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Proprioception Impairment and Treatment Approaches in Pediatrics

Kamatchi Kaviraja

Abstract

In children problems like trauma and injuries are quite obvious. Other problems related to sensory system dysfunction are identified at the later stages of the child due to lack of awareness of the sensory integration problems which is not obvious. Some children have behavioral problems and some are poor at the school which is related to each other finally cause trouble to perform their daily routine. Early identification and intervention play a major role in improving the ability and development of the proprioceptive senses. Hence this chapter will introduce the new aspect of proprioception sense and its dysfunction. It would enhance you to identify the problems and understand the challenges that the child come across due to increase or decrease in proprioceptive input. We will be able to help them to overcome these challenges and frame a treatment strategy and help them to lead a successful life.

Keywords: proprioceptive dysfunction, sensory integration, gravitational insecurity, postural insecurity, modulation

1. Introduction

It is important to learn about the 7 senses. We all are familiar with the five senses and the other 2 senses are the Vestibular sense of balance, movement and Proprioception body position sense. By integrating, or combining all the information we get from our senses, we can 'make sense' of the world around us and successfully move through and interact in our world [1].

Proprioception is a continuous loop of feedback between sensory receptors throughout your body and your nervous system. Proprioception, also called kinaesthesia, is the body's ability to sense its location, movements, and actions. Children who are clumsy, uncoordinated, and sensory seeking are often experiencing proprioceptive dysfunction. The following are common signs of proprioceptive dysfunction:

- Sensory Seeking (pushes, writes too hard, plays rough, bangs or shakes feet while sitting, chews, bites, and likes tight clothes)
- Poor Motor Planning/Control and Body Awareness (difficulty going up and down stairs, bumps into people and objects frequently, difficulty riding a bike)
- Poor Postural Control (slumps, unable to stand on one foot, needs to rest head on desk while working)

These children often self-regulate by engaging in behaviors that provide proprioceptive input such as toe walking, crashing, running or flapping. Heavy work or tasks that involve heavy resistance and input to the muscles and joints is essential to regulating proprioception [2].

Children that have difficulty sensing or processing proprioception often try to self-regulate by engaging in activities and/or behaviors that provide intense or frequent proprioceptive input [3].

Sensory Processing/Sensory Integration is when our different sensory systems work together to process different sensations from our body and/or environment. So, we are able to identify and give meaning to the different sensations we experience to accomplish daily activities and move in a coordinated manner. **Sensory Processing Disorder** is the inability to receive and efficiently use sensory information. Difficulty in processing sensory information interferes in our daily activities and impacts our functional ability to perform different tasks [4].

Benefits of sensory integration therapy may include: [5]

- Modulation of sensory systems
- Self-regulations
- Improved function in school, home and community
- Improved independence with activities of daily living (ADL)
- Maximized functional ability to perform daily and recreational activities
- Enhanced motor planning ability
- Active involvement and exploration of environments
- Efficient organization of sensory information

Assessment and intervention should explicitly focus on links among self-regulation, social participation, skills and perceived competence to address parents' expectations [6].

Interventions are proposed that relate to children's participation in contexts in which they live, learn, and play as well as the support of parents in the occupation of parenting [7].

Parents usually understand their child better than anyone else. They play an important role during the intervention and throughout their life time. I hope this chapter would enhance them to understand and give a clear picture of the child who have difficulty with proprioception dysfunction. The concept of this chapter comes from a body of work developed by A. Jean Ayres, PhD, OTR. This theory has been further developed and refined by the research of Dr. Ayres, and other occupational and physical therapists.

2. Proprioception impairment and treatment approaches in pediatrics

2.1 Proprioception

Proprioception refers to the sense of relative position and movement of the limbs and body. The mechanoreceptors embedded in the joint muscle, tendon and skin provides the proprioceptive information [8].

For good control of the muscle and voluntary movement proprioception is required. In pediatric conditions like CP, autism, Downs syndrome and development disorders it is always associated with proprioceptive deficits and hence the movement control is affected [9].

Proprioception provides ability to move. if there is any deficit in proprioception, our body movements would become slower, difficult and require more effort to perform a movement.

Processing of proprioception occurs:

| | | |
|------------|-----------------------------|--|
| CNS | The spinal level | The proprioception detects changes in the length and tension of the muscle and provides a stream of information to the cerebellum. |
| | Cerebellum | This information integrates with vestibular information. ↓ This contributes to postural control and a sense of gravity. |
| | Somatosensory Cortex | The proprioception information is integrated with the tactile system through dorsal column medial lemniscal pathway. |

Proprioception always integrates with tactile and vestibular system [10].

Sherrington has the first studies on these topics in 1906, he has been established that muscle spindles are a major source of proprioceptive feedback to the central nervous system and appear to mediate the conscious perception of movement and limb position for the proprioceptive information [11].

The development steps:

| | |
|-------------------------|---|
| 1 Month | The newborn will interpret some of his body sensations and respond with built in reflex movement respond to <ul style="list-style-type: none"> • Gravity and movement • Muscle and joint sensation • Sound • Smell & taste • Touch |
| 2 & 3 Months | <ul style="list-style-type: none"> • Eyes and neck motor functions • Grasping • Raising up |
| 4 to 6 Months | <ul style="list-style-type: none"> • Arms & hands movements • Airplane position • Recognizes the moving and loved to be moved |
| 6 to 8 Months | <ul style="list-style-type: none"> • Locomotion • Spatial perception • Finger and eyes • Motor planning • Babbling |
| 9 to 1 Months | <ul style="list-style-type: none"> • Play • Standing up • Words |
| 2 Years | <ul style="list-style-type: none"> • Localization of touch • Moving • Mapping the body • Climbing • Self-hound |
| 3rd to 7th Year | By 5 years the child becomes mature sensorimotor being. |

The important age of development of sensory integration after birth is from 1st month to 7 years. Sensory stimulation, motor activity and exposure to environment during the early childhood have a great influence on the neurons and major role in the development of sensory and motor processes [12, 13].

2.2 Role of sensation

Sensations play a vital role in giving sensory input and information to the CNS. Every sensation is a type of information from the nervous system to produce a response and control the body and mind to the given information with a good amount of sensation or the sensory input is necessary for the development of the nervous system (**Figures 1–5**) [2, 14].

| |
|--|
| INTEROCEPTORS - Sensation which gives information about the inside of the body |
| ↓ |
| Visceral Sense |

3. The process of sensory integration

Proprioception sense which is provoked by getting the information from contraction and stretching of the muscles, pulling and compression of the joints between bones.

The sensation from one's own body which occurs during movement both during static and dynamic and which always sends information to the brain about position is the proprioceptive sense [8].

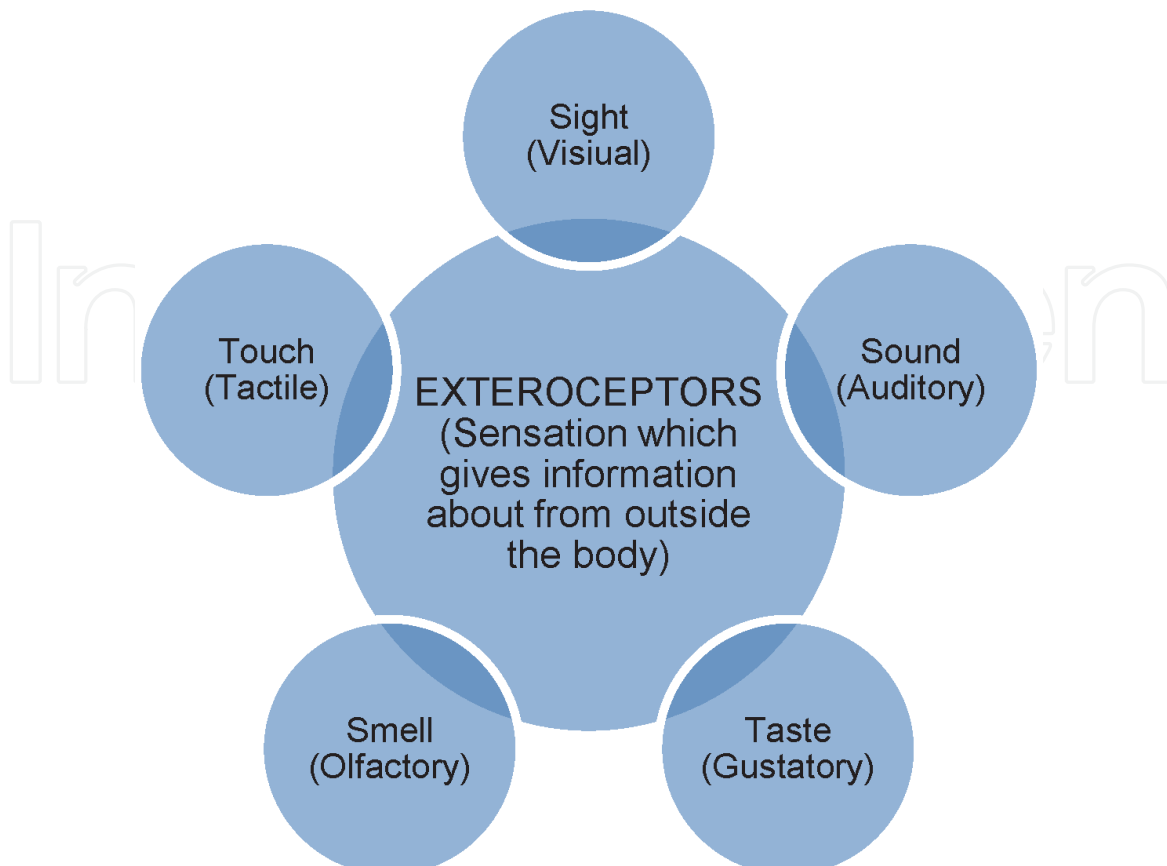


Figure 1.
Exteroceptors.

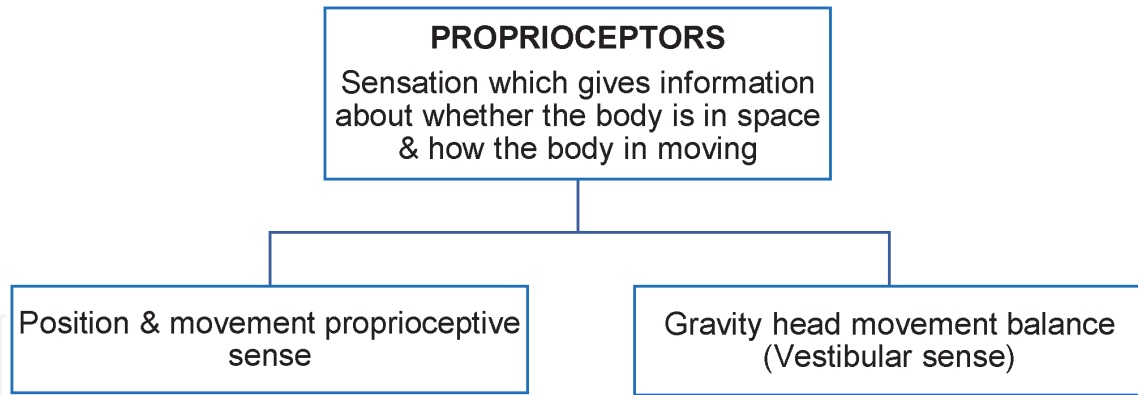


Figure 2.
Proprioceptors.

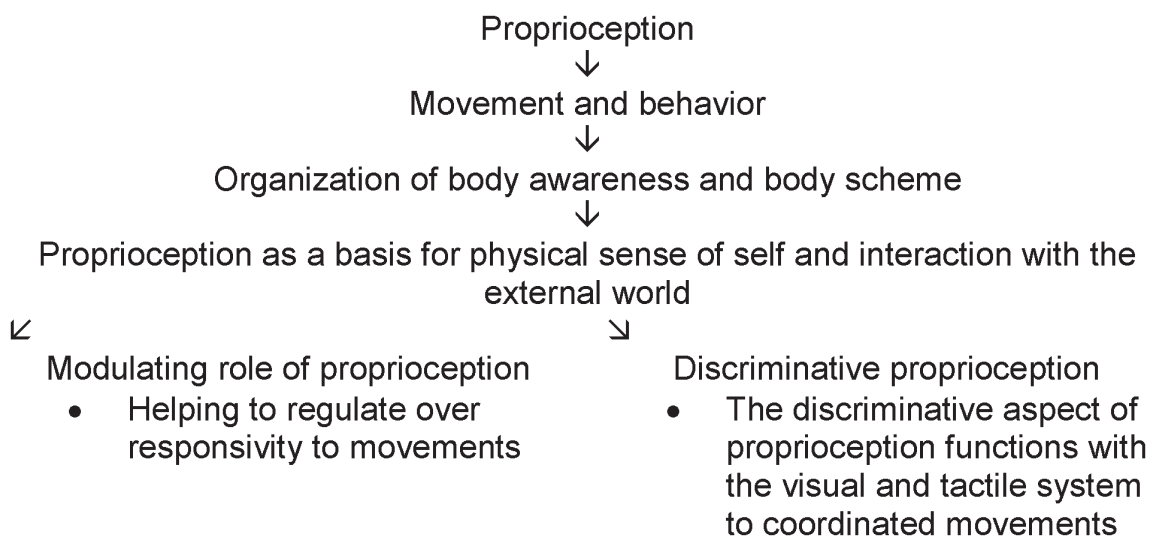


Figure 3.
Functions of proprioception.

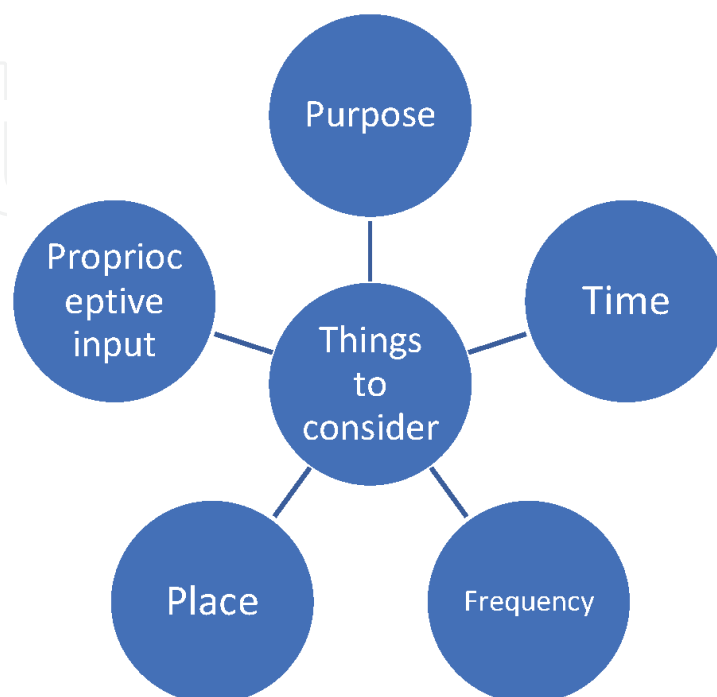


Figure 4.
Things to be consider.



Figure 5.
For parents.

Proprioception is the unconscious awareness of the body in space or at resting position. The somatosensory system plays a major role in the sensory integration.

- The motor execution depends on somatosensory feedback.
- Important for body balance and praxis
- Important for reticular activating system.
- Important for the development of muscle tone.

Proprioception helps us to move. When proprioception is affected the child finds it difficult to perform the normal movement. The child finds it difficult to walk, clumsier, slower and must give more effort to perform the normal movement [15].

Any deficit or problem in the proprioception will lead to sensory integration dysfunction.

Causes,

- Hereditary factors
- Developmental disabilities
- Chemical factors

Due to lack of awareness about the neurological deficit, the parents will not be able to identify the problems or the difficulties faced by the children. They will not be able to analyze the learning and the behavioral problems are due to the sensory issue.

Sometimes lack of opportunities to play and explore and sometimes lack of interaction with the environment can also lead to these types of sensory seeking or sensory deficit in children.

It is always the responsibilities of the parents to give the child the required “sensory diet”. Sensory diet is the required amount of sensory input that the child can gain from interacting with the surrounding and peer groups through playing etc. and explore new ideas and techniques to play and enjoy.

3.1 Functions

The modulating influence of proprioception over the senses appears to occur at the level of cerebellum, thalamus and somatosensory cortex [16].

4. Proprioceptive dysfunction

- Sensory seeking
- Poor motor planning/Control and body awareness
- Poor posture control
- Balance affected
- Uncoordinated movement
- Clumsiness.

The deficit associated with proprioceptive system.
The under reactivity to typical sensory stimuli:

- Hypo responsivity to proprioceptive input
- Usually exhibit hypo responsivity to touch
- Always seeks proprioceptive input to regulate or maintain state of arousal

Both over responsivity and under responsivity. Both extremes may occur in the same children [2].

- Gravitational in severity, Vestibular proprioceptive disorders
- Proprioceptive sensitivity.

4.1 Sensory diet

“The daily total of sensorimotor experience needed by a person to adaptively interact with the environment”.

Sensory diet is for the self-regulation. The importance of the proprioceptive system in to give a person with information on how far to reach, how much pressure, where we are in space, to learn about body schema. It involves movement, compression and stretching at a joint.

Ayres conceptualized SPD as a disorder of body scheme in which children misperceive their immediate space and their surrounding space. She believed that therapy based on a “sensory integration approach” would normalize the spatial perceptions from multiple sensory systems and contribute to successful participation in daily life activities [17, 18].

Several authors have reported on the motor control difficulties related to poor proprioceptive processing among children with ASD, including decreased postural control and motor planning, overreliance on proprioception, difficulty matching proprioception with vision during reach, decreased organization of space, and poor motor anticipation [19, 20].

5. How to give proprioceptive input

Proprioceptive input can be given in two different ways one is calming and other is excitatory.

Calming activities is usually given to child who is over aroused.

Excitatory proprioception inputs are given to under arouse and the excitatory input should increase arousal state of the child.

It is important to assess the child's current state of arousal state of the child.

It is important to assess the child's current state of arousal.

Proprioception always woks along with the vestibular system which has a great influence and effect on the child behavior of the child.

Heavy work activities activate proprioceptive receptors

1. A big ball pit, bean bag, rolling up with blankets and pillows, jumping on bed
2. Trampoline jumps gives a great proprioceptive input
3. Wheel barrow walking
4. Pushing and pulling activities
5. Tight hugs, deep pressure

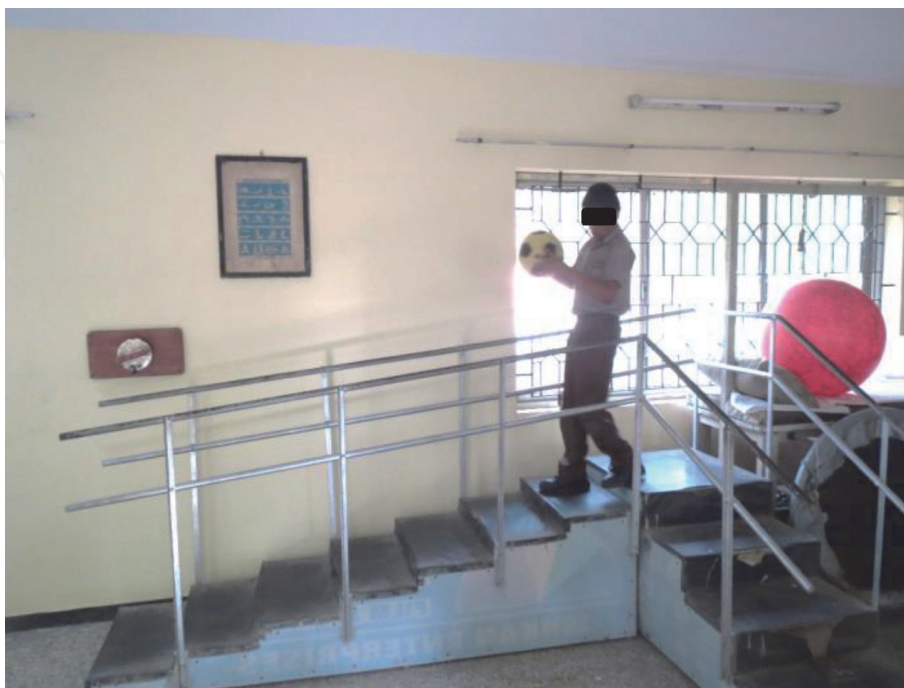


Figure 6.
Staircase walking with a ball. Ask the kids to climb up & down the stairs holding the ball for about 10 minutes 5 times followed by 1 minute rest 2 sets a day for 2 weeks.

6. Hand push, pull, compression
7. Wall pushes, star jumps
8. Squeezing a ball
9. Staircase walking with a ball (**Figure 6**)
10. Climbing wall bars, ropes
11. Throwing and catching weighted balls
12. Obstacle walking and crawling
13. Balance board activities (**Figure 7**)
14. Passing the ball (**Figure 8**)
15. Tug of war



Figure 7.
Balance board activities. Ask the kid to step on the balance board 8–10 minutes first with support and then without support then to reaching activity twice a day 2–3 weeks.



Figure 8.
Passing the ball. Ask the kid to pass the ball by kicking 10–15 minutes twice a day for 2–3 weeks.



Figure 9.
Horse riding. Ask the kid to sit comfortably and start rocking 10–15 minutes twice daily for 3 weeks.

6. Oral activities

1. Chewing
2. Blowing balloons

3. Blowing bubbles
4. Blowing small ball along a table
5. Oral massages

First can give full body movements.

- Frog leaps
- Horse riding (**Figure 9**)
- Crab walking
- Gorilla jumping
- Somersaulting
- Yoga

Continue with heavy workout

- Bear walks
- Cheetah runs
- Elephant stomp

The animal theme is a wonderful creative outlet and we can encourage the child to make animal sounds and gestures.

- Scooter board (**Figure 10**)
- Crawling on all fours
- Crushing activities
- Swiss ball activities (**Figure 11**)

The points to consider for giving proprioceptive input

- The purpose is to decide whether the activity to be given should stimulate an under responsive or sensory seeking.
- Secondly to identify the trigger points and suitable time to engage the child. We should identify when the child will get distracted.
- We should observe the child and analyses when she/he reach the calm alert state. This will help us to identify how long and how often activities should be given.
- Activities which can be done with parents at home can be taught to parents and the activities can be scheduled. Some activities like wall pushes, squeeze object, jumping etc.



Figure 10.
Scooter board. Ask the kid to go for prone lying and using the hand pushing backwards to propel forward. 10–15 minutes twice daily 3–4 weeks.



Figure 11.
Swiss ball activities. Ask the kid to sit on the swiss ball & then bouncing followed by reaching activities 8–10 minutes twice daily 2–3 weeks.

- Therapy based exercise.
- Using a SI unit with various textures and different kind of swings and mirrors to provide a visual feedback and the child can receive a maximum amount of proprioception input from the environment or the therapy room where it is well prepared for the child to receive the inputs.

The parents should try to analyse the behavior and the adaptive response that the child reacts or any changes which takes place before and after the therapy.

More often the sensory issues are mistaken for behavioral issue. The children always struggle with proprioceptive difficulties either hyperactive or decreased arousal level to perform their daily living activities.

First and foremost, the patient should analyse and whether the child avoid the proprioception inputs or seeking for proprioceptive input.

The parents should analyze and understand. If the child avoids the proprioceptive inputs

- Always the child will be lethargic
- Always tries to sit in a place
- Condition like autism the child will not have eye contact or social interaction
- The child will avoid physical activities
- Lack of coordination
- Inability to perform sports activities, climbing ladder and ropes
- Develops poor body posture

If the child seeks proprioceptive input

- The child always jumps and runs around
- Always on the move
- Aggressiveness
- Biting, kicking, hitting, pushing
- Always wants to chew and bite objects

A prolonged and multidimensional care is needed for the children [15].

There should always be an interaction between teacher, parent and therapist.

Sensory activities like deep breathing exercise with vital support. Sensory supports can be given with weighted blankets [21].

Assessment plays a major role in the development of the child integration. It is important to be aware of the assessment and evaluation required for the correct diagnosis for the child.

Therapist plays a major role to diagnose and to give the sensory integration Intervention.

- Identification of sensory integrative deficit
- Documentation of the level of function of the child
- Appraisal / reappraisal changes based on the outcomes
- Perform an informal assessment then with formal assessment the sensory integration and praxis tests “gold standard” for evaluating sensory integration and praxis functions.

SIPT is a standardized assessment tool with normative data for age limit 4–0 to 8–11 of age.

Some of the clinical outcome measures

1. OTA- Watertown clinical assessment which helps us to observe and examine sensory modulation and sensory discrimination.
2. Sensory profile (Dunn, 1994, 1999) Screens for SI dysfunction by assessing sensory responsiveness.
3. Sensory Integration Inventory (Rev. ed) (Reisman and Hansches, 1992) this screens for SI dysfunction.

7. Conclusions

Several studies have found evidence that children with sensory processing disorder can gain more insight into their development by assessing and providing an exact intervention at their right age and time. I hope this chapter would help out the parents to analyze the difficulties the children go through and guide them in the right path.

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Conflict of interest

Nil.

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