K.Y. Teng (2015). Social skills deficits in autism: A Study among Students with Austim Spectrum Disorder in Iinclusive Classrooms. Univ. J. Educ. Res., 3(12):1001-1007.

Zhao, Y. ; J.P. Dong ; X.J. Wang ; J.T. Wang and Z.M. Liu (2005). Application of sensory integration in central coordination disorder. Zhongguo Linchuang Kangfu. 9:110–111.

دور التكامل الحسي في إعادة تأهيل المرضى ذوي الإعاقة: مقالة مرجعية

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تم تطوير نظرية التكامل الحسي (SI) في الأصل بواسطة جان أيريس للتركيز على المعالجة العصبية للمعلومات الحسية. تم إستخدام العلاج التكاملي الحسي (SIT) أو نهج SI لعلاج الأطفال متحدّي الإعاقه منذ السبعينيات. ويستند إلى فهم أن التدخلات في المعالجة العصبية وتكامل المعلومات الحسية تعطل بناء السلوكيات الهادفة. وفقًا لأيريس، لا تتم معالجة المعلومات الحسية بمعزل عن غيرها، ونظرًا لهذه الميزة الأساسية للجهاز العصبي المركزي، فإن التدخل العلاجي الذي يتضمن الإحساس للتأثير على الإدراك متعدد الحواس سيؤثر على التعلم والسلوك. إقترحت أيريس (1972) أنه من خلال تطوير هذه الوظائف الحسية الحركية، وعلى وجه التحديد من خلال تسهيل الإستجابات الحركية الجسدية التكيفية يمكن للشخص تطوير التعلم والقراءة والرياضيات والإدراك البصري والسمعي والمهام الحركية التي تتطلب مهاره.

تم تصميم العلاج لتوفير تجارب حسية يمكن التحكم فيها بحيث يتم إستثارة الإستجابة الحركية التكيفية. تتمثل أهداف العلاج في تحسين التعديل الحسي المتعلق بالسلوك والإنتباه وزيادة التفاعلات الإجتماعية والمهارات الأكاديمية والإستقلال من خلال تحسين التكامل الحسي. تهدف الأنشطة المقدمة إلى مساعدة الجهاز العصبي على تعديل وتنظيم ودمج المعلومات من البيئة، مما يؤدي إلى إستجابات تكيفية مستقبلية.