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## Sensory-Motor Integration: A Perceptual-Motor Approach for Enhancing Motor Planning in Children with Special Needs

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Sensory-Motor Integration (SMI) is a multifaceted approach developed by the authors to enhance the quality of movement and motor planning for children with special needs. This chapter describes the SMI approach as well as its methods of assessment and intervention. This material is intended to serve as a guide for parents and professionals who seek new methodology for instructing movement in children with special needs.

SMI can be best described as a multisensory approach to addressing learning needs of children who have been diagnosed primarily with developmental delays, autistic spectrum disorders, hypotonia/motor delays, and apraxia, among other diverse clinical diagnoses related to early childhood development. By incorporating visual- and audio-motor perception, kinesthetic awareness, laterality, directionality, haptic perception, and vestibular stimulation, SMI enables children with special needs to sequentially and successfully acquire motor capabilities and motor planning.

The goals of the SMI approach are to:

- Enhance the child's quality of movement and motor planning.
- Expose the child to a multisensory milieu that will strengthen his relationship with the world around him.

- Incorporate perceptual-motor activities to improve visual-motor, audio-motor, and spatial awareness.

To achieve these goals, SMI builds upon two basic concepts: a child (1) learns to move, and (2) learns through movement. The fundamental difference between these two concepts is very important. *Learning to move* involves continuous development in a child's ability to use the body effectively and joyfully, with increasing evidence of control and quality in movement. It involves the growing ability to move in a variety of ways, in expected and unexpected situations, and in increasingly complex tasks. *Learning through movement* implies using movement as a means to an end, but the end is not necessarily the end of improvement in the ability of the child to move effectively. It is a means through which a child may learn more about herself and about her environment. It is not enough to assume that movement control and skill development will automatically occur for all children simply by virtue of having experienced a movement task: the challenge is far greater than this. To imply that a child *may not* improve and extend the range of quality in her movement as she tries to express feeling through movement is not to

say that she *will not*. The learning environment must make it possible. Consequently, it is essential for therapists to know what they hope to accomplish both *in* and *through* movement as they plan for this learning environment. In other words, to know what is possible, therapists must know the child and know movement.

### MOVEMENT: THE BASICS

A number of clinicians have observed the importance of movement to the larger goal of integrating different mental processes. For example, it has been observed that, through movement, individuals have greater access to thoughts and emotions and can better translate them into a language of action. It is this expression that creates intelligence and individuality. Hannaford (1995) hypothesized that “Every time we move in an organized manner, full brain activation and integration occurs, and the door to learning naturally opens.” Recent research has suggested that two areas of the brain—the basal ganglia and the cerebellum—which are associated solely with control of muscle movement, are also critical to coordinating thought. These areas are connected to the frontal lobe, where subsequent motor planning and reaction time occur (Humphries, 1990).

Neuropsychological functions relate to movement and are extremely important in how the child will feel about himself emotionally, as well as interact with, and learn from, his social world. For example, problems in motor planning and sequencing (stringing together a set of motor responses) not only lead to frustration and lowered self esteem in a child, but may also impair a child’s further brain and social-emotional development, including:

- *Play with parents and peers.* When a child cannot maintain reciprocal motor responses with others in a play game, the

result is dysynchrony, or the child being “out of sync.”

- *Exploration of the environment*, which leads to a sense of one’s body and a sense of self, and the ability to distinguish reality from one’s imagination.
- *Mastery of separation anxiety*, and control over his body environment.

Furthermore, these children frequently have temperaments that are immature, demanding, needy, oppositional, and defiant. These qualities, in addition to the child’s movement difficulties, will further strain the child’s relationship with her parents, who may already have their own stresses, such as marital problems or financial difficulties. Parents may then respond negatively, leading to a vicious cycle of constant tension and negative interactions between child and parent. The consequences of this negativity may be seen in temper tantrums, emotional outbursts, control and power struggles, and other adversarial behaviors. By the age of 2 or 3, children can begin to manifest the beginning of certain developmental pathways, placing them at risk for specific problems later in development. An awareness of these patterns allows a therapist to intercede with early identification of at-risk children, early treatment interventions, and—very importantly—prevention. There is conclusive evidence that school programs for preschoolers with learning disabilities are working by preventing future learning failures.

The SMI approach stresses the importance of a multisensory approach that stimulates two or more sensory apparatus each time a child attends a therapeutic session. The typical SMI candidate ordinarily exhibits several of the following characteristics: low muscle tone, delayed speech, poor motor planning, poor body awareness, and a fear of heights.

SMI attempts, in each therapeutic session, to encourage the child to perform activities that she has not been able to accomplish elsewhere. We allow her to engage in activities that demand rapid and frequent left brain-right brain communication, and make certain the child is exposed to situations where she is able to express herself freely and creatively, stimulating many new avenues of the nervous system. Activities that involve height, speed, excitement, courage, and revolution activate many different parts of the cerebral cortex, causing never-before-stimulated parts of the brain to “wake up!” (Youssefi, 1987).

The critical link between brain activity and movement has been a curiosity to scientists for many years. Scientists have long recognized that children who skip the critically important crawling stage may exhibit learning difficulties in the future school years. The motor act of crawling activates development of the corpus callosum. Performing cross lateral movements, like crawling, stimulates both sides of the body to function in unison. With equal stimulation of the two hemispheres, the senses actively access the neural pathways, which allow both sides of the body to move together in an integrated fashion for more efficient movement (Hannaford, 1995).

### **THE IMPORTANCE OF THE INDIVIDUALISTIC SENSORY-MOTOR INTEGRATION APPROACH**

In addressing the children’s mental health needs as well as their physical and emotional well being, SMI creates an environment for learning that addresses the specific learning deficiencies of each individual child. SMI, in conjunction with other essential developmental therapies, aids in sensory-motor processes such as reading, writing, language development, cognition, social awareness, kinesthetic awareness, and self-concept. The difference

between the SMI approach and other distinct therapeutic approaches lies primarily in the implementation and lesson planning procedures. It is based on the belief that children surmount insurmountable tasks through the knowledge of and exposure to multisensory activities that are designed specifically to meet individual needs.

It is imperative for children to be exposed to and explore each and every aspect of the sensory milieu in order to be proficient in their learning processes. Thirty years of experience with children with special needs and with movement has led to the formation of a few basic principles for SMI, which are:

- Children perform more efficient motor planning when given the opportunity to explore diverse movement settings.
- Children with special needs need to engage in integrated activities in order to improve multifaceted learning deficiencies.
- Affect-driven responses can be attributed to a child’s interest and sensory-motor needs.
- Therapists involved in the child’s treatment program play a critical role in motivation and encouragement.

### **FORGOTTEN PERCEPTUAL-MOTOR AND SENSORY EFFICIENCY THEORIES**

Motor therapy specialists and perceptual-motor pioneers discovered many links between movement and learning. Unfortunately, their contributions and hypotheses have long been overlooked and unappreciated. The lack of demand for perceptual-motor theory and a lack of educational curriculum for the field has buried many important concepts and methodologies.

Research by many theorists supports the principles behind the integrated SMI approach. Raymond Barsch (1967) explored the educational needs of children whose

problems in learning did not lend themselves to precise and neat categorization. Barsch's theory of "movigenics" depicted the origin of development of patterns and movement in man and the relationship of those movements to his learning efficiency. Barsch's primary concern was the developing child and his problems in achieving a mature adult status. The backbone of Barsch's "movigenics" was the concept that physical and cognitive movements are inseparable. Barsch based his theory on the concept that "Man moves. Man learns. He learns to move. He moves to learn." This concept helps to describe problems confronted by children in static classroom and learning environments. Barsch, therefore, linked the necessity of developing mature movement patterns to proper cognitive processes, which would lead to success in learning environments.

Newell Kephart further advanced the theory of perceptual-motor development and its impact on academic potential. In his now classic book, *The Slow Learner in the Classroom*, Kephart (1960) stated that in order for learning to take place effectively, perception and movement had to be coordinated—a process that occurred through a wide variety of sensory experiences and movement opportunities. As a result, movement and perception had to be integrated and function simultaneously (Arnheim & Sinclair, 1975).

Getman, an optometrist who believes visual perception could be developed through motor training, analyzed perceptual-motor development and its component parts. According to Getman, perception is a process through which an individual's sensory skills translate reaction to the environment into physical movement. An individual's perception of her environment serves as a blueprint for her subsequent motor tasks. Perception includes the integration of visual, auditory, and tactile functions.

The interdependence between perceptual and motor skills is a priority for the SMI methodology and for children's academic and social success (Youssefi, 1987). A child with special needs may inefficiently integrate these perceptual-motor skills. To address this need, Jean Ayres analyzed central nervous system processes and their impact on learning (Ayres, 1979). Her theories of sensory integration described how the child used the input of the eyes, ears, and body to acquire information from the outside environment to help make sense of it. According to Ayres, the brain must organize all sensations to learn in order to behave normally. Exposing children to tactile stimulation, vestibular stimulation, and motor activity stimulates and involves portions of the brain stem. With the information from the sensory system, a child can perceive and learn on a progressive level.

Bryant Cratty (1969) developed his concept of adaptive physical education to address the needs of children who required special services. Cratty stressed the importance of the motivational levels of children when learning in academic and nonacademic settings. Cratty believed a child's inability to perform motor tasks could lower his self-esteem as well as his acceptance by peers, which could adversely affect motor and cognitive processes (Arnheim & Sinclair, 1975).

The SMI methodology uses the frameworks established by these pioneers and others. It has, however, sought to systematize the work of various pioneers into a practical, individualized approach that can help children integrate the most critical motor and sensory processing capacities. With these concepts as background, the following section explores the SMI approach in detail.

## MOTOR DEVELOPMENT

The observable course of motor development in humans begins about 7<sup>1</sup>/<sub>2</sub> weeks after conception when, for example, the fetus flexes its head laterally away from stimulation in the lip region. By week 8<sup>1</sup>/<sub>2</sub>, this isolated avoidance response has radiates into patterns of movements organized in space and time. Simple lip stimulation now elicits contra-lateral flexion of the neck and trunk, extension of the arms at the shoulders, and rotation of the pelvis away from the side of stimulation.

The earliest patterns of motor behavior appear to be genetically coded in the species; that is, humans have some initial organization or template that guides the pattern of new formations. In addition, there are some operational rules that lead to patterns of behavior. Variable changes in these patterns are accounted for by the particular conditions of individual experience (learning). The study of motor development is concerned with the factors that influence motor behavior, the design of experiences that will result in desirable changes in behavior, and the influence of this learning on the capacity of the individual for future development (Thomas, 1984).

As a child grows, expectation of more mature movements increases proportionally. Movement becomes symbolic of life and existence. Movement is the sole manner of the physical *expression* of intelligence. It is believed that movement as the important expressive aspect of the human personality has great potential for use in educational programs for the child with special needs. However, motor activity constitutes only a component of the human personality. Numerous distinct modalities accompanied by, or exclusive of, overt action are also brought into use as the human infant and adult deal with their worlds (Cratty, 1969).

Similar to building blocks, there are graduated levels of motor development and motor planning originating from fundamental sensory-motor development. Children should complete patterns at every stage of development before they can efficiently carry out a more complex pattern. If a child misses a critical developmental stage, if he lacks the link from one pattern to the next, he will show evidence of problematic motor performance. The following behaviors may be indicative of a disintegration of senses and of gaps in motor development:

- Poor coordination
- Poor awareness of time and space
- Poor visual judgement
- Clumsiness
- Poor rhythm
- Poor flexibility of movements
- Poor handwriting
- Difficulty maintaining balance
- Motion sickness
- Kinesthetic and tactile defensiveness
- Fear of velocity
- Fear of inversion
- Fear of heights

Fortunately, delayed reflexive activity, which is indicative of poor sensory-motor development, can be detected at an early stage. Within the first few months, a parent should be able to identify certain motor patterns their infant has displayed or skipped. Table 1 describes the expected movement pattern of a growing child.

To reach and enjoy full motor maturity, the infant must receive the constant stimulation that comes from experiencing a rich variety of stimuli. However, if the interactive environment has excessive visual or auditory stimuli, sensory overload will occur and hinders the natural course of development. Incorporating the sensory systems into learning has an enormous impact on delayed and

**Table 1. Expected Movement Patterns of Growing Children**

Age	Expected Movement Pattern
Newborn-12 weeks	<ul style="list-style-type: none"> <li>• Predominately reflexive</li> <li>• Flexion of knee and hip when soles of feet are pricked</li> <li>• Head flexes laterally towards source of stimulation</li> <li>• Head is held erect and steady</li> <li>• Rolls front side to back</li> <li>• Reaches for hanging object</li> </ul>
15 weeks	<ul style="list-style-type: none"> <li>• Grasps hanging object</li> <li>• Rolls from back to side</li> </ul>
7 months-8 months	<ul style="list-style-type: none"> <li>• Sits alone</li> <li>• Transfers object from one hand to the other</li> <li>• Crawls purposefully to get from one place to the next</li> <li>• Homolateral pattern of crawling observed</li> <li>• Creeps on hands and knees</li> <li>• Cross-lateral pattern of creeping observed</li> <li>• Pulls up to a standing position</li> </ul>
9 months	<ul style="list-style-type: none"> <li>• Follows simple commands</li> <li>• Picks up food with hands and attempts to self-feed</li> <li>• Copies simple movements</li> </ul>
11 months	<ul style="list-style-type: none"> <li>• Stands alone</li> <li>• Grasps and releases object</li> </ul>
12 months	<ul style="list-style-type: none"> <li>• Walks alone</li> <li>• Uses hands and fingers to explore space (under, over, beneath, across)</li> <li>• Uses hands and fingers to push and pull objects</li> <li>• Changes directions</li> </ul>
14 months	<ul style="list-style-type: none"> <li>• Awareness of force distribution increases (stroking vs. striking)</li> <li>• Maneuvers efficiently about objects</li> <li>• Proficient pincer grasp</li> </ul>
16 to 18 months	<ul style="list-style-type: none"> <li>• Crawls up stairs efficiently</li> <li>• Plays “peek-a-boo”</li> </ul>
24 months	<ul style="list-style-type: none"> <li>• Runs</li> <li>• Spins about central axis by taking small steps in a circular pattern</li> </ul>
32 months	<ul style="list-style-type: none"> <li>• Bounces, with both feet simultaneously lifting off the ground</li> <li>• Slides sideward</li> <li>• Walks backwards</li> <li>• Runs and stops on verbal command</li> <li>• Premature under arm throw</li> <li>• Rolls down an incline</li> <li>• Performs inverted somersault</li> <li>• Jumps from a 12-inch elevation</li> <li>• Balances on 8-inch walking board</li> <li>• Proficient grasping and hanging</li> </ul>
3 years	<ul style="list-style-type: none"> <li>• Jumps from 18-inch elevation</li> <li>• Performs somersault on flat surface</li> <li>• Walks on balance beam with 12-inch elevation</li> <li>• Bounces efficiently on trampoline, maintaining balance</li> <li>• Throws object over arm</li> <li>• Dodges oncoming objects efficiently</li> </ul>

autistic spectrum children. Stimulation of the sensory system and motor performance is influenced both by physiological conditions and by the dynamics of the learning environment. Special education professionals suggest a variety of social and personal traits will be enhanced as a child interacts with his learning environment.

Essential to cognitive, social, emotional, and physical development is the interrelatedness of perceptual-motor processes, motor delays, hypotonicity, sensory-motor integration disorder, and audio-visual perception difficulties. The SMI approach to integrating

higher neural functions maintains that certain elements of movement and perception are essential to establish a network of neural pathways that interrelate, and to enhance communication of the left and right brains. These elements improve limb articulation, dominance, depth perception, body and space awareness, balance, and general coordination (Arnheim & Sinclair, 1975). Locomotion, balance, non-locomotion, kinesthetic awareness, visual-motor perception, and audio-motor perception are areas of main intervention by a SMI therapist (see Table 2).

**Table 2. Areas and Elements of Sensory-Motor Intervention**

Area of Intervention	SMI Elements
Locomotion	<ul style="list-style-type: none"> <li>• Rolling</li> <li>• Crawling</li> <li>• Creeping</li> <li>• Walking</li> <li>• Hopping</li> </ul>
Balance	<ul style="list-style-type: none"> <li>• Static balance</li> <li>• Dynamic balance</li> <li>• General balance</li> </ul>
Nonlocomotor movements	<ul style="list-style-type: none"> <li>• Throwing</li> <li>• Catching</li> <li>• Batting</li> <li>• Kicking</li> </ul>
Kinesthetic awareness	<ul style="list-style-type: none"> <li>• Laterality</li> <li>• Directionality</li> <li>• Body and space awareness</li> <li>• Haptic perception</li> <li>• Tactile perception</li> <li>• Airborne activities</li> <li>• Velocity modulation</li> </ul>
Visual-motor perception	<ul style="list-style-type: none"> <li>• Eye-hand coordination</li> <li>• Eye-foot coordination</li> <li>• Fine motor visual planning</li> <li>• Fine motor coordination</li> </ul>
Audio-motor perception	<ul style="list-style-type: none"> <li>• Following verbal commands</li> <li>• Beat discrimination</li> <li>• Coding and decoding auditory cues</li> <li>• Move to cadence</li> </ul>
Physical fitness	<ul style="list-style-type: none"> <li>• Static strength</li> <li>• Dynamic strength</li> </ul>

## CASE EXAMPLE: SMI IN PRACTICE

The following example presents the pre-evaluation, evaluation, and remediation procedures conducted for Sam, a 5½-year-old child diagnosed with autistic spectrum disorder.

### Pre-Evaluation

Because SMI training is an educational, progressive intervention program, it is *most* beneficial to children who can at least minimally respond to an educational environment. Due to a child's natural tendency to enjoy movement, the child who does not make eye contact soon finds in SMI an avenue of interest through which the therapist can become a part of his world and engage him in reciprocity.

In Sam's case, he was told to walk next to the therapist and follow him to the other side of the room. Sam was hesitant at first, but then followed. When the therapist initiated a game of catch, Sam had no awareness of the object that was being thrown and was unable to continue the game.

Next, Sam was instructed to stand on a box elevated 2 feet off the ground. Sam was extremely uncomfortable with the situation. As Sam kicked and screamed, the therapists removed him from the box and his mother comforted him. Sam refused to detach himself from his mother after that point. Throughout the entire pre-evaluation procedure, he demonstrated extreme fear of heights and would not allow his mother to leave the room.

However, because Sam was able to follow simple directions and make minimal eye contact, he could benefit from SMI intervention.

### Evaluation and Assessment

After the informative pre-evaluation, the child undergoes a full evaluation procedure,

which is videotaped and later reviewed for detailed analysis. In a full evaluation, the child is separated from his caregiver and asked to perform certain skills based on the specifications of his age and diagnosis.

The following evaluation is a modified version of an SMI assessment, which was used with Sam. As with all children, Sam's movement skills were tested in several important areas. Directions for conducting each test, as well as observation questions, are included.

### Locomotion

**Log roll.** Tell the child to roll like a pencil, either on a mat or down an incline.

*Observations:*

- Do the body parts move together in one line?

**Crawl.** Let child crawl under an object, telling him to "crawl like an alligator."

*Observations:*

- Look for homolateral body movement. Does the elbow meet the knee on one side while the other side of the body is straight?
- Does the head tilt to the side of the body that is flexed?

**Bounce.** Instruct the child to bounce, lifting both feet off the ground.

*Observations:*

- Do both feet leave the ground simultaneously?
- Is balance kept throughout bounce?
- Are arms down by his side or do they jerk?

**Hop.** Instruct the child to hop on designated spots, eight hops on each foot.

*Observations:*

- Is balance maintained easily?
- Does the child tire easily?
- Can the child perform hopping task with both feet?

**Slide.** Demonstrate sliding. Instruct the child to follow.

*Observations:*

- Is head at midline?
- Are arms swinging easily?
- Is there planning of distance and direction?
- Are arms, head, and trunk involved in coordination?

### **Static and Dynamic Strength**

**Grasping.** Instruct the child to hold onto a bar for 10 seconds.

*Observations:*

- Does the head stay in alignment?
- Does grasp appear weak?
- Is the child able to perform the task without assistance?

**Leg lift.** Instruct the child to lay on back and lift both legs 10 inches off the ground. Have the child hold legs off the ground for 10 seconds.

*Observations:*

- Are both feet easily held off the ground?
- Is contraction equally distributed?

**Flexibility.** Instruct the child to sit in a straddle position. Ask him to touch his elbows to the floor and/or forehead to the floor.

*Observations:*

- Does the child perform a straddle sit?
- Does the child perform task with straight legs?
- Do elbows reach the center?

**Hamstring.** Instruct the child to sit in a straddle position. Ask him to touch his elbows and/or forehead to the floor.

*Observations:*

- Does the child perform the task with straight legs?
- Do elbows reach the center?

**Lower back.** Instruct the child to perform an “L” shaped sit. Ask the child to touch his toes.

*Observations:*

- Does child perform “L” sit comfortably?
- Does the child touch toes with ease?
- Are knees kept straight?

**Back.** Instruct the child to lie down in a prone position and hold his ankles.

*Observations:*

- Does the child perform task with ease?
- Does his back contract to achieve an “arch up” position?

### **Balance**

**Balance board.** Instruct the child to stand on balance board and try not to shift back and forth.

*Observations:*

- Does the child maintain balance?
- Is force distributed evenly from both feet?
- Does head remain at midline?
- Are both sides regulating weight shift?

**Walking on 4-inch surface.** Instruct the child to walk on a 4-inch-wide balance beam.

*Observations:*

- Does the child walk heel to toe?
- Do feet alternate?
- Does the child perform task with hesitation?

**Walking on incline.** Instruct the child to walk uphill on an incline.

*Observations:*

- Does the child utilize his whole foot?
- Is weight shift smooth?
- Is balance maintained easily?
- Do eyes follow path?
- Do legs provide adequate balance?

**Walking down declined elevation.** Instruct the child to walk down a 3-foot elevation.

*Observations:*

- Do legs provide adequate balance?
- Do eyes follow path?

- Is child running to avoid controlled posture?
- Is changing directions done with ease?
- Are feet alternating?

### Non-Locomotion

**Catching.** Instruct the child to toss and catch large, medium, and small balls.

*Observations:*

- Do the eyes follow the object?
- Does the body move in space to receive the object?
- Does the body shift weight as needed?

**Throwing.** Instruct the child to throw a small ball to a target that is placed 5 feet from eye level.

*Observations:*

- Do the eyes follow the object?
- Are both sides involved in throwing?
- Which is the dominant arm?
- Are shoulder joints loose?
- Does the child step into the task?

**Batting suspended ball.** Instruct the child to strike the suspended ball with a large bat.

*Observations:*

- Do the eyes follow the object?
- Does the child strike the ball with at least 50% accuracy?
- Is balance maintained?
- Is there planning of distance and direction?
- Are arms, head, and trunk involved in coordination?

### Visual-Motor Perception

**GMS balancing tube.** (This tube is similar to a builder's level, which has a bubble that moves left or right from a midpoint depending on slope. When the level is balanced, the bubble centers at the midline.) Instruct the child to hold the tube with both hands and try to roll the marble to the middle, between the red lines.

*Observations:*

- Does the child distribute force evenly throughout?
- Do the eyes follow the marble?
- Is motor planning adequate?

**Balloon paddling.** Instruct the child to keep the balloon from hitting the ground. Ask him to count how many times he can strike the balloon.

*Observations:*

- Do eyes follow the object?
- Are arms, head, and trunk involved in coordination?
- Is balance maintained easily?

**Running through hoops.** Instruct the child to walk through a series of hoops. If the child walks without difficulty, ask him to run.

*Observations:*

- Is running performed at an even speed?
- Is one foot placed in each hoop?
- Is running done while alternating feet?
- Does the child start and stop on command?

**Tracing using a flashlight.** Provide an elevated surface on which the child can stand. Instruct the child to trace the designated lines with a flashlight.

*Observations:*

- Do the eyes follow the light?
- Are wrists coordinated with arms and fingers?
- Is there planning of distance and direction?
- Is task performed with 50% accuracy?

## Evaluation Results and Lesson Planning

Upon completion of the evaluation procedure, the videotape was reviewed and a lesson plan for Phase I of Sam's therapy was

devised. The results of the evaluation, by assessed area, follow.

### **Locomotion**

Sam, at 5<sup>1</sup>/<sub>2</sub>, had the motor proficiency expected of a child at age 2 years, 3 months. The test of locomotor skills revealed his ineptness in large and small muscle control, a lack of communication between left brain and right brain functions, and the inability to produce effective motor-planning sequences.

**Locomotion Intervention and Lead-Up Drills.** The following activities were selected to enhance Sam's ability to utilize his upper and lower extremities and improve locomotor skills.

**Log roll.** The child lies on his back with his shoulders positioned on a line, body fully extended, feet together, arms flat to the ground above his head. One therapist takes the left arm over the right arm in a crisscross manner, while a second therapist takes the left leg over the right leg in the same crisscross fashion, and proceeds to roll the child. Each time the child makes a full revolution of the body, he must become reoriented to the horizontal plane. The head first turns in the direction of the roll, followed by the hips. The trunk is twisted, the shoulders lifted, and one thigh rotated inward and over the other thigh. In this manner all segments of the body are aligned and maintained in good control. When the child is able to roll effectively in one direction, then rolling in the other direction should be attempted.

**Crawl.** Crawling is a natural extension of rolling. Like rolling, crawling provides the physically clumsy child with security because the body is fully in contact with a surface. The child moves along the floor in a prone position by various movements of the

arms and legs. Each crawling task must be executed in the proper form before the next higher-level skill is attempted. Crawling is attempted in an amphibian fashion by moving the arm and leg on one side of the body in unison and then moving the limbs on the opposite side. The head should be turned toward the side on which the limbs are flexed. One therapist bends the child left arm, and bends the child's left leg so the elbow meets the knee. A second therapist holds the right arm and right leg, creating a straight line from the right hand to the right foot. One therapist counts "1-2-3" and manually alternates extended and bent positions.

**Bouncing.** The ability to propel the body upward from a supporting surface requires much strength, balance, and coordination. To efficiently produce the correct pattern of bouncing, the child must distribute force equally between the right and left sides of the body. Modification of bouncing can be performed on a trampoline or mini trampoline. If the child has no pattern of bouncing, a therapist must stand behind the child, hold his hips, and initiate the motor act of jumping.

**Hop.** The motor act of hopping requires static and dynamic balance, dynamic strength, and motor planning. The child must be able to stand on one foot to perform the act of hopping. Once he has mastered balancing on one foot, he will be able to proceed to the next level, hopping with support. A therapist stands behind the child, holding the child's left leg behind him and his right arm forward to initiate hop direction. As the therapist proceeds to walk forward, the child will reflexively want to maneuver forward, hence initiating the hopping task. Once the child has mastered this task, he will be able to perform hopping on an adaptive surface (e.g., springboard or minitramp).

## Static and Dynamic Strength

The awkwardness in motor activity of children with special needs can be attributed to below-average motor fitness because motor ability and fitness are mutually dependent. Sam exhibited below-average muscle tone and tested at a proficiency level of a child of 3 years, 5 months. He had trouble maintaining balance and posture throughout the evaluation. Sam was only minimally able to perform static and dynamic strength activities. Sam could not sit in a chair without tiring, was unable to maintain his posture while walking, had no concept of hanging, and was completely unable to utilize fingers and wrists to hold a pencil. The following remediation procedures were devised to treat Sam's lack of static and dynamic strength.

### Static and Dynamic Strength Intervention and Lead-up Drills

**Arm hang.** Arm hanging is used to determine the efficiency of grasping ability. An average 5½-year-old boy should be able to hang for 10 seconds or longer. A proficient arm hang suggests adequate strength of the shoulders, wrists, and forearm. The ability to hang from a bar, being suspended in the air without any support, involves regulation of the vestibular and proprioceptive systems.

The therapist starts with a stick, 4 inches in diameter, with two lines drawn where the child should place his hands. The therapist raises the stick up and down until the child begins to support his own weight. Once the child feels comfortable with the stick, the therapist leads him to a bar with a 4-foot elevation. He holds the child's feet until he is comfortable hanging without support, making certain that the child's grip is correct. The whole palm of the child's hand should be in contact with the bar.

**Arch up.** A modified pushup is a significant method for examining arm and shoulder

strength and muscle endurance. The child assumes a prone position with fingers pointed laterally away from him; legs are extended and relaxed. The child should then straighten both arms simultaneously to produce a "seal-like" position.

**Abdominal and trunk strength.** To improve upper abdominal muscle strength and endurance, the child should perform abdominal curls. The child assumes a supine position with knees bent, feet flat on the mat and arms folded across chest. The child lifts his head up until his chin touches his chest, rolls both shoulders forward, and lifts his back from the mat so that he comes to a full sitting position. Since Sam was not interested in performing this drill, the therapists modified it to create a more interactive approach to "boring" sit-ups. The therapists laid 10 beanbag animals on the floor directly behind Sam's head. Sam would reach back and pick up a beanbag with both hands, and then sit up and shoot it in into a target. This allowed him to practice projectile management (throwing) while developing abdominal and trunk strength.

## Flexibility

Flexibility refers to the capacity to move a particular joint in the body through its range of motion. A full range of motion of the hip flexor allows the child to crawl effectively; a full range of motion of the shoulders and wrists allows the child to explore the world of creative shapes and its relationship to body awareness. Sam exhibited extremely poor flexibility. The simple act of tying shoes was a motor disaster. When he sat on the floor to remove his shoes, his hands barely reached his toes. The position was extremely tiresome for Sam. After 2 minutes of reaching and struggling, he gave up and asked his mother for help. Crawling was problematic because of lack of flexibility in the lower trunk

region. Consequently, activities to improve Sam's hamstring and trunk flexibility were of high priority.

### **Flexibility Intervention and Lead-Up Drills**

**Hamstring.** The child sits on the mat with legs extended away from each other and toes pointed. The child tries to touch both elbows to the space created by the "v" shape position.

### **Balance**

Balance is defined as the ability to maintain equilibrium while engaging in various locomotor and nonlocomotor activities. There are three basic categories of balance: (1) static balance—the ability to maintain a specific position for a given amount of time, (2) dynamic balance—the ability to control the body in motion, and (3) object balance—the ability to support some external objects without letting it fall.

Sam suffered from severe vestibular dysfunction as well as an excessive fear of elevated surfaces. Sam was unable to perform the simplest of balance tasks. When asked to walk across a balance beam with a 4-inch width, he walked with one foot leading the other, a behavior below his expected age proficiency. In fact, for static and dynamic balance, Sam tested at a 23 months of age level. The top priority for his lesson planning was to help him get over the fear of elevated surfaces and familiarize him with revolution and velocity.

### **Balance Intervention Implementation and Lead-Up Drills**

**Balance board.** The therapist instructs the child to stand on a balance board and maintain his balance.

*Level 1:* The child may use the wall or a bar for support as the therapist stands behind the child and holds his knees. The child needs

to have an idea of what the correct manner of balancing feels like.

*Level 2:* The child uses therapist as support.

*Level 3:* Child stands alone.

*Level 4:* Child stands on balance board while catching a medium-size ball.

**Walking across a 4-inch-wide balance beam.** The therapist should be positioned in such a way that he can easily give verbal directions and can spot the child when it is necessary. The child should hold all balance postures for 10 seconds.

While balancing on a 8-inch side of the balance beam, the therapist instructs the child to:

- stand heel to toe, right foot in front of left, hands placed on the waist,
- stand heel to toe, left foot in front of right, hands out to the side,
- stand on left foot with arms crossed,
- stand on right foot with arms crossed,
- walk along the balance beam heel to toe, and then
- walk backward heel to toe.

**Walking up an incline.** For this exercise, an elevated square is placed on a mat-covered surface, with one side of an 8-inch beam placed on the elevated square to create an uphill slope. The slope should be no more than 30 degrees from the floor.

*Level 1:* The child creeps up the beam to adapt to height of elevation.

*Level 2:* The child walks up the beam with one foot leading with support.

*Level 3:* The therapist places beanbag buddies at increasing higher levels to indicate how high child should go (e.g., "Sam, go up and say 'hi' to Mr. Alligator").

*Level 4:* Two therapists hold the child's hands and briskly walk him up the beam. (This helps the child walk with alternating feet.)

*Level 5:* The child goes up the incline by himself.

**Walking down an elevated surface.** Walking down an elevated surface involves tremendous strength as well as balance. The child must be able to control his speed as he walks down the beam. (Running down the beam is a good indicator of lack of visual-motor perception and static balance.) For this exercise, the therapist places a beam on an elevated surface to raise it 30 degrees from the ground, with the 8-inch side up. The therapist places dominoes or beanbag buddies on the beam about 1 foot apart from one another and asks the child to either count the dots on the dominoes or talk about the beanbag buddies as he steps over each object. This task will allow the child time to balance while he counts the dots or names the animals.

### **Nonlocomotor Skills**

It is developmentally and socially important for a child to succeed in performing skills that consist of propelling and retrieving various objects. The child tends to receive a tremendous amount of self-gratification and praise from peers. Conversely, the child with special needs may lack the eye-hand or eye-foot coordination necessary for effectively managing objects in play. Nonlocomotor skills are motor tasks involving force application, reaction time, and visual judgment.

Sam had severe visual-motor impairment and subsequent focal failure. In addition to the lack of visual acuity, Sam had no concept of reciprocity and had no interest in engaging in any catching, throwing, or batting tasks. Towards the end of the evaluation, Sam began to engage in several bouts of catching and throwing. A main priority for lesson planning was to enhance his awareness of reciprocity and reaction time.

### **Nonlocomotor Intervention and Lead-Up Drills**

**Catching.** Catching is a reflexive activity proficient in a child by the age of 3. It

involves awareness of time, space, and use of legs to aid in the catching task. When using the skill of catching to improve visual-motor planning, the therapist should stress the fact that the eyes must remain open and watching the ball at all times. The thought of catching induces fear in many children. To minimize the anxiety as much as possible, a light plastic or rubber ball approximately 9 inches in diameter should be used at first.

*Level 1:* Place a hula hoop in front of the child. Ask him to toss the ball around eye level and let it drop into the hoop. The task is to toss the ball and have a designated area for it to drop in.

*Level 2:* Move the hula hoop 8 inches from the child's feet, and ask him to toss a medium-size ball, about 6 inches in diameter, and let it drop to the ground.

*Level 3:* Instruct the child to toss the medium-size ball and catch it.

*Level 4:* Instruct the child to toss a small ball, about 4 inches in diameter, and catch it.

**Throwing.** Throwing is a skill that involves the release of an object with one or both hands in one of three basic patterns: (1) underarm pattern, (2) side arm pattern, and (3) overarm pattern. It also is a motor act that demonstrates the physics principle of a summation of forces as the total force of all the muscles and levers in the body move in a sequential pattern. Since the object is controlled by the speed and direction of the hand doing the throwing, improving a child's throwing ability requires the therapist to consider methods for developing speed and controlling the direction of the hand movement. It is imperative that each child be afforded ample opportunity to handle a variety of projectiles. In Sam's case, the therapists used small balls that were projected toward a target.

*Level 1:* A child who has no throwing pattern should start with a large rubber ball, 9 inches in diameter. The therapist should

start with underhand rolling. When object rolling is being taught, the child should lower his body by bending his knees with the back straight and head lifted.

*Level 2:* The child's hands are placed on opposite sides of the ball with palms facing each other and fingers apart and pointing down. The ball is held in front of the body. As his arms swing forward, the child should flex his knees and release the ball onto the ground by extending his elbows and wrists.

*Level 3:* The child uses two hands to throw the ball underhand.

*Level 4:* The child performs a two-hand chest pass.

*Level 5:* The therapist places the child's feet in a stride position, opposite to the dominant throwing hand. The therapist should hold the child's dominant hand behind the corresponding ear and then guide the child's arm forward to perform a throw into a target.

### **Visual-Motor Perception**

One of the most important factors that links vision to movement is postural fitness. Posture is the primary pattern of movement on which all other patterns are based. Problematic visual perception may cause the child to exhibit poor and unstable posture. It is invariably found that children with movement problems are unable to integrate movement with vision. They also are unable to make accurate movements with their upper and lower extremities with adequate control.

Sam tested extremely below age level in the area of visual-motor perception. He constantly tripped over objects and bumped into obstacles that were in his way. His poor posture resulted in an extremely limited span of visual stimuli. He could only interact with the area immediately around him. Sam was able to make minimal eye contact; however, the therapist had to stand right in front of him and hold his chin for 10 seconds

before any eye contact was achieved. Sam had no scope of vision above that of his eye level. His lesson plan would surely include maximum visual-motor perception at a very basic level.

### **Visual-Motor Perception Intervention and Lead-Up Drills**

#### **Balloon paddling.**

*Level 1:* The therapist allows the child to play with a balloon. The therapist instructs the child to try to keep the balloon off the ground as long as possible, counting each time the child hits the balloon. If the child cannot follow the balloon, the therapist must bat the balloon back and forth to the child until he can perform the task without help. The therapist instructs the child to keep his eyes on the balloon. This drill for increasing visual-motor perception allows the child to expand his visual field: for children who have difficulty "looking up," balloon paddling exposes them to the wonderful world of "up!"

*Level 2:* The therapist uses two paddles—one red and one yellow—and instructs the child to alternately hit the balloon once with the red and once with the yellow, while correctly saying "red, yellow, red, yellow" in time to the hits. This activity promotes verbal feedback and allows verbal processing to occur at the same speed as the action is proceeding. This task involves significant visual-motor planning.

*Level 3:* The therapist uses two paddles and two balloons and asks the child to keep the two balloons within reach.

**Running through obstacles.** If the child hits the hoops as he runs through them, the therapist uses the following lead-up drills:

*Level 1:* The therapist places colored dots on the ground and asks the child to walk across the "river" by way of the "stones." Telling the child to keep his feet dry and out

of the water will help the child understand the concept of taking big steps.

*Level 2:* The therapist places the hoops around the colored dots and asks the child to walk across the river and not touch his foot to anything other than the dots.

*Level 3:* The therapist lays 10 hula hoops on a matted or carpeted surface and instructs the child to walk through the hoops without hitting the edges. If the child is placing two feet into each hoop, the therapist asks him to try to place only one foot in each hoop.

*Level 4:* If the child can walk through without touching the edges of the hoops, the therapist asks the child to run through. (By age 5<sup>1/2</sup>, the normally developed child runs through with 90% accuracy.)

**Flashlight tracing.** Tracing shapes and lines with a flashlight improve handwriting and visual motor accuracy. Therapists try the following lead-up drills if the child is not proficient in tracing with a flashlight.

*Level 1:* The therapist draws a figure on a dark surface so that the child can stand on a elevated surface and be directly above the drawn figure. The child flashes the light at the start position and travels in between the drawn lines until he reaches the finishing line.

*Level 2:* The therapist draws a figure that incorporates the shapes of the alphabet, circles, half circles, straight lines, slanted lines, and zigzags. She traces the line and instructs the child to superimpose his light over the therapist's light. The two lights travel together until their lights reach the finish line.

*Level 3:* The therapist draws the same figures as in Level 2, but the child alone uses a light to trace the figure to the best of his ability. (A typical 5<sup>1/2</sup>-year-old boy should be able to stay on the line for 90% of the figure.)

## Audio-Motor Perception

Children with special needs usually have difficulty processing auditory information as a result of a dysfunctional vestibular apparatus or structural deformities, which occur in the ear. The SMI technique of integrating auditory and motor perception provides the child an opportunity to connect auditory organization to movement that he already knows. Thus, pattern recognition, force application, and reaction time improve tremendously.

Sam was a relatively average listener. He followed simple verbal commands; however, he could not react to them in an organized fashion.

## Audio-Motor Perception Intervention and Lead-Up Drills

**Drum activities.** The therapist sits directly in front of the child and holds a buffalo drum, making sure the child imitates the position. The child tries to copy the therapist's rhythm.

*Level 1:* The child says how many beats the therapist is making (the therapist should not exceed 2 beats initially).

*Level 2:* The child copies the number of beats the therapist played.

*Level 3:* The child plays "soft like a mouse," then "loud like an elephant."

*Level 4:* The child plays two loud beats, followed immediately by two soft beats, creating a pattern of BAM-BAM-bum-bum.

**Sound localization.** This is the ability to determine the direction of sound. The following activities are lead-up drills to improve a child's sound localization.

*Level 1:* The therapist stands behind the child and rings a bell, twice on the right and then to the left. The child points to the direction from which the sound originates.

*Level 2:* The therapist blindfolds the child and asks him to follow the sound of the therapist's voice and try to catch him. "Where am I, Sam? Catch me!" Although the child

should be challenged, the therapist should not allow the child to fail, but allow the child to catch him.

### **Agility, Speed, and Body Awareness**

The child with special needs, whose problems include poor body perception, often has difficulty moving effectively in space. Bumping into obstacles and dropping things are indicative of poor body and space perception. Sam had marked trouble with body awareness. During the evaluation, Sam exhibited a lack of mental imagery and acquisition of body boundaries. He was unaware of his body in space, he did not want to be airborne. Sam was uncomfortable with velocity and height—he would tremble at the very thought of swinging or hanging.

### **Agility, Speed, and Body Awareness Intervention and Lead-Up Drills**

**Running through poles.** This is a drill used to increase body and space awareness. Ten poles, each about 5 feet high, are placed on a carpeted area in a straight line. The child runs through the poles in a zigzag fashion (similar to how a slalom skier races). A drawn path gives the child a visual cue of where to go. There is always a start and a finish line.

**Swinging in octagon.** A suspended octagon should be placed 5 feet above a matted area. The child sits in the donut, holding the handles, legs straight in front of him (see Figure 1 for a picture of an octagon).

*Level 1:* The therapist swings the octagon back and forth.

*Level 2:* The therapist swings the octagon left and right.

*Level 3:* The therapist swings the octagon in a circular manner, first slowly, then gradually increasing the speed.



**Figure 1. Child in an Octagon**

**Rolling in Octagon.** Place the octagon on a matted area. The child lays on his back inside the octagon and holds onto the handles.

*Level 1:* The therapist holds the child inside the octagon as he rolls the octagon back and forth.

*Level 2:* The child lays on top of the octagon in a prone position. The therapist holds him by the legs and rock him back and forth, then left and right

*Level 3:* The child gets inside the octagon and hold his legs straight onto the walls of the octagon. The therapist rolls the child all the way around, holding one hand on his legs to push them to the walls of the octagon, and having one hand free to roll the octagon.

### **Laterality**

Laterality is defined as internalizing the awareness of the difference between right and left. Sam had no awareness of right and left. His therapists started with very simple tasks to teach the concept of the right side of the body by utilizing many techniques, including the following one.

### Laterality Lead-Up Drill

**Visual awareness of left and right via balloon paddling.** Using a soft paddle stick with protusions at each end, the therapist marks an “L” and an “R” to represent right and left protusions. The therapist instructs the child to strike the balloon with the left and then with the right protusions.

### Multisteped Motor Planning

Since Sam exhibited poor balance and coordination, as well as poor visual-motor perception, multisteped motor-planning skills were not a part of his initial lesson planning. However, the following lead-up drills were introduced 6 months after his therapy began.

### Multisteped Motor-Planning Intervention and Lead-Up Drills

#### Jumping Jacks.

*Level 1:* The child makes “angels in the snow,” performing X and I positions.

*Level 2:* The therapist draws a picture of an X and a picture of an I on a wall where the child can stand directly in front of it. The child copies the pictures on the wall with his body position, first by making an X, then by making an I position.

*Level 3:* The child performs jumping jacks to a cadence of “X 2,3,4, I, 2,3,4.”

**Making knots.** Using two pieces of rope (one 3 feet long and the other 2 feet long), the therapist wraps about 3 inches of each end with a different color of tape (e.g., red and gray).

*Level 1:* The child ties a knot with the 3-foot rope. The therapist observes the knotting pattern.

*Level 2:* Following a U-shape drawn on the floor with chalk, the child superimposes the U-shape with the 3-foot rope, keeping track of the red-taped end. The red end should represent the child’s left hand. Next, the therapist draws two crossing lines in the

middle of the U-shape. The child superimposes the rope over the crossing lines, keeping the red-taped end on the top.

*Level 3:* Using a 2-foot piece of rope that is thinner in diameter than the 3-foot rope, the child performs the same task as described in Level 2, again placing the red-taped end over the gray. The child reaches and pulls the red-taped end to form a knot. This procedure is repeated eight times.

### Finger-to-thumb taps “a good morning ritual.”

*Level 1:* The therapist places a sticker on the thumb of the child. The child touches every finger individually to the sticker: the thumb is saying “good morning” to all the fingers.

*Level 2:* With the sticker removed, the child taps his thumb to each of his fingers.

### Advanced Multisensory Intervention Drill

The following activity requires proficient balance, coordination, audio-motor perception, projectile management, and visual-motor perception.

**Rhythm response.** The child stands on a balance board, holding a 9-inch diameter ball. The therapist stands directly behind the child, holding a drum. The child listens to the number of drum beats and tosses the ball according to the number of beats heard, while maintaining his balance. If the therapist hits the drum twice, the child will perform two tosses of the ball. The task requires the child to integrate the eyes, ears, and vestibular system with gross motor coordination and projectile management.

### Sam’s Progress with SMI

In the 2 years since Sam started his SMI training, he has made tremendous improvement in every aspect of his therapy. Sam now runs,

jumps, flips, swings, and climbs up a 40-foot spider net! He completely integrates visual-motor and audio-motor perception while performing motor tasks and absolutely loves swinging—fast. Sam was selected as the case example for this chapter because he has made significant progress and provides readers a perfect opportunity to understand why. Sam speaks and asks questions, and greets his peers and the staff members with a warm smile every day. More important, he now enjoys the wonderful world of movement.

## CONCLUSION

This chapter presents parents and professionals with a motor therapy program that uses the techniques of the SMI approach. The model presented is to be used in accordance with the concepts previously discussed, including:

- Academic tasks normally require skill in forming perception, symbol recognition, visual language development, and other motor-perceptual abilities.
- Practice and training aimed at helping children develop these skills can prevent or alleviate a certain proportion of learning problems.
- Children with learning disabilities often demonstrate inadequate development of perceptual-motor skills.
- Preparation for these tasks requires development of general coordination, physical balance, spatial relationships, eye-foot and eye-hand coordination, eye movement control, and sensory perception.

Just as children learn to walk and talk, they must learn to utilize their senses to fulfil motor and cognitive needs. They demand opportunities to examine things in their environment by looking, feeling, smelling, and sometimes tasting them. Through the manipulation of objects and gaining control of their body movements, children are using the sensory-motor process to learn and perform skills that require problem solving. They need to take things apart, discover how they work, and put them back together. They need to identify and relate to the various colors, shapes, sizes, textures, and noises around them. Thus, children learn to make a sensory impression and produce an appropriate motor response.

Information applicable to the development of motor skills, sensory processing, and perceptual proficiency comes from a variety of sources including psychology, neurology, anatomy, physiology, physical therapy, occupational therapy, and human development. The goal of the SMI approach is to identify those movement priorities in both objective and expressive functioning that will further abilities best allocated to the motor and perceptual framework, in the psychological, social, intellectual, and physical development of the child. Finally, the concept of SMI factors that make up the intricate system of motor planning should be interwoven with the acquisition of new skills and extended through movement with different environmental stimuli. ■

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