Down Syndrome: Sensory Integration, Vestibular Stimulation and Neurodevelopmental Therapy Approaches for Children

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Abstract

Down Syndrome is a disability characterized by significant limitations both in intellectual functioning and in adaptive behavior as expressed in conceptual, social, and practical adaptive skills. There are various degrees of sensory integration dysfunctions in children with an intellectual disability. Sensory integration is the organization of sensory input for use. Function of learning depends on the child's ability to make use of sensory information in order to perceive sensory information from his environment, integrate this information and plan and form purposeful behavior. Sensory integrative intervention, vestibular stimulation, neurodevelopmental therapy approaches are effective methods used as occupational therapy/ physiotherapy interventions in separate or combined programs with educational, behavioral and pharmacological interventions in children with an intellectual disability.

Definition of Child with an intellectual disability

The Diagnostic and Statistical Manual (DSM-IV) (American Psychiatric Association 1994) and ICD-10

Classification of Mental and Behavioral Disorders (World Health Organization 2008) classify individuals with child with an intellectual disability according to the severity (mild, moderate, severe, profound, other and unspecified) of the impairment in intellectual functioning. The American Association on Intellectual and Developmental Disabilities (AAIDD) has defined an intellectual disability in a child as a disability characterized by significant limitations both in intellectual functioning and in adaptive behavior as expressed in conceptual, social, and practical adaptive skills, which originates before the age of 18 (AAIDD 2008). Adaptive behavior signifies the quality of daily performance in dealing with environmental needs. Adaptive behavior is the sum of many abilities in order to achieve community integration. In adaptive behavior impairments, dealing with social needs is very important for children with an intellectual disability. AAIDD has suggested a 3-step process of Diagnosis, Classification and System of Support for the importance of adaptive behavior with relation to children with an intellectual disability. In this system, there are ten adaptive areas considered critical to a diagnosis of a child with an intellectual disability: communication, self-care, home living, social skills, community use, self-direction, health and safety, functional academics, leisure and work. In defining children with an intellectual disability, if the individual has limitations in two or more adaptive areas and an intelligence quotient (IQ) of 70-75 or below and the age of onset is 18 or below, the individual can be diagnosed as a child with an intellectual disability (Lambert et al. 1993).

AAIDD (2008) has specified five assumptions essential to the application of the definition:

1. Limitations in present functioning must be considered within the context of community environments typical of the individual's age, peers and culture.
2. Valid assessment considers cultural and linguistic diversity as well as differences in communication, sensory, motor, and behavioral factors.
3. Within an individual, limitations often coexist with strengths.
4. An important purpose of describing limitations is to develop a profile of needed supports.
5. With appropriate personalized supports over a sustained period, the life functioning of the person with child with an intellectual disability generally will improve.

Normal Motor Development

Normal development of movement and function is essential to the child's motor control achievement and learning. Motor learning develops in stages. The child first learns a skill and generalizes it to other circumstances. Movement and posture are learned in a sensory state or environment. Physical activity is necessary for motor development. The infant should move actively to gain basic motor skills such as rolling, coming to a sitting position, crawling, standing and walking. The development of postural control in children occurs in stages to their ability to integrate sensory information. Between the ages of 1 and 3 the sense of sight is dominant; and it is a powerful sense for achieving and maintaining the orientation of the upright position. At these ages the proprioceptive system generates simple and incomplete information. Practice is needed for the somatosensorial system to utilize proprioceptive information effectively. Between the ages of 4 and 6 somatosensorial and vestibular input is greatly used. Between the ages of 7 and 10 responses similar to those of adults are observed. The fundamental source of postural stability in children and adults is somatosensorial. General movements and reflexes enable voluntary and adaptive motor control; postural control develops first and provides the basis for movement, and coordinated movement takes place (Woollacott and Shumway- Cook 1986, Martin 1989, Aubert 2008).

Factors affecting the ability of movement

Factors of the musculoskeletal system

Mechanic factors such as gravity, gravity line, base of support and centre of gravity affect the development of movement. Characteristic of the muscles in the musculoskeletal system, movement of joints, joint range, ligament range, and tension of muscles are important factors for the development of maximum performance. Achievement of postural control is significant for endurance against gravity and muscle strength (Martin 1989).

Neuromotor factors

There are two kinds of reflexes: primitive and postural reflexes. Primitive reflexes are spontaneous, stereotypical responses to a specific stimulus. Postural reflexes are seen throughout life, also called automatic reactions, variable responses to stimuli, and aim at keeping the head and body in an upright position. As the infant develops and gains greater control of movement against gravity, the primitive reflexes decrease as the postural or automatic reactions appear. Postural reactions appear in the following order as reactions of righting, protective, and equilibrium. The aim of the righting reaction is to maintain the correct orientation of the head and body. Protective reactions are extremity reactions to rapid displacements of the body by horizontal or diagonal forces. Equilibrium reactions occur during the changing of the centre of gravity by the movement of the body or support surface (Martin 1989, Aubert 2008).

Milestones of gross and fine motor development

From one to two months, the infant begins to display a decrease in physiologic flexion along with an increase in active extension against gravity while in a prone position. Around three months, the infant shows more symmetry in alignment and movement of the body. Around the fourth month, the infant practices bilateral use of flexion and extension that facilitates strong symmetry. At four months, the infant gains control of the head. At six months, the baby has good control of the head and displays strong control against gravity. Between six and eight months, the infant is able to rolling supine to prone segmentally. At eight months, the infant can come to a sitting position without help. At nine months, the infant starts pulling to stand. Creeping has become the main means of mobility for the 9-10-month-old child. Between 12 and 18 months, the infant can walk independently (Aubert 2008). Fine motor development is characterized by the following milestones: The child gains the ability of raking, five months; palmar grasp, six months; radial digital prehension, nine months; inferior pincer prehension, eleven months and neat pincer prehension, twelve months. Though the order of the milestones in these developments is generally as such, cultural differences and the child's previous experiences may change this order. Due to other individual differences for example motivation, opportunity etc., the speed in gaining these abilities may also change (Martin 1989, Aubert 2008).

Down syndrome and neuromotor control

In children with Down syndrome, there have been a number of observed and measured motor characteristics such as hypotonicity, joint hypermobility, decrease in deep tendon reflexes, maintenance of primitive reflexes, and a delay in the appearance of reaction timing and equilibrium reactions that may have contributed to delayed development. Various studies have shown that children with Down syndrome generally have deficits in eyehand coordination, laterality, speed, reaction timing, equilibrium and visual motor control (Henderson et al. 1981, Kerr and Blais 1985, Shumway-Cook and Woollacott 1985, Connoly and Michael 1986, Woollacott and Shumway-Cook 1986, Haley 1987, Stratford and Ching 1989, Dyer et al. 1990, Uyanik et al. 2001, Jobling and Virji-Babul 2004, N. Virji-Babul et al. 2006).

In children with Down syndrome, delays in postural reactions take place with the delays in motor development. Therefore, it is essential that therapeutic programs which increase the stimulation of postural reactions are utilized in the intervention program. Specifically, some children with Down syndrome need to develop strategies in order to eradicate useless sensory inputs. The formation of postural synergies and sensory inputs through integration is important in the therapeutic approach (Haley 1986). For the maintenance of stability, rapid-automatic postural responses should occur. In children with Down syndrome, dysfunction of stereognosis and decrease in motor skills are also related to hypotonia. Hypotonicity disrupts the feedback mechanism which enables the perception of the position of the body in space, and plays a role in the voluntary control of muscles, and as a result body posture and the quality of movement are affected (Woollacott and Shumway-Cook 1986). Due to the develop child with an intellectual disability of the cerebellum and the brainstem, coordination and timing components of motor control are affected (Seyfort and Spreen 1979). These dysfunctions observed in children with Down syndrome may also continue after preschool and adolescence periods. The occurrence of balance and coordination problems in these children supports the view that individual therapy may be useful not only during preschool period but also during all adolescent life (Connoly and Michael 1986, Moni and Jobling 2000).

Sensory Integration Theory

Sensory integration is "the organization of sensory input for use" (Ayres 1979). The term sensory integration which signifies a neurological process was first developed by Ayres. This process enables the spatial-temporal usage of the sensory information the individual gets from his body and environment and the perception, interpretation, and integration of information in order to plan and form organized motor behavior. According to this theory, mild and moderate problems in learning are related to motor in coordination and weak sensory process (Ayres 1972a, Ayres 1972c, Bundy and Fisher 1992, Fisher and Bundy 1992, Scheerer 1997).

Sensory integration theory is based on the view that neural plasticity and sensory integration occur in the developmental order, and brain functions integrate with the related systems hierarchically. Adaptive motor response is the most significant parameter of sensory integration. "An adaptive response is a purposeful, goal directed response to a sensory experience" (Ayres 1972b, 1979).

Three main sensory systems play a role in the growth and development of the child - tactile, vestibular, and proprioceptive systems (Williamson and Anzalone 2001):

1. *Tactile System*; provides information about the environment by the sense of touch. The stimulus of the tactile system is received by the receptors in the skin which is the largest organ of the body. The tactile system has two components. The first is the protective system which informs when touching is harmful, and the other is the discriminative system which informs of the difference between harmful and beneficial touch.
2. *Proprioceptive System*; is a system which receives sensory stimulus from the muscles and joints. Push and pull activities related to muscles and joints provide maximum stimulus to this system. The proprioceptive system is also important for the development of fine and gross motor muscles. The insufficient proprioceptive system also negatively affects motor planning ability.
3. *Vestibular System*; Vestibular system receptors are within the inner ear and are related to hearing. The receptors in this system respond both to movement and gravity. The vestibular system is a system that affects balance, eye movements, posture, muscle tone and attention.

Assessment

In a child with an intellectual disability; motor, perceptual and cognitive skills should be considered comprehensive assessments. A multidisciplinary team consisting of a doctor, physiotherapist, occupational therapist, psychologist, language and speech pathologist, social worker and special educators will make the best assessment and intervention plan for the child. In all levels of function, motor development, oral function and nutrition, sensory integration, seeing, hearing and intelligence should be assessed (Swaiman 1989).

In the functional assessment, one or more measurement results are used in making some decisions about the functional performance of the child (Ottenbacher et al. 1999, Ottenbacher et al. 2000, Uyanik et al. 2003b).

These measurements can be divided into three groups which assess the measurements of motor functions, activities of daily living (ADL), and make developmental assessment. The majority of the tests examine both motor functions and daily-life activities (Taggart and Aguilar 2000).

Two commonly used pediatric functional assessment methods are The Functional Independence Measure for Children (WeeFIM®) and Pediatric Evaluation of Disability Inventory (PEDI). WeeFIM® comprises 13 motoric-based daily living skills and 5 cognitive items (Msall et al. 1994). PEDI is a comprehensive test consisting of 197 items used in the assessment of self-care, mobility and social functions of children between 6 to 90 months of age (Haley et al. 1992).

In Occupational Therapy, the focus is on the assessment of occupational performance. Occupational performance areas (self-care, productivity, and leisure), performance components (mental, physical, sociocultural, and spiritual), and environment (physical, social, cultural) should be assessed (Watson 1992).

The following are the occupational therapy tests that can be used specifically in the assessment of mental retardation:

- Loewenstein Occupational Therapy Cognitive Assessment-LOTCA (Itzkovich et al. 1993) for the assessment of cognitive problems
- Automatic Postural Reactions Tests (Bobath 1990) for the assessment of motor functions
- Gross Motor Function Measure-GMFM (Russell et al.1993) for the assessment of gross motor functions
- AAMR Adaptive Behavior Scale-School Second Edition (Lambert et al. 1993) for the assessment of adaptive behavior processes
- The Pediatric Clinical Tests of Sensory Interaction for Balance (P-CTSIB) (Richardson et al. 1992) for the assessment of balance deficits in children
- Southern California Postrotary Nystagmus Test (SCPNT) (Ayres 1975) for the assessment of vestibular functions
- Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) (Bruininks 1978) for the assessment of motor skills
- Southern California Sensory Integration Tests (SCSIT) (Ayres 1972b) for the measurement of sensory perceptual motor performance
- Sensory Integration and Praxis Tests (Ayres 1989) which consist especially the assessment of praxis and sensory integration

Researchers who have used the assessment tests stated above have determined the condition range of children with special needs (Kantner et al. 1976, Russell et al. 1998, Uyanik et al.1999, Uyanik et al. 2001, Uyanik et al. 2003b, Düger T et al. 1999, Tural et al. 2001, Bumin et al. 2002, Jobling 2006, Aki et al. 2007).

Interventions in Sensory Integration Dysfunctions

The fundamental principle in the intervention of sensory integration dysfunctions is enabling planned and controlled sensory stimuli with adaptive responses in order to increase the level of organization of the brain mechanism. The therapist's role in sensory integration programs is to arrange the stimuli coming from the environment so as to enable the individuals to demonstrate appropriate motor behavior, and develop self-care, play and school skills (Troyer 1961). Ayres stated that sensory integration is significantly related to the development of hearing and language skills besides motor coordination (Ayres 1979).

Sensory integration assessment, which is performed prior to sensory integration intervention, enables analyzing, synthesing, and interpreting the individual's sensory-perceptual motor behaviors. The assessment consists of the assessment of sensory motor process integration, the adaptation process of the individual, the effects of the maturation and behavior process and defining the developmental profile (Dengen 1988, Ayres 1989, Ayres 2005).

Acquiring skills requires the integration of information. In enabling the child to acquire skills, the therapist uses oral stimuli, supportive visual stimuli, the positioning of the child, passive movement and the suitable environment. The first stage in enabling the learning of the skills is to direct the child toward the desired goal (Gentile 1992).

There are four fundamental principles in the intervention of sensory integration dysfunctions:

1. The intervention process begins with assessment. The assessment of sensory-motor state and environmental adaptations are important in assessing the effect of the intervention, intervention methods and urgent therapeutic goals. The issues below should be considered in order to plan the intervention:

   1. The level of function of the child
   2. The developmental status of sensory integration process of the child
   3. What are the primary aims of the intervention and what intervention methods should be used with what purpose?
   4. How often should the child be treated and what home programs should be given?
2. The intervention program should follow the sequence of motor development seen in typically developing children. When the individual achieves highly controlled behaviors such as running, hopping, writing, and reading, an improvement in the assimilation and adaptation process of the visual, tactile, proprioceptive and vestibular stimuli occurs. Integrating intervention activities into the general play of the children in the program can be beneficial.
3. The intervention depends on the intersensory integration process. The organization of sensory stimulus which is internalized by the adaptation of the body, and the sensory integration process are the main steps of the intervention.
4. It should also be noted that home care for the child provided by parents and family and emotional and social development also play an important role in the intervention. The child's success depends on the therapist's communication and coordination with the patient's family and with other disciplines while planning the intervention program. Specialized programs depend on the age, gender, function loss, skills and interest of the child and the therapist's education (Gilfoyle and Grady 1971, Dengen 1988).

Activity training for sensory perceptual –motor dysfunction

The appropriate adaptation of the environment is very important in the intervention of sensory integration. The environment should be interesting to the child. The following activities are suggested in sensory integration intervention according to the child's proper sequence of development:

1. **Tactile, vestibular, proprioseptive input and feedback**

   Gross motor accommodation; gross postures and patterns of motion (rolling pivot prone, on elbows, all fours, standing, walking in unusual patterns and different surfaces, running, hopping, jumping on twister spots, catching, throwing)

   Motor planning (praxis): is the ability of the brain to conceive of, organize, and carry out a sequence of unfamiliar actions as necessary when learning new skills. Activities directed toward goal achievement help to develop motor planning skills. Net hammock and ball activities can help to improve gross motor accommodation and praxis.

2. **Tactile, vestibular, proprioseptive input and feedback**

   Righting and equilibrium reactions, and integrative patterns of different positions can maintain these stimulations. Play of boat in the ocean in the quadruped position can facilitate balance and equilibrium reactions. Therapists say "you are a boat in the ocean, and I am the hurricane you should try not to fall down" and therapist pushes the child very slowly for couple of times in order to disrupt the child's balance (Kramer 2007).

3. **Tactile, vestibular, proprioseptive and visual input and feedback**

   Apedal and quadrupedal activities; skooter board, bean bag, ball playing, rolling, crawling, relays, follow the leader, rhythm bands etc.

   Ocular control: activities which require the movement of hands and large muscle groups such as throwing and catching, and activities which require little muscle movement such as drawing pictures and drawing lines help to develop ocular control.

4. **Tactile, vestibular, proprioseptive and visual input and feedback**

   Activities for bipedal positions; running, jumping, skipping, hopping games, playground equipment(swings, barrels, slide, climbing bars), ball playing, musical games.

Bilateral motor coordination: When both sides of the body work together in coordination, purposeful hand movements appear and the child can cross the midline of his body.

Proprioceptive activities: climbing, pushing, pulling, carrying heavy objects, working against resistance and pressure

Visual–Spatial Perception: Children with dysfunctions of visual space perception have difficulty in writing and working with numbers. Learning and understanding direction concepts help to develop visual space perception. Activities directed toward vestibular and ocular controls which require knowing the position of objects in space help to develop visual-spatial skills. It is stated that there is a strong relation between visual perception and motor performance (Brien et al. 1988). Motor planning activities and visual space perception games have motor planning components, because motor planning and visual space perception interrelate. Motor activities such as walking, running, stair climbing can be structured to encourage a child to attend visually to spatial features (Kramer 2007). Serial activities (e.g nesting cups and graduated pegs) and many constructional tasks (puzzles, block designs, and graphic copying) can be given as examples to visual– spatial perception.

5. **Tactile, proprioceptive and visual input and feedback**

   In the learning of fine motor skills, appropriate postural stability is important. Also good co-contraction of head, neck and arm muscles is required. Good ocular control, bilateral motor coordination and tactile sense affect hand functions. The child needs activities which consist of all these components in order to develop fine motor skills. For example; puzzles, finger plays, origami, peg boards (Ayres 1979, Lerner 1985, Scheerer 1997, Wilson 1988, Bumin and Kayihan 2001, Uyanik et al. 2003a).

The Role of the Vestibular System in Motor Development

The vestibular system is important in the achievement of normal motor development and coordination (Weeks 1979a, Cohen and Keshner 1989a, Cohen and Keshner 1989b, Shumway-Cook 1992). The vestibular dysfunction is observed in many developmental disorders as motor discoordination and learning disabilities (Magrun et al. 1981, Schaaf 1985, MacLean et al. 1986, Horak et al. 1988, Shumway-Cook 1992). The vestibular system is one of the first sensory systems that develop prenatally and is functional at birth due to the completion of its structure anatomically (Shumway-Cook 1992).

Normally, vestibuloocular inputs are significant in eye-head coordination which is important for stabilizing the look at one point, whereas vestibulospinal inputs are significant in maintaining postural stability with visual and somatosensory inputs (Nashner et al. 1982). The vestibulonuclear complex, the cerebellum and the reticular formation have reciprocal associations and affect motor behavior. The vestibular system is one of the wide sensory systems. Fibers pass into the vestibulonuclear complex from which they pass into the cerebellum and also into the 3. 4. 6. cranial nerves that enable extra ocular muscle movements and into all spinal levels that affect muscle tone (Ottenbacher and Petersen 1983, Kelly 1989).

The vestibular system is particularly important in the development of motor skills, the integration of postural reflexes, forming coordinated eye movements, and visual attention skills, and also in developing inquiring-behavior, and regulating the level of liveliness (Ottenbacher and Petersen 1983).

In contrast to children with isolated vestibular pathology, serious problems are observed in the motor sufficiency of children who demonstrate insufficiency in efficiently organizing visual somatosensorial inputs and normal vestibular inputs for postural control. Therapists who treat children with vestibular dysfunction stimulate the vestibular system with equipment such as swings, scooter boards, and hammocks (Shumway-Cook 1992). Ayres stated that, according to the sensory integration theory, the effect of vestibular stimulation in the central nervous system stems from the plasticity of the nervous system, and that the improvement observed in children in the period following the intervention is continuous because of undeveloped brain plasticity (Ayres 1972a, 1979).

The following can be beneficial as *the therapeutic effects of vestibular stimulation* (Weeks 1979b, Magrun et al. 1981, Pfaltz 1983, Sandler and McLain 1987, Arendt et al. 1991, Dave 1992, Uyanik et al. 2003a, Uyanik et al. 2003c):

1. Developing gross motor functions and reflex integration
2. Regulation functional balance
3. Increasing perception-motor skills
4. Developing hearing-language skills and intellectual functions
5. Increasing socio-emotional development
6. Decreasing self-injurious and/or stereotypical behavior
7. Helping the beginning of intervention by enabling individuals to be more receptive to the different forms of intervention

In assessments of determining the indication of the vestibular stimulation intervention, it is necessary that most of the following findings have positive outcomes: shortening of the post-rotary nystagmus duration, inefficiency in pivot prone (prone extension) position, hypotonicity in extensor muscles, weakness in equilibrium and support reactions, decrease in (co-contraction) joint stability, feeling of gravitational insecurity, and intolerance to movement (Fisher and Bundy 1989).

Vestibular stimulation intervention methods

In the application of vestibular stimulation, the structure and position of the vestibular stimulus is significant in the efficiency of stimulation. Whether the vestibular stimulation has excitatory or inhibitory effects is determined by the form of the stimulation. Slow, rhythmic, and passive movement has inhibitory effect; rapid movement has excitatory effect. Rotational movement and linear acceleration-deceleration stimulate different receptors. Different types of sensory stimuli form by rolling, and swing back and forth. In addition, positioning upside down, lying prone and supine or side-sitting activate different parts of the canals and otoliths at different degrees. The horizontal position and especially the prone position activate otoliths more efficiently than the upright position. The horizontal position is also the best position for semicircular canal stimulation. Ayres pointed out that different head positions and movements are necessary for the stimulation of vestibular receptors, but particularly the horizontal position is more important (Ayres 1979, Kelly 1989).

Types of vestibular stimulation:

1. To normalization of extensor muscle tone by increasing otolith organ input, linear activities are given in accordance with the order of motor development. These are:
    a. bouncing-jumping activities (whilst sitting, kneeling, or standing)
    b. linear swinging activities (using platform and T-swing, glider, hammock and barrel swinging in kneeling, standing, sitting, creeping and, prone and supine positions)
    c. other linear activities (jumping or falling onto pillows or mattress in sitting, prone and supine positions)
2. To development of equilibrium reactions by increasing semicircular canal responses, the center of gravity is changed to create disorganization for a short time and thus phasic head movements are made to appear. For this,
    a. by moving the support surface, the center of gravity is changed as active or passive.
    b. by pushing-pulling activities, displacement of the center of gravity is created. These are activities which enable active equilibrium on steep surfaces such as stairs, ramps and unfamiliar surfaces by using equipments such as balance boards, therapy balls and barrel.
3. To lessen the fear of movement or positional change by increasing the weak passing of otolith input, linear vestibular stimulation is applied in tolerable speeds and durations and in unthreatening positions (Fisher and Bundy 1989).

There are a number of precautions to consider the vestibular stimulation:

1. As a result of over stimulation, sensory overload occurs and this results in organization dysfunctions in the central nervous system. Therefore, over stimulating should be avoided, and before, during, and after vestibular stimulation, the child should be checked for evidence of over stimulation or

under stimulation and allowed to determine his own speed.
2. The over inhibition of the brainstem is the greatest potential harm resulting in seizures, cyanosis, and depression in vital functions.
3. In children with hypertonicity, a counter effect in the form of more tone increase may occur.

Sensory stimulation response is different in each child, and the child should be checked carefully at this time (MacLean et al. 1986, Fisher and Bundy 1989).

Neurodevelopmental Therapy Approach

The Neurodevelopmental Therapy Approach (NDT) which is one of the most common intervention methods utilized in the intervention of children with developmental dysfunction was first used in the therapy of children with cerebral palsy. Later, it was used in the intervention of many developmental disabilities. The NDT approach focuses on the normalization of hyper or hypotonic muscles, the specific handling intervention of equilibrium reactions and the child's movement and its facilitation. NDT is a popular therapy method within the intervention approaches of infants and children with neuromotor dysfunction (Bobath 1980, Harris 1981).

NDT has included three basic components related to neuromotor control:

1. Postural tonus
2. Reflexes and reactions
3. Movement patterns

One of the primary purposes of NDT is the facilitation of normal muscle tone in order to maintain normal postural and movement patterns. For this purpose, researchers have focused on a complex facilitation-inhibition process for many years. The Bobaths recognized that inhibition is a major factor in the control of movement and posture. It is considered to be important in the development of selective and graded movement for function. Many studies on the effects of NDT were conducted by Bobaths and other researchers, and the outcomes were satisfactory (Bobath and Bobath 1967, Bobath 1980, Bobath 1990, DeGangi et al. 1983, Ottenbacher et al.1986, Lilly and Powell 1990, Mayston 1992).

In the Bobath method, the child's functional skills are observed, and analyzed. The intervention is based on this detailed analysis, and it is customized. With functional activity education, the effects of the intervention are increased. In this approach, normal postural reactions, or problems in the relation between the central postural control mechanism and coordination need to be defined first. For automatic and voluntary activities, normal postural tonus, normal reciprocal interaction of the muscles and automatic movement patterns are priorities. All upper motor neuron lesions can be described as a disturbance to this mechanism, resulting in abnormal postural tone (spasticity, hypotonia, fluctuating tone), disordered reciprocal interaction of muscles (overfixation, lack of grading), and a disturbed automatic background of activity on which skills can be performed (Mayston 1992).

The Bobath method was used with more dynamic and functional approaches in later years. Automatic righting, equilibrium and protective reactions which were thought to be the basis of functional and voluntary movements began to focus on the facilitation. In order to enable the child to control equilibrium reactions and movements by himself, technical approaches that were applied manually were utilized less. In such an approach, because the child's reactions are corrected by the therapist's techniques, more interaction takes place between the therapist and child with a disability (Mayo 1991).

Combined Interventions

In studies conducted in the child with an intellectual disability, researchers facilitated normal mental and motor development by utilizing different stimulation techniques together. In children with developmental problems, approaches such as sensory integration intervention, perceptual-motor intervention, neurodevelopmental therapy, vestibular stimulation, play therapy, language-cognitive approaches are more effective when used individually or consecutively as may be required (Bobath and Bobath 1967, Ayres 1972a, Ayres 1979, Bobath 1980, Bumin and Kayihan 2001, Uyanik et al. 2003a, Jobling 2006).

The purpose of the NDT approach used together with play therapy is to develop individual cognitive and perceptive skills, to enable appropriate activity experiences that provide stimulus to normal movement patterns and to motivate the child by supporting normal developmental needs within the program. For this purpose, by performing activity analysis first, the therapist determines the important sections of the activity according to the child's needs and NDT targets. In this analysis, the child's motor, cognitive, perceptual and psychosocial needs and activity components are assessed. In addition, the specific NDT instrument is determined according to the child's needs. Subsequently, by giving play activities suitable for NDT techniques, the therapist enables the child's active participation in daily life activities (Anderson et al. 1987).

In enabling the child to acquire skills, the interaction of human and non-human environmental factors is significant. Therefore, the intervention should be directed not only by taking the child into the program but also by environmental adaptations that increase the child's functioning and by activities such as play activities that are multipurposeful. Thus, the child actively participates in the intervention process, skills and roles are practiced and the child becomes able to discover and integrate sensory information received from the environment by forming meaningful relations with people and objects (Lindquist et al. 1982a, 1982b). From this concept, Child-Centered intervention and Structural-Developmental intervention terms were defined to be used in the intervention of infants and young children with attention and emotional problems. In Child-Centered intervention, the child starts the play activities, and the therapist is the observer and facilitator. As in approaches applied in Snoezelen or multimodal sensory rooms, the environment is organized by arranging the available toys and materials, and a safe environment is created in which sensory-motor development can be increased without imposing prohibitions, or creating a feeling of failure (Uyanik et al. 2009). In the Structural-Developmental intervention approach, the child is taught how to gain developmental skills, and how to develop motor functions needed for sensory integration and skill performance. While this intervention is being applied, NDT or perceptualmotor training techniques can be used together to facilitate the child's performance (DeGangi et al. 1993).

General principles of combined programs applied on child with an intellectual disability as follows:

1. By taking the children's intelligence into consideration, activities that are easy to learn, and comprised of the easiest possible movement components are chosen.
2. The order of normal development is followed in the program. Following the assessment of reflex development, the appropriate activities are chosen after determining the level of weakness of integration between the child's response at one level below and top level adaptation behavior. The activities are adapted to supine-prone position, quadruped, sitting, and standing positions within the order of development.
3. By having each child work alone in the same room, confuse effects which may be caused by other people or the room arrangement are avoided.
4. By utilizing each equipment appropriately during programs, the amount of stimulation is adjusted to the tolerance level of the child. By equipping the therapy room with equipments that provide different sensory stimulations, play surroundings alternatives are created within the environment, thus enabling attentiveness and motivation.
5. In the improvement of sensory-perception-motor responses, the development of proprioceptive feedback is beneficial. Motor responses of the child are aimed to be increased by using methods such as positioning and movement activities, and applying resistance, and by utilizing touch, and equilibrium stimuli. By increasing visual stimuli besides touch and proprioceptive equilibrium stimuli, postural and motor adaptation is aimed to be achieved.
6. The program is carried out step-by-step, from easy to difficult and only progressing once the skill in the previous step has been accomplished (Gilfoyle and Graddy 1971).

DeGangi et al. 1993 stated that the following are the issues to be considered while applying the sensory-motor approach in a combined intervention of child-centered activity and structural-developmental intervention respectively:

- Behaviors and searching for the sensory stimulation that is needed for the self-organization of attention and motor movements
- Forming the idea of motor movement in the general concept of play, and developing the plan

- Organizing motor movement patterns according to activity requirements
- Increasing tactile-proprioceptive and vestibular sensory inputs which are formed in daily activities
- Practicing postural control and balance
- Putting bilateral integration components in order and teaching of their patterns
- Teaching of motor planning components with the external direction of the therapist
- Enabling the acceptance of sensory stimulation under the direction of the therapist and enabling this to be used
- Observing and controlling behavioral responses to sensory inputs

The following are the issues to be considered while applying the neurodevelopmental therapy approach in a combined intervention of child-centered activity and structural-developmental intervention respectively:

1. Creating motivation for movement and starting the movement
2. Self-generation of the planned activities
3. Detailed planning of body movements in space
4. Practicing motor movements in play schemas
5. Putting motor movements in order, timing, and planning
6. Satisfaction in motor activities
7. Developing posture and movement components
8. Practicing real-skill performance
9. Eye-hand coordination
10. Equilibrium, strength, and postural adaptation, and stability

The following are the issues to be considered while applying the functional approach (Activities of Daily Living-ADL) in a combined intervention of child-centered activity and structural-developmental intervention respectively:

1. Developing a feeling of interest in performing daily activities and motivation
2. Developing the effort of self-expression by using various activities such as drawing
3. Experiencing learned functions by using daily life devices
4. Developing visual-spatial skills within the environmental setting
5. Developing creative self-expression through play, artistic activity, movement and other activities
6. Developing more complex play levels
7. Practicing self-care skills
8. Developing perceptual and visual-motor functions which are necessary for learning
9. Transferring skills learned in therapy to the school and home environment (DeGangi et al. 1993).

Family Education

To help develop the potential of the child, education and rehabilitation programs should be initiated in the neonatal period. The aim is to establish a close relationship between the infant and the family and start developing independence in occupational performance areas in developmental milestones. It is important that the family is aware of the help they can get from the professionals and the areas of learning in which the infant needs stimulation. Ayres stated that there are five important things that parents can do:

1. recognize the problem so that they will know what their child needs
2. help their child to feel good about himself
3. control his environment
4. help him learn how to play, and
5. seek professional help (Ayres 2005)

Sensory integration, vestibular stimulation, neurodevelopmental therapy approaches etc. (combined sensory-motor and language-cognitive approaches) together with educational, behavioral and pharmacological interventions on a lifespan focus for the child may be beneficial. All children with Down syndrome do not progress at the same rate and progress is slow. Other factors such as health needs often limit the time available in the typical developmental period but with ongoing assistance motor milestone can be attained and supported (Uyanik et al. 2003a, Jobling & Virji-Babul, 2004).

Family education within early intervention programs for infants should give importance to the prone position and the variety of movement, and should consist of occupational therapy / physiotherapy programs toward the development of postural reactions, proprioceptive and vestibular stimulation, the perception of the sense of touch and body awareness, ocular control and the development of visual-motor coordination. As the child grows up, educating the family on sociocultural and spiritual components, besides mental and physical components of occupational performance, will increase the success of social integration of the child with an intellectual disability.

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