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Introduction to the Underlying Theoretical Concepts of Neuro-Developmental Treatment and Sensory Integration

In the early 1980s, a clinician trained in neuro-developmental treatment had the opportunity to observe an evaluation performed by Dr. A. Jean Ayres. The child being evaluated, an 8-month-old girl, had been referred because of delayed motor development. The assessment conducted by Dr. Ayres concluded the following: slow or absent righting and protective reactions, and a 2- to 3-month delay in gross motor development.

Dr. Ayres's proposed explanation for these findings was a dysfunction in the vestibular system: the child did not adjust her posture because she did not register her movements in space and in relation to gravity. The clinician, who perceived the child's problems in a different way, debated Dr. Ayres's findings. The clinician felt that the child had a neuro-motor dysfunction, which interfered with the movement production in response to gravity. Dr. Ayres maintained her position and recommended intervention that incorporated sensory integration (SI) as well as neuro-developmental treatment (NDT) principles.

The clinician did not hear about the case again until five years later. During those five years, the child received therapy utilizing sensory integration and neuro-developmental treatment approaches. The child had also been diagnosed with right hemiparesis. This diagnosis suggested that the delayed responses could have a neuro-motor base. However, although the neuro-motor deficit was present clinically, the child exhibited signs of severe hyporesponsivity to vestibular/proprioceptive input. The inadequate postural reactions and delayed gross motor development observed five years earlier were probably a result of the vestibular dysfunction rather than the neuro-motor problem.

The above case represents the dilemma that faces therapists when determining the optimal therapeutic intervention to address a child's specific problems. It is important to identify the primary or most fundamental problem hindering normal development before deciding on the most appropriate intervention. The question that guides the assessment process is often, Are the signs of dysfunction primarily due to disorders in sensory processing, neuro-motor functioning, cognitive abilities, or socio-emotional well-being? The answer to this question determines the appropriate treatment approaches to be used in the intervention. Sensory integration and neuro-developmental treatment theories provide two important frames of reference that contribute to understanding the child's problems and how they affect the child's functional performance.

Deciding if NDT, SI, or a combined approach would be the most appropriate intervention strategy requires an understanding of their theoretical bases; specifically, what areas each theory addresses, how each

approach analyzes the child's problems, how intervention is provided, and how the two approaches differ. Chapter 1 analyzes the theoretical foundations and practical applications of neuro-developmental treatment and sensory integration theory, focusing primarily on the rationale for utilizing both approaches. This book focuses on assessment and treatment utilizing a combined neuro-developmental treatment and sensory integration approach and concentrates on sensory and movement problems and their effect on the child's performance of daily activities.

Theoretical Foundations

Neuro-Developmental Treatment

Neuro-developmental treatment was developed during the early 1940s by a physical therapist, Berta Bobath, and her husband, a physician, Karel Bobath. The approach evolved as a response to the need for more effective treatment of the neuro-motor dysfunctions presented by the child with cerebral palsy (CP). The most frequently utilized interventions prior to that time included the use of braces, surgery, and passive stretching. The Bobaths provided a new frame of reference that viewed children with CP as having difficulties with postural control and movement as they attempted to rise against gravity. One of the Bobaths' most important contributions to the field is the description of abnormal motor development in the child with CP and its comparison to the normal counterpart (Bobath and Bobath 1975).

NDT is based on the premise that the presence of normal postural reflex mechanisms is fundamental to the performance of a motor skill. The normal postural reflex mechanisms, consisting of righting and equilibrium reactions, were seen as underlying normal tone, reciprocal innervation, and normal patterns of coordination (Bobath and Bobath 1964; Bobath 1971b). The problem in CP, described as a release of abnormal tone and reflexes, resulted in abnormal patterns of muscle coordination (Bobath 1959; Bobath 1971b). The Bobaths further proposed that the release of abnormal tone and tonic reflexes interfered with the development of righting and equilibrium reactions, which are necessary in the acquisition of normal postural control (Bobath 1959). In the Bobaths' last stage of developing their approach, they recognized the need to address functional performance during treatment. This was a significant change from previous expectations that addressing the postural deficit would automatically be transferred into everyday tasks (Bobath and Bobath 1984). Some of these premises continue to be revised today.

From the inception of NDT, the Bobaths identified sensory information as playing an important role in motor responses. They hypothesized that a normal central nervous system produces a motor response that is fed back into the system, identified by the individual as efficient, and then incorporated into the habitual movement repertoire (Salek 1979) (see figure 1-1). Children with cerebral palsy use abnormal movement patterns even when these patterns may require the expenditure of large amounts of energy. The sensory feedback elicited by the motor act further reinforces the pattern utilized (see figure 1-2). The Bobaths describe the sensations of movement as pivotal in the production of all movements, since movement that is identified as belonging to one's repertoire is repeated, regardless of its effectiveness.

NDT was developed to address this sensorimotor aspect of movement. It is geared toward eliciting a greater variety of movement experiences in the child with CP, which, in turn, provide more normal sensory experiences. These sensory experiences are incorporated into the child's movement repertoire and ultimately repeated spontaneously.

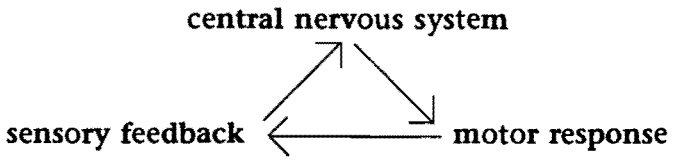


Figure 1-1: A normal central nervous system produces a normal movement that is fed back into the system through sensory experience and incorporated into the habitual movement pattern (Salek 1979).

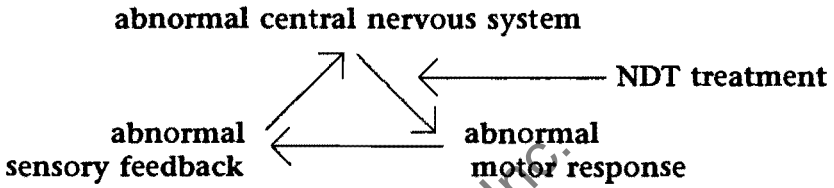


Figure 1-2: An abnormal central nervous system produces abnormal movement that is fed into the system through sensory feedback and incorporated into the movement repertoire. Treatment is geared toward changing the movement, which will change the sensory feedback (Salek 1979).

Advances in the areas of motor learning and motor control have modified some of the initial assumptions of NDT theory (Bly 1991). Recent findings suggest that sensory input is important in eliciting postural adjustments; however, postural adjustments may also be produced by the individual in anticipation of an event that requires a change of posture in relation to gravity and will rely on feedforward as much as on feedback (Bly 1991). These findings add another dimension to treatment and, in a way, approach sensory integration. The impact of the advances made in motor control and motor learning will be reviewed later in this chapter.

Sensory Integration

The theory of sensory integration was developed in the early 1960s by A. Jean Ayres, an occupational therapist and psychologist. When treating children with CP, Ayres noticed that some of these children were unable to perform a motor task for reasons other than the existing neuromotor deficit (Ayres 1984). She hypothesized that in some cases inadequate visual perception, rather than inadequate motor control, hindered these children's capacities to function. At first Ayres's interest focused on investigating the impact of visual perception on movement. Her research findings in visual perception did not provide the answers to all of the existing perceptual problems and led her to study the importance of tactile, kinesthetic, and vestibular processing on movement, learning, behavior, and emotional well-being (Ayres 1979).

Ayres conducted numerous factor-analytic studies in children with and without learning difficulties and identified dysfunctions in the tactile, vestibular, proprioceptive, and visual systems. Dysfunctions in sensory

processing were found to interfere with the development of motor planning, language, behavior, emotional well-being, and cognition (Ayres 1972a, 1979, 1985, 1989). Research by Ayres and others supported these assumptions and established the foundation for the development of sensory integration theory (Ayres 1972a).

The theory of sensory integration is summarized in figure 1-3, which is based on Ayres's (1972a, 1979, 1984, 1985, 1989) theory. From left to right, this diagram is a developmental progression of the child from birth to the school years. SI theory emphasizes that tactile, proprioceptive, and vestibular systems contribute to the development of muscle tone, automatic reactions, and emotional well-being (Ayres 1972a, 1979). At birth, the child's actions are often in response to input from these sensory channels. The reflexes and reactions present in the infant are elicited by tactile, vestibular, and proprioceptive processing; for example, rooting, grasp, and placing reflexes occur in response to tactile input, while labyrinthine head righting, Moro response, and traction occur in response to vestibular/proprioceptive input.

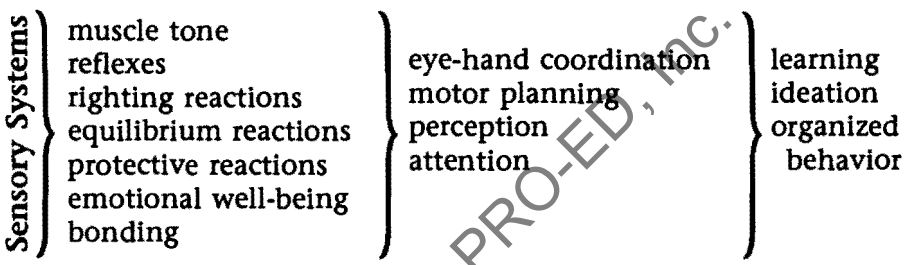


Figure 1-3: The sensory systems and their impact on movement, learning, and behavior.

The tactile, proprioceptive, and vestibular systems also contribute to emotional well-being and mother/infant bonding; for example, children calm down when firmly swaddled in a blanket or when gently rocked. These are emotional responses that are affected by sensory input, such as pressure and movement. As children mature and expand their relationships with the environment, the visual and auditory systems become more important and are integrated with the other sensory systems. For example, infants learn to visually focus on an object and direct their hands toward it. This eye-hand coordination requires the integration of several types of sensory input: vestibular, proprioceptive, and visual information to maintain the upright posture, and vision and proprioception to guide the approach to the target. When the child's hand makes contact with the object, the child integrates tactile information about the object's texture with visual information about size, shape, and color. Further manipulation of the object generates proprioceptive/kinesthetic feedback from the child's hand movements in response to the object, which may help to clarify information about size and shape.

Inadequate processing of sensory input may negatively impact motor, cognitive, and socio-emotional areas of development. Sensory integration treatment was developed to help children who present problems in motor, cognitive, and socio-emotional development that are related to inadequate sensory processing. The difference from previously utilized approaches is the focus given to the sensory aspect of the action.

Basic Hypotheses of Neuro-Developmental Treatment and Sensory Integration

When combining treatment approaches, it is important to determine if the hypothesis of each theory offers congruent explanations for the same phenomenon (Parham 1987a). NDT and SI approaches offer complementary explanations for different phenomena. While SI focuses on the sensory processing aspect of the motor act, NDT focuses on the motor response to the sensory input. NDT and SI each provide the missing element for the other, resulting in a more comprehensive approach to the child's problems. Table 1-1 summarizes the bases of NDT and SI.

Table 1-1
Summary of the Bases of Neuro-Developmental Treatment and Sensory Integration

	Neuro-Developmental Treatment (NDT)	Sensory Integration (SI)
Aim of Theory	treatment approach for abnormal postural adjustments and movement patterns in the CP population	understanding sensory processes and states of sensory integrative dysfunction
Focus of Treatment	increasing and improving motor output for functional performance	normalizing sensory processing and integration to produce adaptive responses
Assessment Method	initial emphasis was on clinical observations—standardized assessments are in the process of being developed	standardized assessment tools from the start (SCSIT, SIPT)—clinical observations used in conjunction with standardized assessment
Evolution	refer to figures 1-4 and 1-5 for details	

Adapted from Blanche, E. and J. Burke. 1991. Combining neurodevelopmental and sensory integration approaches in the treatment of the neurologically impaired child: Parts 1 and 2. *Sensory International Quarterly* XIX(1/2).

The first two differences between NDT and SI are found in their aim and focus. NDT was originally developed as a treatment approach for an already identified diagnosis (CP). In contrast, sensory integration theory was aimed at understanding how processing of sensory input impacts normal development and contributes to states of dysfunction; the types of dysfunction had not been previously identified in the literature. The focus of NDT is to enhance motor control during the performance of functional skills while the focus of SI is to understand sensory processes and their impact on motor, cognitive, and emotional development.

Differences and similarities between NDT and SI are also found in assessment methods. The assessment method of both approaches includes clinical observations of motor responses; however, NDT focuses on dysfunction in motor output while SI concentrates on dysfunction in sensory processing. In addition, the theoretical body of sensory integration includes standardized assessment tools (SCSIT and SIPT) that evolved in conjunction with theory and treatment (Ayres 1962, 1989).

Until recently, standardized assessment tools to measure quality of movement were not available. At present, a few assessment tools are available that objectively analyze components of movement, including *Movement Assessment of Infants* (Chandler, Andrews, and Swanson 1980), *The T.I.M.E.™* (Miller 1994), and *Alberta Infant Motor Scale* (Piper and Darah 1994). These assessment tools will facilitate the evaluation and research in NDT and early intervention.

The last major area of comparison is the evolution of theoretical concepts. The questions that prompted the development of both neurodevelopmental treatment and sensory integration originated from clinical situations. Bobath's (1954) question focused on how to treat children with CP; Ayres's (1969, 1972a) question focused on previously unidentified sensory processes underlying learning, behavior, and movement. The approach to each question was different. The Bobaths addressed the question within the clinical setting. They developed a treatment approach and, in the process, described the movement problem in CP in a different manner than previously documented. After the Bobaths clinically assessed the success of the intervention, they searched the literature for the underlying neurophysiological hypothesis that explained its effectiveness. Figure 1-4 depicts the evolution of NDT theory.

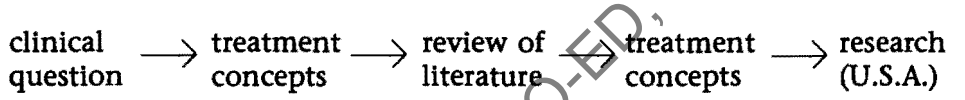


Figure 1-4: NDT: Evolution of theory and treatment concepts

The question that led to the development of SI originated in the clinic, but its answer was first addressed through a review of the literature and research (Ayres 1962, 1963, 1965). In the process of learning about sensory processing, Ayres developed standardized evaluation tools that later helped to define the theoretical constructs. After Ayres formulated some answers regarding how to identify sensory dysfunctions, she returned to the clinic to conduct more research on the effectiveness of the intervention (1972c). Ayres continued to conduct research on the nature of the disorder until her death in 1988 (Ayres 1985, 1989). Figure 1-5 depicts the evolution of SI theory.

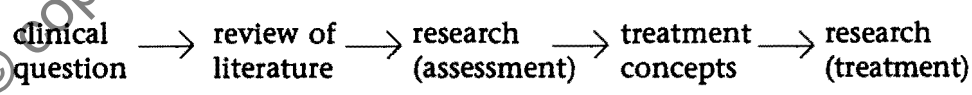


Figure 1-5: SI: Evolution of theory and treatment concepts

The history of NDT reveals that research was not performed during the initial stages of theory and treatment development. The need for research became evident when the treatment approach became popular in the United States, where a strong research tradition prompts verification of treatment assumptions. At the present time, research focusing on the effectiveness of both approaches continues to be conducted.

NDT and SI offer complementary explanations for different phenomena. An SI frame of reference focuses on processing and integrating sensory information and their impact on skill development (Ayres 1979). The model of SI summarized in figure 1-3 (page 4) provides a simplified view of the theory. Initially, sensory processing impacts the development of reflexes, postural reactions, and emotional well-being. Next, sensory processing impacts motor planning, eye-hand coordination, language, and purposeful organized actions. Later, acquired skills that are affected by sensory processing include attention, learning, and organized behavior in time and space. This increased complexity in functional performance requires the integration of multiple sources of sensory input.

SI treatment addresses the development of all of these areas of functional performance. The theory of SI stresses the importance of treating the sensory processing disorder; however, no detailed explanation exists for evaluating or treating postural deficits. Sensory processing is important in developing adaptive skills for purposeful and efficient interaction in the environment. The theory proposes that lower levels of development contribute to higher levels. Based on SI theory, postural control provides the necessary building blocks toward the development of higher-level skills. Precise clinical assessment and treatment of postural control and automatic reactions are necessary as they impact development in other areas. It is here that NDT provides the tools to identify and treat dysfunction. It is important to clarify that in the case of an identified SI dysfunction, NDT is considered an addition to the SI treatment and is most definitely not utilized to take the place of SI therapy.

From an NDT frame of reference, NDT provides a model to explain movement dysfunction. This model identifies the sensory component of movement but does not address the impact that abnormal sensory processing has on the development of postural control and movement. SI complements NDT by increasing our understanding of sensory processing, motivational aspects, and praxis (Montgomery 1991). For instance, children who do not process sensory information adequately will not respond as expected to the therapeutic handling offered by an NDT approach. This maladaptive response to treatment is often incorrectly interpreted by the therapist as a movement disorder or as a behavioral problem. In the child with cerebral palsy, SI can then be utilized to identify and treat sensory processing dysfunctions and to impact arousal level, motivation, and movement responses. Again, SI is not to be used as a substitute, but as an addition to the NDT approach.

Principles Common to Neuro-Developmental Treatment and Sensory Integration

Although NDT and SI evolved from different disciplines and with different research traditions, they share the following common basic principles:

- address a central nervous system dysfunction and offer neurological explanations
- address automatic basis of movement and behavior
- utilize motor control theories to describe treatment processes
- attempt to obtain an adaptive response in treatment

Addressing a Central Nervous System Dysfunction

Both CP and sensory integrative dysfunction have a neurological base. However, while CP occurs as a result of damage in the cortical and subcortical centers of the brain that control movement, sensory integrative dysfunction is considered a dysfunction of the subcortical mechanisms of sensory processing (Ayres 1972a; Moore 1984).

The movement disorders presented by the child with SI dysfunction have a sensory processing base and are not due to damage to cortical centers. The sensory processing disorders presented by the child with CP may have several bases and may be primary or secondary (Moore 1984). Primary sensory processing deficits occur as a result of the cortical and sub-cortical lesions that are responsible for the movement deficit. The damage in the motor production areas may have also affected sensory processing areas. Secondary sensory processing deficits occur as a result of lack of movement that, in turn, deprives the child of normal sensory experiences (Moore 1984; Windsor 1986). The reduced movement results in the child's inability to obtain meaningful information from the environment.

Addressing Automatic Basis for Movement

Both NDT and SI treatment approaches advocate the development of automatic postural control and coordination. NDT focuses on the ability to use automatic postural adjustments in response to changes in the environment and changes in one's body during the performance of functional activities. SI focuses on the development of adequate sensory processing skills and the integration of multiple sensory experiences during play and functional activities. Attention is necessary when learning a new task but normal sensory integration ensures that excessive cognitive strategies are not required to compensate for the sensory requirements of a task. The sensory and motor aspects should become automatic once the task is habitual.

Utilizing Motor Control and Motor Learning Theories to Describe the Treatment Process

The findings made in motor control and motor learning theories impact the therapeutic approaches of occupational and physical therapists. As a result, advances in these theories affect the evolution of SI and NDT.

In sensory integration, the most evident utilization of motor control and motor learning theories is found in the explanation of practic disorders. Ayres (1985) referred to the motor learning literature to help explain the nature of dyspraxia as a disorder in the relationship between limited practic development and the demands of the physical environment (Ayres 1985). Fisher (1991) applies the findings of motor learning theories to explain the role of feedforward on praxis. Based on the work of Ayres, Fisher (1991) subdivides practic disorders into four groups: practic disorders with a tactile base, or *somatodyspraxia,* practic disorders with a vestibular base, or *bilateral integration and sequencing disorders,* disorders in constructional ability that may be due to inadequate visual perception, and praxis on verbal command deficits that may result from a left hemisphere dysfunction. Somatodyspraxia is a disorder that affects the sensory feedback mechanism. Bilateral integration and sequencing disorders are affected by an inadequate feedforward mechanism (Fisher 1991; Cermak 1991), or the ability to anticipate actions in space and time.

The recent findings in motor control and motor learning have also affected the application of NDT principles. Bly (1991) applies these findings to NDT principles and proposes that the movement limitations in the child with CP are attempts to reduce degrees of freedom in one joint and thus gain control over movement in another joint. These attempts were traditionally referred to as *fixing*. Therapists utilizing an NDT approach use key points of control to help the child gain control over a movement (Bly 1991). Reducing the degrees of freedom by fixing is also observed in the child with SI deficit, who could benefit from the addition of an NDT approach.

Traditionally NDT has emphasized the application of sensory input to elicit a postural response; however, Bly (1991) states that the postural mechanism needs to rely on feedforward or anticipation as much as on feedback from the environment. In treatment, we need to motivate the child to initiate postural control throughout a functional activity rather than exclusively rely on the therapist to impose movement (Bly 1991).

The importance of motivation in task-oriented and context-relevant activities that is presently emphasized in motor learning theories (Bly 1991; Horak 1991) is also addressed in SI theory and traditional occupational therapy. Horak (1991) describes a task-oriented approach as advocating less "hands on." In the clinic, less "hands on" requires emphasizing function through the practice of movement patterns within a functional task-oriented context and the teaching of motor problem-solving strategies to meet the environmental demands. In NDT these findings emphasize the need for the child to actively participate in problem solving the movement rather than be a passive recipient of imposed movement (Horak 1991; Bly 1991).

Producing the Adaptive Response in Treatment

Ayres (1984, 1) defined the adaptive response as "an effective response or interaction" with the environment. The individual either responds to sensory input presented by the environment, such as in the production of a postural reaction, or initiates a sensorimotor action in response to an "invitation" from the environment, such as maneuvering through an obstacle course (Ayres 1984). It can be said that NDT addresses lower-level adaptive responses, such as postural adjustments, and SI addresses adaptive responses at lower and higher levels, such as motor planning, attention, and organization of complex behaviors in space and time. However, the advances that have been made in motor control and motor learning theories have affected the use of sensory input in the production of postural responses when utilizing an NDT approach. At the present time, the importance of the client's initiation of postural adjustments during functional activities is being emphasized (Bly 1991).

Clinical Applications of Neuro-Developmental Treatment and Sensory Integration

Based on the complementary theoretical formulations of NDT and SI, these approaches can easily be combined in the clinical setting. However, practitioners must be aware of the differences in therapeutic application as these will assist in the clinical reasoning process. The differences are found in three areas: the purpose of treatment, the roles of the child and therapist, and the role of the treatment environment. These points are summarized in table 1-2 (page 10).

Table 1-2
Differences in Therapeutic Application of NDT and SI

	Neuro-Developmental Treatment (NDT)	Sensory Integration (SI)
Purpose of Treatment	Elicit automatic postural adjustments to impact function	Enhance sensory processing to impact movement, learning, and socio-emotional well-being
Role of the Therapist	Therapist controls direction and planning of the session	Therapist controls the environment and guides the child; treatment is child-centered
Treatment Environment	Utilizes movable surfaces, including therapist's body	Utilizes suspended equipment, large equipment, and/or textured equipment; needs large space for unlimited possibilities

The Purpose of Treatment

The purpose of a traditional NDT session is quite different from that of an SI session. The goals of treatment in NDT include inhibiting abnormal patterns of movement while facilitating normal movement synergies during functional activities. Attaining control in these areas will expand the child's functional capability in daily living activities. The child is therapeutically handled to change movement components that occur during functional activities. The child can be treated while engaged in situations such as riding a bike, getting dressed, or self-feeding (Bobath and Bobath 1984).

The purpose of an SI session is to increase the child's ability to freely interact with objects and space within the ever-changing environment. Specific treatment objectives include normalizing sensory processing to affect arousal levels, attention, and motivation, and enhancing ideation, motor planning, and organization of behavior. Attainment of these goals improves the performance of functional tasks in the environment.

Montgomery (1991) offers an NDT and SI integrated assessment model that includes observation of: motivational state, motor programming, sensory feedback and feedforward, developmental skills, and biomechanical constraints (Montgomery 1991). In such a model, SI and NDT provide different information in each assessed area, which yields a more holistic picture than when only one approach is utilized.

The Roles of the Child and the Therapist

When combining NDT and SI, it is important to be aware of the varying role of the therapist. The differences between NDT and SI exist in the focus of each treatment approach and the style utilized by the therapist to address the child's deficits.

As previously mentioned, the focus of NDT and SI is different both theoretically and clinically. NDT focuses on specific movement patterns that affect function and therefore requires a more direct therapeutic intervention. The treatment session is directed and controlled by the therapist. The therapist can make a decision regarding the activities to be used during the session and often has a good idea of how the session will progress. The session may focus on handling a specific part of the body, such as the

trunk or the upper body, in order to obtain the movement component needed for a specific functional task. This component will ideally become part of the child's motor repertoire during everyday activities. Two sessions may be similar or identical and still be considered successful.

Successful SI intervention is not strictly controlled by the therapist. Due to the nature of SI dysfunction (including tactile defensiveness, autism, gravitational insecurity, and dyspraxia) and its impact on behavior, the therapist's role is to cue into the child's deficit, allow the child to assume control over actions during the treatment session, and modify the environment in order to obtain the desired adaptive response. The therapist utilizing an SI approach has a global view of the child that includes arousal level, attention, motivation, motor planning, and problem solving. The session relies on the child's inner drive and intrinsic motivation to interact in the environment. Inner drive and intrinsic motivation are utilized in treatment by encouraging the child to choose the activities to be performed. The sequence of an SI session cannot be predicted beforehand. Most important, the clinician needs to understand the child's needs and follow the child's lead without imposing previously planned activities. Therefore, the focus of an SI session may appear less specific. The clinician needs to provide activities that are difficult enough to challenge the child but still ensure success. Therapy sessions that continue to repeat previously performed activities have questionable therapeutic value.

The Importance of the Therapist's Individual Style

Each clinician needs to be aware of his or her own style and its effect on treatment and on the child's behavior. Therapeutic style can be viewed in a continuum from total control to total freedom. Therapists who tend to have control over the session constantly challenge the child to produce adaptive responses through handling and by modifying the environment. Therapists who allow more freedom during the session challenge the child to produce adaptive responses through the intrinsic motivation of the child. Figure 1-6 depicts this continuum.

SI session _____ NDT session

More freedom _____ More control

Figure 1-6: The continuum of SI and NDT sessions.

The style of most therapists falls at some point on the continuum rather than at either extreme. Therapists modify their style according to the child's behavior, the environment, and their own perceptions of how a specific treatment session is progressing. Allowing a sense of freedom by providing the child with choices during the treatment session is a successful strategy to use with children diagnosed as autistic or who are hesitant and insecure. Increased control and challenge, on the other hand, is a more successful strategy when dealing with more passive children or children who avoid challenging situations.

Various styles are more successful in different situations. During the intervention it is important to recognize one's own style and to modify it if necessary to meet the child's needs. However, situations exist in which the therapist may be unable to adjust his or her style enough to accommodate the child. A different therapist may be more successful in this situation.

Figure 1-7: The therapist utilizing NDT is usually in closer contact with the child.

In reference to NDT and SI, each of these approaches requires a different treatment style. The utilization of NDT requires the therapist to have more control over what will be done and when (see figure 1-7). The therapist frequently challenges the child to adjust posturally during the session by moving the child in space to modify the movement and sensory input that the child receives. The therapist may need to allow more freedom when encouraging the child to initiate movement, as supported by the recent findings in motor learning (Bly 1991). When expecting the child to initiate action, arousal and motivational states need to be addressed. These aspects are the traditional focus of SI. Once the child is moving, offering choices and allowing freedom provide information about motor planning, sensory processing, and volitional movement.

On the other hand, the therapist utilizing an SI approach allows the child to move freely and to have control over the choice of activity to be performed. SI capitalizes on the intrinsic motivation of the child, so the child's drive to perform an activity is pivotal to the success of the session. However, the therapist needs to incorporate a firmer strategy when addressing postural deficits. Utilizing aspects of an NDT approach provides the therapist with information about alignment, postural stability, and movement patterns. These areas often require a higher level of direct intervention than that traditionally utilized in SI. The goal of the therapist, in that case, is to incorporate the principles of NDT in such a way that the child does not lose the intrinsic motivation to perform the activity.

The Role of the Treatment Environment

The utilization of the environment differs quite a bit between NDT and SI. In a traditional NDT approach, the therapist uses the hands to guide the child's movements, while in an SI approach, the therapist modifies the environment to obtain the desired response from the child (see figures 1-7 and 1-8). Therefore, the physical environment plays a much more important role in a treatment session utilizing an SI approach than in a treatment session utilizing an NDT approach. The therapist utilizing an SI approach needs an environment that provides the opportunity to explore and experience a variety of sensory input while producing novel adaptive responses.

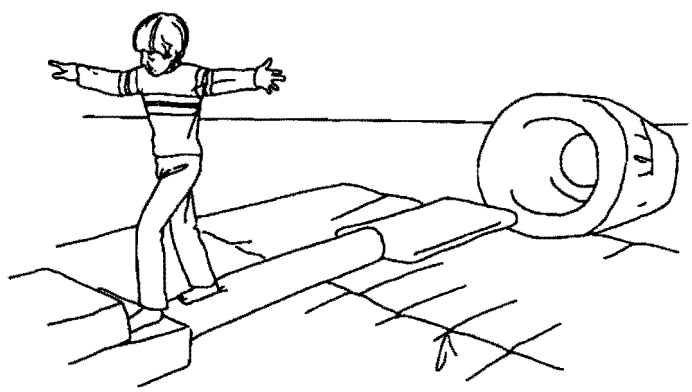


Figure 1-8: The therapist utilizing an SI approach positions herself further away from the child, allowing the child to explore the environment.

The therapist utilizing a traditional NDT approach needs an environment that provides the opportunity to experience the postural adjustments and basic movement patterns required during functional tasks. The recent drive to incorporate contextual cues into the NDT treatment of CP increases the importance of the environment. Further environmental differences between NDT and SI are observed in the use of space and the availability of equipment.

Sensory integration therapy requires a physically and emotionally safe space that invites the child to move and explore. The space needs to be large enough to allow for the safe use of suspended as well as other types of equipment and to allow for novelty in order to assist the child with organizing behavior.

Treating children who have motor planning, ideational, or behavioral problems requires a space that can be changed from one session to another so that the child does not memorize a pattern of response. Novelty and flexibility in the SI clinic can be facilitated through the utilization of a ceiling support system that allows for the use of a variety of suspended equipment, as well as other large and portable equipment, for activities such as climbing and constructing. As children treated with SI often have better movement control than children traditionally treated with NDT, the environment should also allow the child opportunities to jump, run, hang, slide, glide, push, pull, swing, and roll (see figure 1-9).

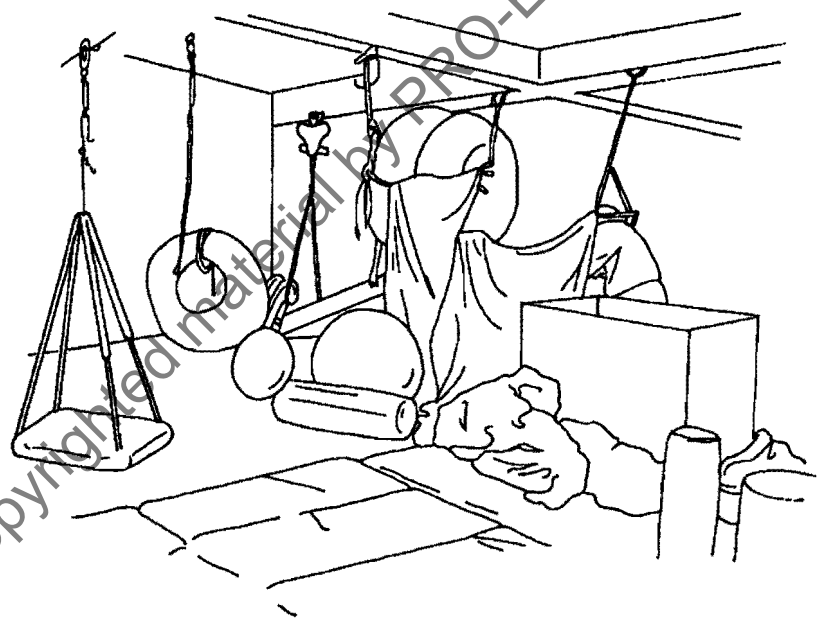


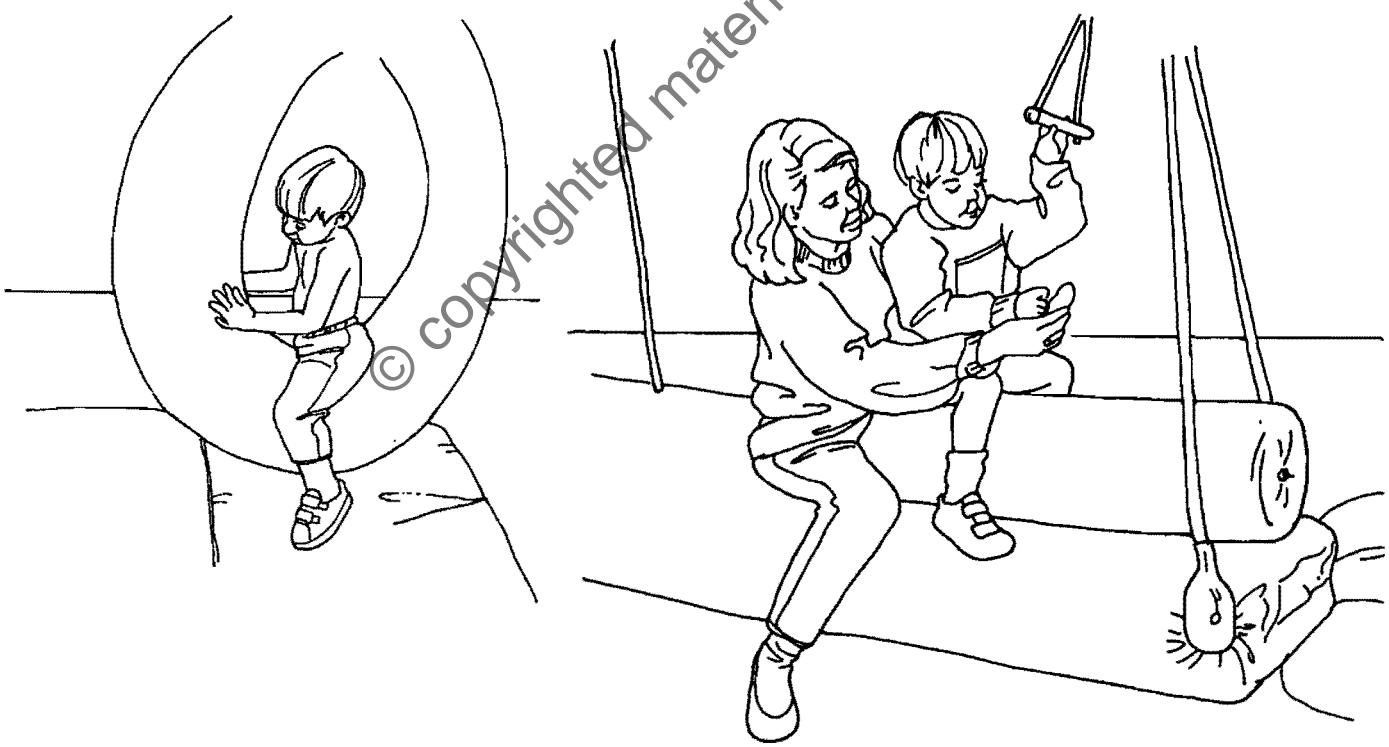
Figure 1-9: This illustration shows an example of the space traditionally utilized in SI. The equipment utilized in NDT (bolsters and balls) occupies part of that space.

NDT does not necessitate such a large space; however, it does require some basic equipment. When facilitating postural control for movements, the space is not as important as the equipment, which provides movable surfaces. Some of the most common equipment includes balls and bolsters of all sizes. When treating small children, therapists may even use their own bodies to facilitate postural reactions; for instance, the therapist may sit a child on his/her knee while the child rests both feet on a mat. By moving the knee slowly from side to side, the therapist challenges the child's postural adjustments.

The need for a smaller space and less equipment for an NDT approach allows the therapist more flexibility in choosing the location of the therapeutic intervention. Children treated with NDT can easily be treated at home, in school, or within other functional contexts. On the other hand, the challenge of treating children with SI dysfunctions in the school and at home requires immense creativity and adaptability.

In addition, the SI clinic needs to include materials that provide tactile and proprioceptive input. Proprioceptive input is increased when actively contracting a group of muscles against resistance (Fisher 1991), which is often received during play with bulky or heavy equipment. A variety of tactile experiences can be provided by covering the equipment with different textures. Other types of somatosensory input are provided through the use of large pillows, mattresses, and inflatable cushions, which are used for protection and to provide additional deep pressure (Ayres 1979; Slavik and Chew 1990).

Although the utilization of space and equipment in SI and NDT has traditionally been different, most of the SI equipment can be adapted to suit the child with CP. Daniels and Mattice (1987) describe the use of a bolster swing and an adjusted platform swing to address problems typically seen in children with CP. In addition, a child with CP can sit on a bolster swing or tire swing with the feet placed on the floor. The increased movement possibilities provided by this equipment allow the child to initiate movement with the lower extremities (see figure 1-10). Chapter 6 offers specific ideas for adapting the SI equipment for children with CP. When utilizing SI equipment with the child with CP, the therapist continues to control the child's movement experiences; however, this is often accomplished by controlling the equipment, rather than by physically handling the child. In some cases, the therapist sits on the equipment with the child and moves the equipment to encourage the child to shift his weight (see figure 1-11).



Figures 1-10 and 1-11: The use of SI equipment with the child who has CP.

Combining Neuro-Developmental Treatment and Sensory Integration

The style of a combined NDT and SI approach depends on the child's difficulties, the therapist's skills, and the context of the interaction. NDT and SI can be combined in different ways. Both approaches may be used together, without one taking precedence over the other. Either NDT or SI may also be used as the primary treatment approach with the other method serving a secondary role or used only in specific situations. For example, SI is the primary treatment approach with children who have learning disorders, attention deficits, and autism, and NDT is the primary treatment approach for children with CP. Finally, NDT and SI may be combined by having two different therapists each utilize one of the approaches. In this last case, close communication is strongly recommended.

Precautions

It is important to emphasize precautions when utilizing any treatment approach with a population for which it was not intended. When utilizing NDT with children who have sensory integrative dysfunctions, a number of concerns are evident. Hypo- or hyperresponsiveness to therapeutic handling is an important consideration. Therapists should also consider whether the changes in position and the movements they impose are perceived by the child as threatening, as is often the case with gravitational insecurity. Utilizing NDT with a child whose problems go beyond postural deficits limits progress in other important areas, such as praxis and organization of behavior.

When utilizing SI with the child with CP, difficulties may also arise. An increase in abnormal posture and movement may occur; for example, linear vestibular input increases extensor tone and in some children with CP excessive extensor tone does not need to be increased. Also, children with CP often lack independent mobility in the environment. In such a case, a pure SI approach would be difficult and inappropriate.

Summary

SI and NDT offer complementary explanations for a child's deficits. NDT focuses on the postural aspects and their impact on function, while SI focuses on sensory aspects and their impact on motivation, attention, movement, and socio-emotional well-being. Both approaches can be easily combined in the clinic while treating the child with CP and/or SI dysfunction. However, combining NDT and SI requires a deep understanding of their theoretical bases and the clinical applications of each approach.