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Prevention and treatment of behavioural and learning disorders with sensory integration therapy

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Sensory integration disorders, which are often hidden in the background of learning and/or behavioural disorders, can cause serious difficulties in the daily activities of the students, in the implementation of learning and/or behaviour. Upon hearing the term 'sensory integration', two interpretations appear in the minds of professionals. On interpretation refers to the integration, sensory interconnection coordination and interdependence of sensory systems as a typical, neurological maturation process that provides the basis for subsequent learning and behavioural organisation processes. Based on a second interpretation, 'sensory integration' is a therapeutic methodology, diagnostic, and therapeutic procedure that provides assistance to people who are lagging behind in the maturation of sensing systems and perception processes. Learning and/ or behavioural disorders can be caused by impaired information acquisition processes, sensory modulation, and integration in the nervous system. The following study comprehensively presents the diagnostic process and the relationship between the learning and behavioural differences related to sensory integration disorders

Keywords: learning disabilities, behavioural disorders, nervous system, information processing, sensory integration, neuroplasticity, sensory integration therapy

Introduction

In the rapidly changing world around us, constant adaptation, quick recognition of opportunities, adequate modification of our behaviour, and the continuous renewal of knowledge are necessary skills. Children face the need to acquire these competencies as soon as they enter school; as they age, this progress becomes more and more intense. In addition, we can conclude that even with the most dynamic and modern curriculum development, it is not possible to learn everything in school that an individual will need throughout his or her adult life. This finding has led to the realisation that, in addition to knowledge transfer, our schools need to emphasise skills and prioritise their development. As a third step after information transfer and skill development, modern pedagogy has now come to realise the importance of devoting time and energy to underscoring the role of non-cognitive factors related to knowledge and experience. Given its support of knowledge acquisition, we consider such a psychological factor

as essential for the development of a child's need to acquire knowledge, shape knowledge-related values, teach children different ways of acquiring knowledge, and discover their surrounding environment for themselves, while also becoming active participants and creators (Csapó, 2002).

The transformation of public education, the shift of the school system towards a skills-developing, child-centred school, and the social program of ensuring equal opportunities point in the direction of increasing diagnostic needs (Gereben, 2004). This statement is subsequently true in the treatment of students with behavioural issues: after a comprehensive diagnosis of the child and the exploration of his/her bio-psycho- and social background, a personalised, individual development plan is prepared in each case.

This work is facilitated by the development of diagnostic methods originating from the knowledge system of clinical special education, which has started to develop dynamically in recent years. The greatest momentum driving this development lies in the multifaceted research conducted in the field of cognitive psychology. The subject of cognitive psychology is the study of cognition, that is, the learning process as it occurs in the broadest sense. To use the metaphor of a computer's operating system, it introduces the cognitive person as an information processing system. To simplify the term, cognition can be understood as the sequence of the following three main processes that both overlap and increase by level: 1) the senses absorb information; 2) visual, acoustic, tactile, spatial perception abilities evaluate and decode these stimuli; 3) stimuli are interpreted with the help of higher-order cognitive functions and integrated into the system of existing knowledge, i.e., an internal representation of knowledge is created.

Cognitive therapies help to make this processing procedure as perfect as possible. In a broad sense, cognitive therapy is a procedure that, in contrast to automatically processing events, teaches clients to focus on the information of a given situation, thereby attempting to reduce reliance upon erroneous assumptions and schemes. During the therapeutic process, a dynamic 'behavioural correction' function steps into place that is capable of self-regulation and helps the client overcome new problems independently, thus enabling the improvement of problem-solving skills (Zsoldos, 2004). A number of cognitive developmental therapies have emerged, including Marianne Frostig's Visual Perception Development Program (Frostig, 1978), Felice Affolter and Heide Helstab's Perception Development Procedure, Brigitte Sindelar's Cognitive Developmental Program, and Jean. A. Ayres Sensory Integration Therapy (Ayres, 1979a).

Sensory integration disorders and their therapy

The phylogeny of the development of the sensory integration method

The dual meaning of the term sensory integration can be interpreted as follows. On the one hand, we can define it as all perceptual processes and their neural coordination that are based on neurological and neuropsychological processes which ensure the organisation of adequate behaviour that adapts to the environment. In the course of sensory integration, information acquired through

sensory organs, the neural processes of perceptual and information processing, and the planning and execution processes of these units are connected. The process of sensory integration is therefore essential to each of our everyday activities, be this playing, learning, speaking, the world of work, or even taking care of ourselves (Schaefgen, 2002a). On the other hand, the term 'sensory integration' also refers to a therapeutic practice in which the client is examined and the process of therapeutic treatment occurs when the client is disturbed to such an extent that it manifests as a disorder in the individual's day-to-day activities. Both terms are the result of the professional activity, research, and therapeutic practice of American occupational therapist and psychologist Anna Jean Ayres. She was the creator of the term 'sensory integration' and the associated therapeutic procedure (Ayres, 1979a). A. Jean Ayres defined the term sensory integration as 'the neurological process that coordinates the functioning of our interior and the outside world and allows our bodies to function effectively by adapting to the environment' (Ayres, 1979b, p.17). Rega Schaefgen, one of the German followers of Ayres' therapeutic work, described the essence of the process of sensory integration as 'the most efficient way of acquiring and processing information that is necessary for our daily activities' (Schaefgen, 2000, p. 21).

Based on spatial and temporal differences in incoming information, different sensory modulations are activated, coordinated, and connected. Sensory integration can be interpreted as a way of processing sensory information. In Ayres' professional view, the processes of proprioception are the basis of complex perceptual processes. As a fundamental finding, she stated that the areas of vestibular, tactile, and proprioceptive perception do not receive sufficient emphasis on the part of doctors and educators in connection with the development of children. Thus, the starting point of her professional research was that she situated these sensory areas in the focus of her work based on the understanding that neural processing methods are fundamentally decisive in the organisation and execution of human behaviour (Ayres, 1979b),

Ayres developed a standardised test (Southern California Sensory Integration Test / SCSIT/) to support her research as well as the development of her theory. Each test task measured and evaluated a neuropsychological function. However, the measurement of visual and tactile functions was associated with specific motor functions. In this test, Ayres used the method of factor analysis to develop a nomenclature for sensory functions or dysfunctions. Later, when SCSIT came under revision, using the group-building method a new test (Sensory Integration and Practice Test / SIPT) was used to group children based on similar test profiles (Fisher et al., 1999).

One of the most important professional issues in connection with therapy is the behaviour, participation, and activity of the therapist during the sessions. In Europe, Sweden, and Germany, the motivational factor is primarily the person of the therapist who instructs, for example, the usage of the sensory devices. According to the American practice, the child is instead motivated to use the sensory devices. In this latter approach, collaboration with the therapist is a less important factor, but in both cases the goal is the same: to improve function (Schaefgen, 2006).

Based on the researchers who continue the work of Ayres, the main findings found in connection with the theory of sensory integration have been summarised in Chart 1 (Roley et al., 2004; Reményi et al.,, 2014, p. 299).

Chart 1

Main findings of Ayres' followers (Roley et al., 2004; Reményi et al., 2014, p. 299)

1. Neuroplasticity	The genetic and biological endowment of the nervous system that is capable of transformation and develops and forms via interactions with the environment.
2. The 'top-down' and the 'bottom-up' processes	In a complex integrative system of the nervous system, the integration of cortical and subcortical information is a back-and-forth process in which subsystems are built and to which regulatory mechanisms are attached. The appropriate activity and implementation is created as a result of the two systems' cooperation.
3. Behaviour organisation and regulation	The individual is in constant interaction with the environment. Changes in the environment and opportunities for cooperation together develop the ability to respond appropriately. A sensory-matched integrated central nervous system regulates and directs our behaviour.
4. The structure of the central nervous system	The reactions of our body are triggered and shaped by changes in our external and internal environment around and within us. Activated nervous system structures form their function. The creation of this is influenced by individuality, the social context, and sensory and motor experiences. Together, these form the process of sensory integration and activity and execution.
5. Implementation process and the learning process	The process of carrying out an activity is determined by the individual and his/her previous experiences. Based on this, sensory integration can be shaped within biologically determined boundaries according to the concept of learning theory.
6. Motivation	Sensory and motor activity are generated in response to environmental changes. Proper integration of sensory information in performing the right activity is responsible for creating the right behaviour. Upon success, this tried- and-tested method of integration is stored and incorporated into the functioning structure and function of the nervous system.

Based on Chart 1, some experts believe that these disorders fall somewhere between the neurotypic area of development and the psychiatric-neurological disorders. However, sensory integration disorders can have a lasting and severe impact on children's neurological development, thereby providing a foundation for the conformation of later learning and behavioural disorders. 'Consequences can include behavioural disorders, learning disabilities, problems with physical activity, cognitive performance, and interpersonal relationships. Performance disorders, emotional underdevelopment, insecurity also strongly affect the ability to learn as well as the ability to thrive in life, so it becomes clear that sensory integration disorder is currently a very underestimated problem' (Schaefgen, 2006, p. 23).

The mechanism of action of sensory integration therapy

It is crucial for each therapist to be aware of the exact components upon which the therapeutic activity is based. According to Schaefgen's (2002a) course, the following elements play an important role in the mechanism of action in therapy. Defining and recognising the problem, clarifying the given situation, the relationship between the therapist and the client, their interaction, the course of the treatment, the expected consequences, the involvement of the individual's possibilities, and the mobilisation of their reserves all comprise essential aspects of any given therapy.

In addition to the components mentioned above, in connection with sensory integration therapy it is essential to mention the important role that the perception of one's own body and the use of various body movements play in therapy. After all, one of the most important pillars of therapy is to perform the planned and tried-and-tested movement activities in the therapy room with the help of therapeutic aids. During sensory integration therapy, the following factors can be observed that are specific to this therapy (Borchardt 2001):

1. Achieve performance improvement through exercises to be performed
2. Use of therapeutic devices
3. Use of technical means
4. Changing the environment / physical, social /
5. Improvements to acquire and maintain sensory and motor skills

Various joint activities, movements, sequences of movements, and play can be categorised as mediating tools of therapy. In sensory integration therapy, it is necessary for the child to have the opportunity to solve the given task or play situation based on his/her own idea, as well as for the therapist to guide them playfully in the correct direction or to the implementation of a better solution, as needed. Param, Cohen and Koomar (2003) list the following components that are absolutely essential to the mechanism of action in sensory integration therapy:

1. Therapist-child interaction (Therapeutic relationship)
2. Tasks that are appropriate to the child's level of development
3. Well-organised environment from a sensory point of view (Appropriate room, therapeutic devices)
4. Tasks that regulate the sensory system, hidden in therapeutic activities

Diagnoses of sensory integration disorders and their meaning in everyday practice

Disorders in sensory integration can cause milder or more severe behavioural and learning disorders in the development of motor and cognitive skills in children. However, these problems may be related to a lack of proper motor coordination, a reduced sensory processing or integrating ability, or a problem with the cognitive-motor system's ability to control and organise, even though the symptoms could clearly be linked to a central nervous system injury or a sensory partial ability problem. In these cases, the focus of therapy is therefore

on the tactile, vestibular, and proprioceptive areas, as well as on the important role of sensory information in movement planning.

When observing signs of sensory integration disorder in a normal community of children, we can conclude that not all children show the same clinical condition. Various manifestations of this disturbance are possible, as well as various ancillary symptoms that may occur in addition to the underlying problem, such as general developmental delay or delayed speech development (Schaefegen. 2005b). It is therefore important to state that in the event of a possible disorder of sensory processing, the most important reason for diagnosis is different performance or underperformance that has been observed in various areas. This usually arises during the acquisition of reading, writing, and counting and is associated with problems in fine motor skills and spatial orientation.

The occurrence of these problems can be observed and predicted at an earlier stage of life, when a problem arises in the following areas (Schaefgen, 2005a). (Chart 2)

Chart 2

Observations predicting sensory disturbances (own edition)

Self-dressing	Putting on and taking off shoes, tying and unfastening shoelaces, putting on and removing trousers, jumpers, buttoning up shirts, blouses, jackets
Eating	Primarily when using cutlery or a napkin, unpacking and packing for snack-time, opening beverage bottles, peeling oranges, opening and resealing packaging
Personal care	Problems with nail trimming, hair washing, combing, hair trimming, brushing teeth, nose blowing, potty-training
Playing and completing tasks	Clumsiness in construction games, board games, catching and throwing the ball
Communication	Difficulty making and keeping connections
Free time activities	Lack of ideas and contacts

Consistent with all these observations, the following conclusion can be drawn: 'clumsiness' in different areas always has a social consequence in the future.

In the first stages of development, games and movement tasks are always the driving force of development. Movement dexterity gives the child a higher sense of competence; consequently, their self-esteem will be more developed. In sports and games, dexterity is a very important component as it determines a child's social status. The more skilful the child is when playing games or doing sports, the happier. He or she will have more friends compared to a clumsier child. Less dexterous children tend to become more introverted, shy, and less confident in themselves and others.

Children who experience a developmental lag or 'clumsiness' during eating and dressing are much more likely to cause conflict or provoke their environment during these awkward situations, thereby diverting attention from their condition. In my work, this finding can be observed in many cases. I can also add that in these cases we cannot achieve results by means of discipline because the clumsiness underlying these outcomes has not been eliminated. In such situations, practice is the only solution (Czigler, 1999; Schaefgen, 2000).

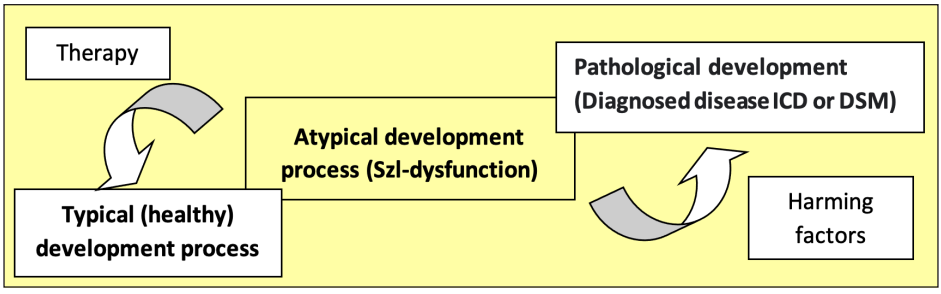
The relationship of sensory integration disorders to international classification systems (BNO, DSM)

According to the approaches applied to date, the problem of sensory processing does not lead to clearly diagnosable, classifiable problems and diseases. However, recent approaches suggest that sensory processing disorders may appear as a trigger in the background of diagnosable diseases. Sensory integration disorders should therefore number among the risk factors for diagnosed childhood neurological and mental illnesses. This necessity is because pre- and postnatal brain and nervous system development can be problematic due to various damaging factors (e.g., poisoning, alcohol, nicotine, etc.). Such chronic, non-specific factors can lead to persistent, pathological reactions that are risk factors for sensory processing disorder.

In the non-typical developmental process, attention deficit disorder, execution planning disorder, movement clumsiness and hyperactivity, learning disorders and behavioural disorders, communication disorders, social communication disorders, emotional injuries (shyness, lack of motivation), emotional lability and aggressivity can occur. This is why it is important that these problems are recognised, diagnosed, and treated in a timely manner. (Graph 1) Thus, despite these problems, at these sensitive stages of the nervous system, a healthier course of development can be ensured.

Graph 1

The effect of therapy on development (Borchardt, 2005, p. 42)



Among children aged 5–11 years, the incidence of dyspraxia is 6% (DSM). As with other disorders, these problems are more common in boys than girls. However, these differences often have a cultural background as well. For example, girls tend to have greater problems with large movements and

coordination, an issue that is most likely due to the fact that parents are more likely to prohibit girls from activities such as climbing trees. In the gender distribution in general, strenuous activities and gross motor skills are weaker in girls while the results of boys lag behind in drawing and other activities requiring fine motor skills. For most tests, these gender differences cannot be taken into account; an exception is Marianne Frostig's test for movement development (FTM), wherein differences between boys' and girls' results can be included in the evaluation table (Schaefgen, 2002c).

Possible underlying causes of sensory integration disorders

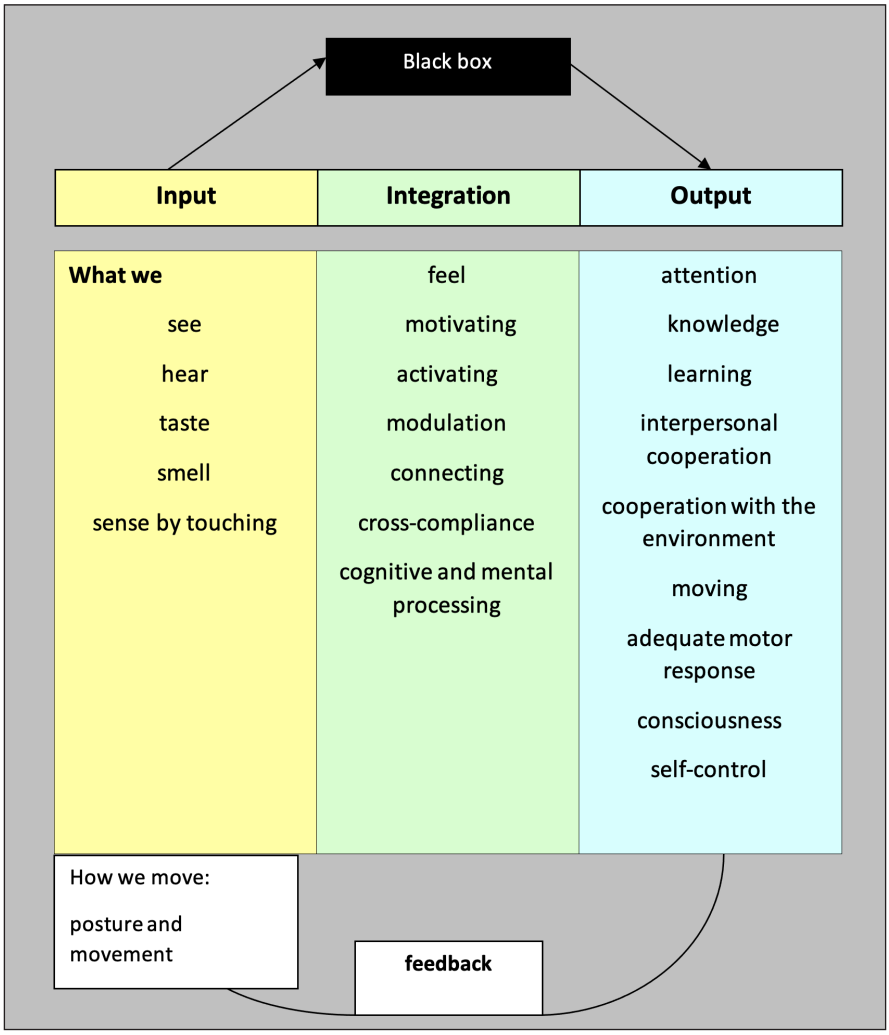
In many cases displaying sensory integration disorder, a single cause cannot be named while, the condition's background often remains indefinite. The several different causes of sensory processing disorder most often occur in combinations. The multifactorial causal background can often be combined by factors influencing development (Schaefgen, 2002a):

- genetic factors
- complications during pregnancy
- complications during birth
- childhood diseases
- brain injuries (hypoxia, accidents)
- developmental disorders
- family factors
- disciplinary problems (inadequate communication of rules)

Basic concepts and the theory of sensory processing

The theory of sensory integration was developed by Ayres essentially to prove the relationship between the issue of sensory processing and the difficulties encountered in acquiring mobility as well as school skills (Schaefgen, 2002a). The theory's starting point was that poor sensory integration performance without additional disabilities (e.g., deafness, blindness, etc.). leads to learning difficulties. However, the process of sensory integration cannot be observed from the outside since exactly what processes take place in the central nervous system cannot be seen. We can only assume what may happen within the 'black box'. This is shown in Graph 2.

Graph 2
The process of sensory integration (following Borchardt, 2005, p. 52)



A child's behaviour can be observed while he or she notices a dog, for example. As the dog is being perceived, we can draw conclusions based on the child's activities and reactions regarding the process and quality of sensory integration that has meanwhile taken place, yet we cannot examine the process itself (Schaefgen, 2004b). It is therefore very important for professionals to be aware of the processes that take place in the nervous system, the problems that may arise, and their consequences, all of which can be manifested in the child's different behaviours. Because of the problems that occur during sensory processing in the nervous system, we can only infer from the product, i.e., the child's behaviour and reactions.

The theory of sensory integration consists of three components (Schaefgen, 2002a):

1. The theory of sensory integration itself (nervous system function)
2. Test procedures and therapeutic tools developed on the basis of theory
3. A specific method of treatment and development (special therapeutic method (Chart 3)

Chart 3

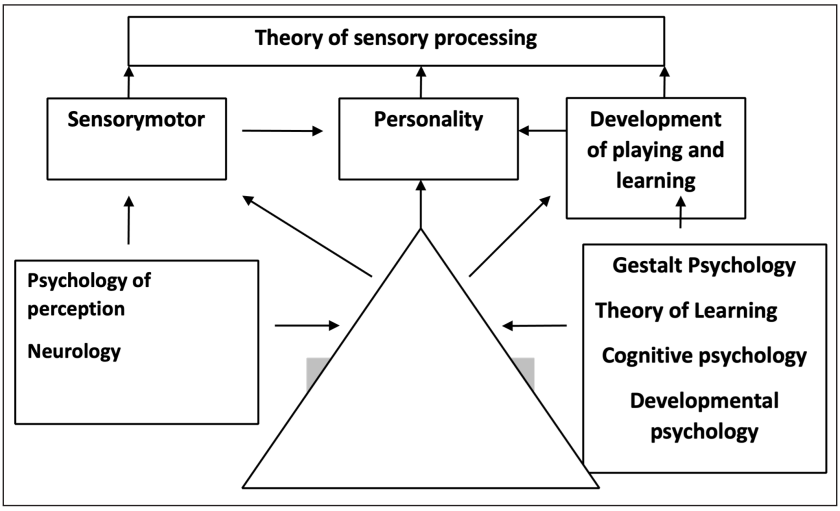
Components of the theory of sensory integration

1. Theory	2. Examination	3. Method
The success of the learning process depends on the quality of sensory integration.	Disorders of sensory integration lead to a learning problem.	Targeted development of sensory integration improves the quality of the learning process.
The process of learning depends on the ability of an individual to absorb, process, and respond to information received from the environment and movement.	If the uptake and / or processing of information, stimuli is impeded, the individual is unable to respond properly, and thus the learning process is impeded as well.	Better stimulus uptake and processing leads to better responses, thereby enabling a more appropriate learning process.

Graph 3 shows what a diverse body of knowledge has been built into the theory of sensory integration from its very conception. This knowledge system can be found in America and Germany primarily in the training of occupational therapists, but Hungarian special education training also has almost all its components. After all, any therapeutic, developmental profession can only function properly by seeking the most perfect problem and striving to solve it. Ayres summarised her theory as follows: proper self-perception of the body is essential above all, since only if the child has this, will be able to respond appropriately to the stimuli of the environment. A good body scheme is essential for an individual to recognize directions and to place and use their body in the environment.

While information from the environment gains meaning, at the same time the triple process of conception, design, and execution (which can also be called the ability to respond appropriately) must be completed. This triple activity is a unique ability that requires all three components for performing the proper reaction. Perception and activity are both the end product of sensory integration. Somatosensory, vestibular, and visual information are integrated and regulated, controlled through the activity scheme, and thus the individual's interaction with the environment is organised (Ayres, 1989).

Graph 3
The science of special education and its frontiers (following Roley, 2004, p. 54)



The sensory systems

Higher sensory systems: proprioceptive, tactile, and vestibular systems

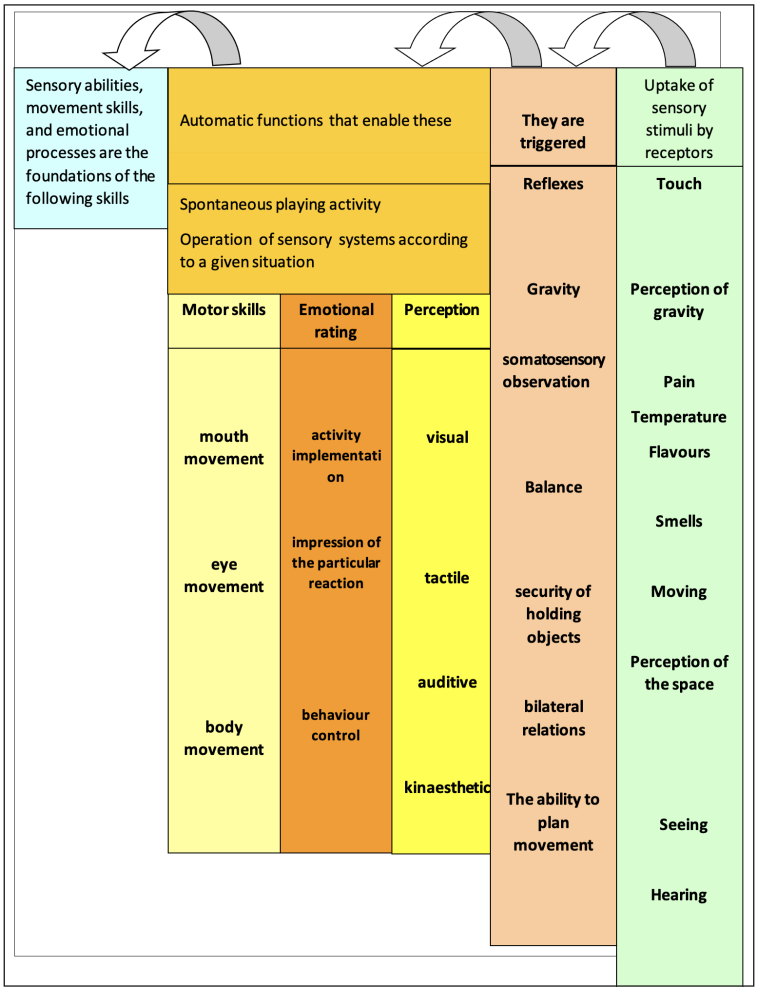
In developing the theory of sensory integration, the three systems she called the foundational sensory system were essential to Ayres. These include the proprioceptive, tactile, and vestibular systems. Just as important is a basic knowledge of the anatomy, the neuropsychology of the nervous system, and human developmental psychology. When discussing the entire sensory system, we must mention the following seven basic systems (Schaefgen, 2003a).

1. proprioceptive system
2. tactile system
3. vestibular system
4. olfactory system
5. gustatory system
6. auditive system

Ayres' starting point for these systems was that the proprioceptive, vestibular, and tactile systems pave the way for the unfolding of visual and auditory systems that in turn allow the unfolding of final skills, i.e., fine motor skills, thinking, imagination, etc. (See Graph 4). This interpretation represents a significant departure from other cognitive ideas, such as the Frostig method. At the forefront of Frostig's theory, visual perception analyses and develops problems in one or another area of visual perception (e.g., shape-background perception) more thoroughly. However, Ayres examines the disorder from a more comprehensive perspective, as she believes that if the basic sensory systems (proprioceptive, vestibular, tactile) are not properly integrated, then the development of the visual system, for example, may not be optimal either (Schaefgen, 2002a).

Graph 4

The course of sensory processing (Schaefgen, 2002a, p. 146)



However, the operation of sensory systems is not an independent, regulatory process and is furthermore strongly influenced by the level of alertness. The arousal level of each sensory system may be different, but they may be interconnected and thus this level of excitement may be amplified. In addition to stimulating the level of excitement, inhibitory factors also act in the regulation of alertness levels. The combination of the two effects can result in the appropriate level of activity, the basis for the proper functioning of sensory systems. Central sensory processing can be considered adequate if all sensory systems work well modulated and integrated (Schaefgen, 2003b). However, the most important role in the development of the appropriate level of activity is played by the inhibitory and stimulating processes, as the result of these two processes is the appropriate level of alertness, which facilitates sensory integration and the

learning process. Ayres (1984) calls this organisational process the modulation of sensory systems. Normally, this level of activity moves in the middle area of the continuum, with children looking for different but not extreme stimuli to form it. In case of attention deficit and / or hyperactivity, the problem is mainly detected in this area (Schaefgen, 1999). If the sensory system is well modulated, it is possible that the sensory processing will proceed properly. The following levels of activity can be observed (Schaefgen, 2003b, p. 98). (Chart 4)

Chart 4

Possibility to monitor the activity level (Schaefgen, 2003b, p. 98)

Ability to sensory discrimination	Each sensory system has an information processing component that aids central nervous system processing.
Co-construction	Stabilisation against increased resistance in case of proper muscle tone is called co-contraction
Muscle tone regulation	Creating the right muscle tension to perform a given activity.
Balance regulation	Movement coordination activity performed by the cerebellum and posture regulation regulated through balance, related to the given movement.

The reticular system (*formatio retikularis*) is the part of the brain where the switch occurs between nervous system activity and awareness, behaviour, and response. Stimuli from all parts of our body, from the sensory, motor, and somatosensory areas, from the perception of the external and internal environment, and even from the autonomic nervous system converge in the reticular system. This is why this system is called an 'activation system' that is part of a large regulatory circle. It has a bottom-up process (brainstem) and a top-down process (cerebral cortex) (Schaefgen, 2002b).

The proprioceptive system

'The perception of one's own body is important in the performance of all movement activities, be it an automatic reaction or a planned movement' (Ayres, 1972, p. 66). When referring to the perception of our own body, we mean information coming from our system (blood pressure, tendons, muscles, joints, etc.), by means of which we receive internal feedback regarding our own movements and activities. This area only processes information coming from our bodies, not stimuli from the outside world. Also, with the help of this system, it is possible to be able to react to the given situation. Proper functioning of proprioception is also essential for the development of the body scheme (Schaefgen, 2002a).

The tactile system

'Tactile functions are the earliest. In individual development, a person's main source of information is the tactile system with which it picks up information from its environment and tells the body that a particular stimulus is acceptable to the body or indicates that it is unacceptable and triggers an offensive or

escape reaction. However, in this reaction, the limbic system also interacts with the tactile system' (Ayres, 1984, p. 61).

With the help of the tactile system, we detect a lot of stimuli from our environment. The tactile system also plays a fundamental role in infancy, and it is even very developed and ready to record information even before birth. The tactile system often comes into contact with the proprioceptive system: the two are collectively referred to as the tactile-kinesthetic system. If the proprioceptive system is associated with the touch-based part of the tactile system, it is also called a somatosensory system.

Hands, feet, and the mouth are the most sensitive body parts in terms of touch. Think of babies: information about the objects surrounding them is gathered primarily with their mouths and hands. By using this information, infants become more and more informed. A further example can be found in the fact that a number of activities have to be done when we cannot use our eyes (e.g., tightening a screw in a hidden place, or orienting in the dark). In such cases, we call upon our tactile system for help (Schaefgen, 2002a).

The vestibular system (Balancing)

'The vestibular system is a unified system. The functions of all other sensing areas work based on basic vestibular information. The operation of balancing allows us to carry out all our other life activities' (Ayres, 1972, p. 55).

The vestibular system absorbs information from both our bodies and the outside world. The vestibular system develops in the womb and is fully operational at birth. The vestibular system is a complex sensory and motor system that can affect muscle tone in most of our body. Numerous studies and observations confirm that the primary function of this system is to develop the ability of spatial orientation and balance (Schaefgen, 2002a).

Chart 5

Summary cahrt of superior sensory systems (based on Kahle, 1996, p. 147)

Sensory system	Proprioceptive system	Tactile system	Vestibular system
Mode of detection	Mechanical sensing: pressure, pulling, pain, vibration, temperature	Mechanical sensing: pressure, vibration, touch, temperature	Mechanical detection: Posture change, body acceleration
Sense, receptor	muscles tendons, joints	Skin	Inner ear: sacculus and utriculus
Task	- force distribution - position of body parts - movement of body parts - temperature change	- Stereognosis - detection of the shape of objects - temperature change	- direction, e.g. lifting the head - posture - movement coordination: position, walking
Function	motion planning, movement coordination	Touch, tactile sensing	Placing the body in space, balancing

The subordinate sensory system: visual and auditory system

The uptake and processing of both auditory and visual stimuli play a subordinate role in sensory integration. Both systems (visual, auditory) are of great importance in cognitive processes (Chart 6). Visual perception is one of our most important channels of information acquisition. By processing visual stimuli, we create our own image of the world. Shortly after birth, the baby follows the changes in the environment with their eyes. The ability to recognise faces begins to develop and continues to develop in the first year of life (Lightfoot et al., 2014). The components of visual perception are: shape perception, colour perception, depth perception (spatial vision), and motion perception.

Auditory perception is just as important as visual perception since hearing is the basis of communication. The baby hears its mother's voice, recognises it, and can also distinguish whether the mother is in the same room. Components of the auditory perception (Roley, 2004):

- tone, pitch
- volume
- localisation
- distinction
- recalling auditory patterns
- time factors

Nor is the role of olfactory (smelling) and gustatory (taste) systems negligible; these systems are less researched and explored areas within the theory of sensory integration and therapeutic application.

Chart 6

Table summarising subordinate sensory systems (own editing based on Kahle, 1996, p. 189)

Sensory system	Olfactorial, olfactory system	Gustatory, taste system	Audit system	Visual system
Mode of detection	Chemical: gaseous molecules	Chemical: sweet, salty, bitter, sour	Mechanical: sound waves	Electromagnetic light waves
Sense, receptor	Nose, mucous membranes	Mouth, tongue, mucous membranes	Inner ear, auditory hair cells	Eyes, cornea, retina
Task	Vegetative and hormonal regulation, distinction between sympathy and antipathy	Taste discrimination, liking or not liking the taste of food	Distinction of noises and sounds, spatial orientation based on hearing	Three-dimensional perception, colour vision
Function	smell	taste	hearing	seeing

Sensory integration and development

Ayres believed that the development of sensory integration would take place in the first seven years of life. Undoubtedly, the majority of children reach a high level of development in sensory integration by the age of 7-9, an age that is already close to the level of adult maturity. The development of sensory integration is closely related to the complexity of the nervous system's organisation of sensory information and the appropriate level of activity in sensory systems.

As a result of the development of sensory integration, it can be observed that the child is able to organise play activities for a longer period of time and also has more control over the regulation of emotions. Children's internal motivation drives them to choose things from their environment that are the most developmental for them, i.e., neither too complicated or too simple. Thus, by observing the activities of children, we can easily determine which stages, sensory processes, and levels of development can be considered appropriate at a given age (Schaefgen, 2002a). The role of sensory integration in development is reviewed based on Chart 7.

Chart 7

The role of sensory integration in development

The main aspects of sensory integration in terms of development
Sensory integration is part of normal development.
Sensory integration develops through sensorimotor activity.

Sensory integration is the basis for:
- posture and movement
- the development of the body image
- spatial and temporal orientation
- cognitive and emotional development
- activity planning and implementation
- learning

The integrational processes can be found:
- in sensory processes
- between body parts
- between the components of the central nervous system
- between the right and left hemispheres

Sensory integration contains:
- neuropsychological
- sensorimotor
- cognitive
- emotional processes

Nervous system (neurophysiology and neurobiology) bases

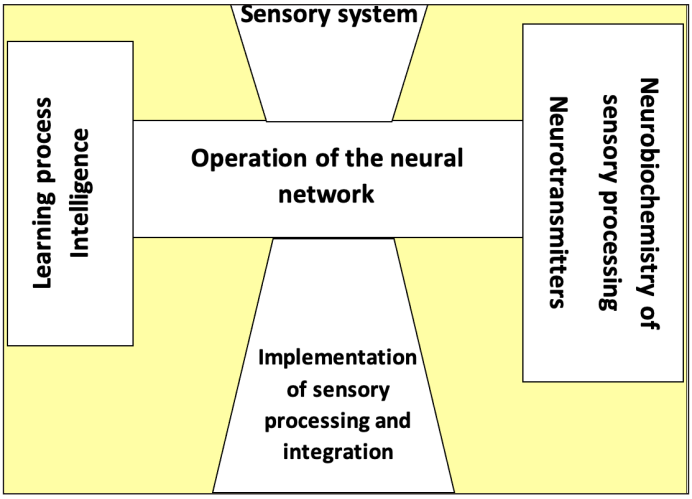
In this part of the study, I will outline the neurological and neurobiological foundations, formulas, and processes that led to the development of the theory of sensory integration and demonstrate the functioning of sensory integration in the nervous system. A prerequisite for the formation of a network of neurons

is the establishment of secure connections of sensory information. The implementation of the processing of sensory information, and in particular its quality, can be observed primarily in practical activities: the learning process, social interactions and everyday life situations. However, it is also important to see below the surface and be aware of what processes are taking place in certain parts of the nervous system. (Graph 5)

The graph below is intended to show the relationship between the senses, the functioning of the nervous system, and the learning process. Even with the knowledge of the many nervous system formulas and the interactions among them, we must not forget that (whether it seems irrelevant or unnecessary or not) in the background of dealing with all this information only one important goal must be kept in mind.

Graph 5

Sensory integration and the nervous system (Schaefgen, 2002a, p. 136)



If we know exactly what is going on during the functioning of the nervous system called the 'black box' (see Graph 2 above), we can effectively help the child who appears in therapy.

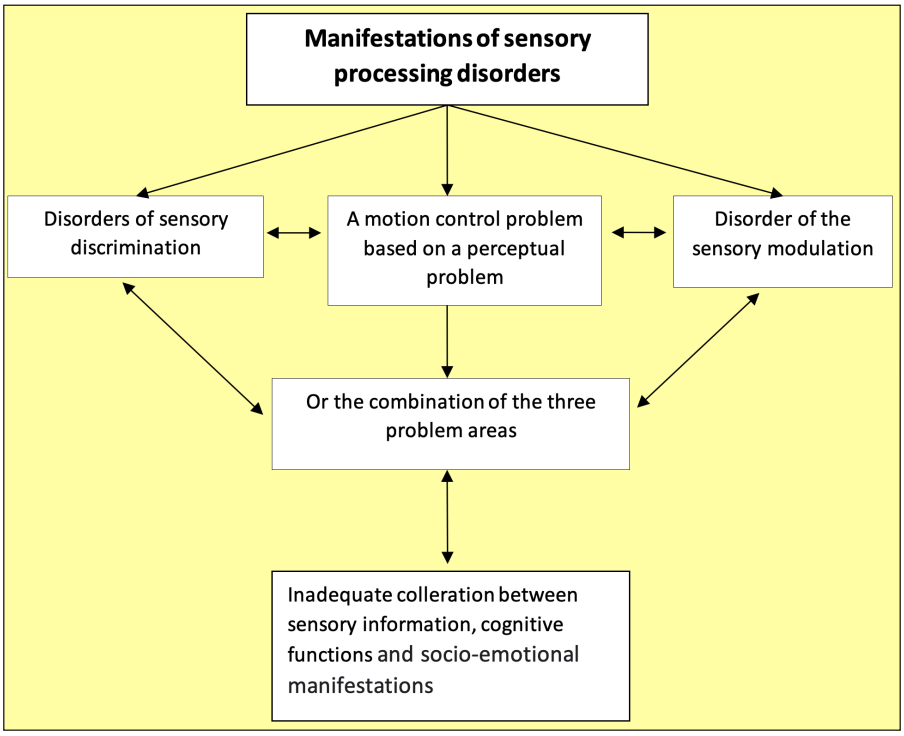
Comprehensive categories of sensory integration disorders

Ayres' research was taken up and continued by her followers, leading to changes in categorisation. Although researchers have been examining sensory processing and working to improve categorisation [Clarc, Mailloux and Parham (1989), Fisher, Murray and Bundy (1991), Kimball (1993), Dunn (1999), Miller (2001), Smith-Roley, Balche and Schaaf (2001), they remain unable to take a common position on the issue of a unified categorisation system and diagnosis. Yet it is clear that many overlaps and common elements exist in their developed systems, as is exhibited in the following categories: (Schaefgen, 2006, p. 160).

1. Disorders of sensory discrimination (sensory discrimination and perceptual disorders)
2. Disorders of sensory modulation
3. Sensory-based movement control disorder (posture problems and dyspraxia)

In the first two categories, disturbance in sensory processing can be observed based on responses to sensory stimuli and socio-emotional responses. In the case of the third category, the disturbance in sensory integration is reflected in motor responses, however an underlying disturbance in sensory processing can often be observed. The correlation among these three areas can be seen in Graph 6:

Graph 6
Disorders of sensory processing (Schaefgen, 2006, p. 165)



Disorder of sensory discrimination

Sensory discrimination entails the qualitative, quantitative, and emotional distinction between individual sensory information. We can differentiate our responses to each sensory stimulus depending on the intensity, length, and subjective judgment of the stimulus. Even limited or malfunctioning sensory discrimination can affect our sensory perception. Thus, from a spatial or temporal point of view, we cannot perceive our contacts and movements

with proper discrimination. The same can apply to our tastes, smells, balance, hearing, and sight. If a stimulus cannot be detected for a sufficiently long period of time, it may not leave a clear impression on the nervous system and this may lead to further uncertainty. Limited sensory discrimination can easily cause a sensory-based movement disorder (Schaefgen, 2005b).

Chart 8 below shows what kinds of problems are caused by discrimination difficulties in each sensory system, according to Ayres (Ayres, 1989, p. 122, own editing).

Chart 8

Discriminatory ability of sensory systems (own editing)

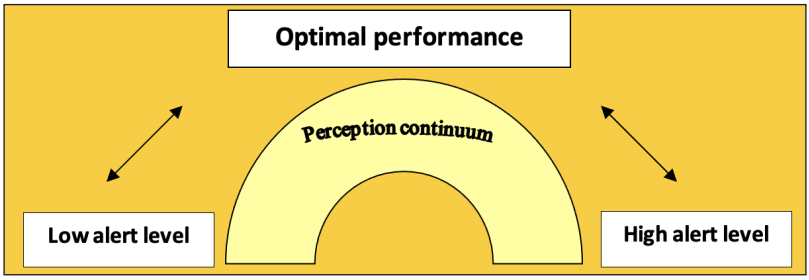
Sensory system	Differentiating function	Abnormal functioning of discrimination
Proprioceptive	Distinguishing between torque, direction, and acceleration of motion.	Inability to distinguish between torque, direction, and acceleration of motion.
Tactile	Recognition of shape, form, size is possible through touch.	Recognition of shape, form, size is not possible only through touch.
Vestibular	Appropriate displacement to maintain balance during head and body position changes.	Improper movement to maintain balance during head and body position changes. Further balancing activities are needed
Olfactory	Distinguishing odours and smells is not a problem.	Difficulty in identifying odours and smells, recognising danger. E.g., the smell of gas
Gustatory	The different flavours are well distinguished.	Distinguishing flavours and avoiding danger is problematic., e.g., rotten food
Auditive	It is possible to distinguish and localise sounds and noises and filter sounds from background noises.	Identification of sounds and noises is impaired, speech hearing is problematic.
Visual	Shape-background distinction, clarity, colour, shape distinction is appropriate.	Difficulties in visual distinction: e.g., shape-background, constants, and distinction of similar colours.

If a problem with sensory systems occurs in this area, very different symptoms can appear. Each sensory system receives, identifies, and processes information from the outside world. However, this process can only take place properly with an appropriate level of activity (Graph 7). If there is a problem during the differentiation and identification of sensory information, then the processing

course of the sensory systems cannot take place optimally either. This disturbance can also cause the modulation disruption of incoming information, as both cognitive and emotional structures receive only an approximate piece of information.

Graph 7

Level of activity required for detection (Borchardt, 2005, p. 89)



Ayres defined modulation as a management process implemented through the nervous system's own level of activity. If this control process does not work properly, then the incoming sensory integration cannot be processed properly by the nervous system, i.e., the modulation of the information is not proper. Below, Chart 9 displays how the operation of each sensory system is affected by the appropriate, too low, or too high activity level (following Schaefgen, 2003b, p. 176).

Chart 9

Modulation of sensory systems (own editing based on Schaefgen, 2003b, p. 176)

Sensory system	Appropriate level of activity, appropriate reaction	Low activity	High activity
Proprioceptive	Identification of proprioceptive information and appropriate response	The position of the hands, feet, movement, muscles does not seem to be perceived.	Movement of muscles and joints is too strong or too uncomfortable.
Tactile	Different touches can be distinguished / people objects, animals, garments /	We do not feel pain, we do not notice any injuries. Distinction is problematic.	Even gentle touches are painful, irritating. Touch of people, animals, clothing is not or hardly tolerated.
Vestibular	Balance and feeling self-confident	No attention to height, depth, fast and dangerous movements.	Postural problems. Fear of change of posture and relocation.
Olfactory	Appropriate response to odours and smells.	The perception of odours and smells doesn't seem to work.	Overwhelming odours can even irritate and cause disgust.

Gustatory	Proper perception of flavours.	Takes everything in the mouth.	Temperature / tea / overreaction, does not tolerate food, toothbrush in the mouth.
Auditive	Proper perception of sounds and noises.	Orientation is problematic, nor do loud noises bother.	Normal noises and sounds are annoying, often provoking anger.
Visual	Visual orientation is appropriate even during changes.	Changes in the position and location of objects and persons do not provoke a reaction	They react sensitively to any change, the intensity of the lighting can be confusing, irritating. Fear in the dark

Sensory-based motion control disorder

In addition to motor performance, the following functions are required to achieve proper performance: space and form perception, appropriate attitude, school skills (writing, reading, counting), speech and articulation, emotional regulation, appropriate level of activity, appropriate relationship with the environment. Chart 10 below summarises the regular and irregular operation of these functions, which have a significant impact on the appearance of learning and behavioural disorders (Schaefgen, 2004b, p. 180).

Chart 10

Regular and irregular function operations following Schaefgen, 2004b, p. 180

Function	Regular operation	Irregular operation
Space and form perception	Problem-free perception of space and form and use of information	Spatial orientation is difficult, problem in shape-background perception, reading and counting difficulties are likely
Appropriate attitude	Attitude appropriate to age, situation, and environment	Behaviour that does not correspond to age, tasks, situation, cooperation with the environment
School skills	Adequate performance in reading, writing, arithmetic, abstractions, and analysis	School performance lags behind the age-average level

Speech and articulation	Speech and articulation work at an age-appropriate level	For no apparent reason, the level of speech and articulation is below average
Emotional regulation	Emotional regulation is appropriate, awareness is age-appropriate	Emotional control is undeveloped and awareness is immature
Proper activity level	Level of activity appropriate to age and situation, with established self-control and independence	Low activity level, low motivation, depressed impression High, aimless level of activity, lots of movement, insufficient self-control
Proper connection with the environment	Proper interaction with the environment, proper problem solving, execution	Interaction with the environment is difficult, tasks are not performed properly

Upon reviewing the main categories of sensory integration disorders, it becomes obvious how many elements of the complex syndrome of sensory integration disorders may play a role in a child's inability to respond appropriately to an everyday situation, resulting in behaviour that is not adequately organised.

Summary

The theoretical and practical model of sensory integration therapy developed by Ayres proves to be an effective method for both the treatment of partial abilities in childhood and the rehabilitation of nervous system injuries. In our study, we demonstrated that, based on the basic concept, Ayres and her followers developed an increasingly complex diagnostic and therapeutic system that responded sensitively to specific educational needs.

The comprehensive categories of sensory integration, such as sensory discrimination disorder, sensory modulation disorder, and sensory-based motion control disorder, can be diagnosed and effectively treated from an early age. Thanks to research, it is becoming increasingly clear that sensory integration disorders can predict the later appearance of syndromes of learning and / or behavioural disorders. Due to this fact, the latest editions of the International Classification Systems (BNO, DSM) already include the main category of sensory integration disorders, a factor that is of great importance for the wider dissemination and acceptance of the theory and practice of sensory integration and the feasibility of further research. This status also draws attention to the fact that the treatment of behavioural and disciplinary problems arising from behavioural disorders requires a much more complex, holistic approach on the part of educators and should not be limited to finding the 'right' means of discipline.

Recognising the role of sensory disorders is especially important for the study of the effect our rapidly changing lifestyle exerts on nervous system maturation and development. The need to do so becomes increasingly urgent as professionals encounter more and more children with developmental characteristics that present atypically from the perspective of the nervous system development process. In many cases, these symptoms act as an early-stage predictor of dysfunctional development while performance disorders may also appear at preschool or school age during the organisation and implementation of more complex activities organised at a higher level. The method of sensory integration therapy presented in this study provides an explanatory principle for understanding these phenomena and an effective diagnostic and therapeutic method for preventing learning and/or behavioural disorders and treating pre-existing disorders from infancy to primary school.

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