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Screening, Evaluating, and Assessing Children with Sensorimotor Concerns and Linking Findings to Intervention Planning: Strategies for Pediatric Occupational and Physical Therapists

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As noted in Chapter 8 (this volume) by Williamson, Anzalone, and Hanft, pediatric physical therapists and occupational therapists have traditionally measured the skills of young children and provided intervention to them in three areas of development: sensory processing, praxis, and motor performance, each of which contain specific elements (see Table 1).

In the past, therapists have used evaluation, assessment, or screening findings to

make decisions regarding the status of a child and to develop intervention plans. Often these decisions were made independently of findings from other professionals or without parental input. However, during the last 20 years, there have been significant changes in how therapists view their role in the measurement and intervention process. Three factors have influenced these changes.

First, public policy and legislative initiatives have required therapists and other professionals to reassess basic methods of collecting developmental or behavioral information. The passage of Part B (PL 94-142) of the Individuals with Disabilities Education Act (IDEA) in 1975 required therapists working in educational systems to serve children within an educational framework, work in a multidisciplinary team, and recognize the inter-relatedness of motor skills to other areas of development. In 1986, Part H¹ of IDEA (PL 99-457) expanded services to

Table 1. Elements of Sensorimotor Development

Areas	Elements
Sensory processing	Modulation Perception Discrimination
Praxis	Ideation Motor planning Execution
Motor performance	Neuromotor Fine motor Gross motor Oral motor

¹The 1997 Reauthorization of IDEA realigned the Act: Part H is now called Part C. In further discussion in this chapter, the early intervention component of IDEA is referred to as Part C.

infants and young children and mandated that services be delivered in a family-centered manner. Therapists broadened their systems and strategies of gathering information about a child's performance and providing services to include collaboration with the family and other team members. Contemporary evaluation and assessment strategies, as well as intervention, how support collaboration among team members and the family, integration of findings across domains and environments, and the reporting of findings in a family-centered, culturally sensitive manner.

Second, research during the last 20 years has clearly indicated that the areas of development typically measured in a young child (e.g., behavior, motor, language, and cognition) are interdependent (Greenspan & Meisels, 1993). Biological, cultural, and environmental variables are recognized to support, facilitate, or impede the development of infants and young children. For therapy to be meaningful, therapists must not only be knowledgeable in how neuromotor development occurs but also in how it may be affected by sociocultural and environmental parameters. For example, muscle tone in a developing child may be affected if a caregiver does not encourage independent movement or holds or positions a child in certain ways (Cintas, 1995). Additionally, cognitive skills are enhanced if a child moves independently within the environment (Berenthal, Campos, & Barrett, 1984).

The third factor that has influenced the measurement process, the development of measurement instruments, and therapeutic intervention is the application of the dynamic systems perspective of motor development (Case-Smith, 1996; Piper, 1993). Traditional measurement instruments used by therapists are based on the neuromaturational theory of motor development advanced by McGraw (1945) and Gesell (1945). Early therapeutic

strategies also used the neuromaturational theory as a framework. The neuromaturational theory is based on the assumption that, as the central nervous system matures, motor development will proceed in a hierarchical fashion. Accordingly, development occurs in a cephalocaudal and proximal-distal direction at a specific rate. As the infant develops, higher centers of the central nervous system inhibit lower centers so that voluntary movements can occur when reflexes are integrated.

Dynamic systems theory views the development of motor skills as emerging from the interactions of many subsystems within a specific task (Heriza, 1991). These subsystems include the musculoskeletal system (joint mobility, muscle strength, and static postural alignment), movement patterns (motor milestones, reflexes and reactions, coordination, balance, and endurance), functional performance, sensation (visual, vestibular, proprioceptive, auditory, and tactile), and perception. According to Heriza (1991), an assessment following a dynamic system paradigm should identify age-appropriate tasks, transition periods, the subsystems impacting movement, and contextual variations.

Chapter 8 provided a review of many tools available to pediatric physical therapists and occupational therapists to gather information regarding a child's sensorimotor development. The components of sensory processing, praxis, and motor development also are described. The authors have stressed the need to include parental interview and child observation as part of a comprehensive assessment strategy. The purpose of this present chapter is to provide a framework that will assist therapists in choosing the most appropriate measurement model and instrument for children with sensorimotor and sensory-processing concerns. Additionally, intervention models and approaches will be reviewed.

THE MEASUREMENT PROCESS

This chapter presents a general discussion of the similarities and differences among the processes of screening, assessment, and evaluation, followed by descriptions of five models used by therapists to gather information for clinical decision making. Additionally, several measurement instruments are described. These instruments were chosen because of their unique contributions to the processes of (a) identifying infants and toddlers who may have a developmental problem, (b) predicting which infants will continue to demonstrate problems throughout childhood, or (c) documenting change in the acquisition of developmental or functional skills or change in the performance of existing skills. A chapter appendix lists several additional instruments not discussed here or in Chapter 8 that are also available to therapists.

Purpose of Measurement

Measurement is the process of describing characteristics of an individual by gathering information in an organized manner. A variety of methods are used to gather information, including (a) interviewing parents and other primary caregivers, teachers, and health professionals involved in the care of a child, (b) observing the child in natural settings, and (c) direct testing of the child. Measurement is conducted for seven purposes, as shown in Table 2. The procedures, strategies, and types of tests chosen as measurement tools will be driven by the purpose of measurement and what type of information is needed.

The IDEA defines evaluation, assessment, and screening as they relate to early intervention and educational programs (IDEA, 1997). The *screening process* is used to detect if a child's behavior or skill development is at a level that places the child at risk for a

Table 2. The Purposes of Measurement

Purpose	Strategy
Identify risk	Screening
Diagnose	Evaluation
Determine eligibility	Evaluation
Plan intervention	Assessment
Determine change in functioning	Assessment
Determine efficacy of intervention	Assessment
Research	Evaluation

developmental problem, concern, or delay. The screening process should be brief and the test used should be easy to administer by a variety of people (physicians, therapists, nurses, teachers, and in some cases, parents). To increase the likelihood that screening takes place on a regular and consistent basis, the procedure should be designed to be used in pediatricians' offices, classrooms, and community-based health and social service agencies, or on an out-patient basis. Additionally, screening instruments should be reliable and accurate (Gilbaide, 1995).

The *evaluation process* is more complex. Evaluations are used to help make a diagnosis, identify atypical development, or determine eligibility for services. Instruments used as part of an evaluation process are usually norm-referenced, standardized tools. Many of the tests measure a single developmental area, such as motor or language (Taylor, 1993), but others are comprehensive developmental scales covering more than one area of development. Evaluation methods include what Kirshner & Guyatt (1985) refer to as a "discriminative index." A discriminative index distinguishes between individuals or groups on specific dimensions, such as the acquisition

of developmental milestones. Discriminative measures are often used to determine if a child's behavior is typical for her age and are used to determine eligibility for services. Many of the tools traditionally used by therapists, such as the Bayley Scales of Infant Development-II and the Peabody Developmental Motor Scales, fall into this category.

Physical and occupational therapists are most often involved in the *assessment process*. Assessments often use comprehensive tools to delineate strengths and needs, develop appropriate intervention plans and strategies, and determine change in individual children. An assessment is most meaningful when it represents the child's typical performance (Shelton, 1989). Thus, the assessment process should gain information regarding the child's abilities and behaviors across domains and environments (Cicchetti & Wagner, 1990). Assessments use a variety of methods to gather information. Norm-referenced and criterion-referenced instruments are commonly used. The assessment process also gains valuable information through ecological and performance appraisals (portfolios). The emphasis in an ecological approach to assessment is on documenting the child's success in participating in activities and routines across domains and environments. The assessment is conducted in the child's natural environment; thus, the skills demonstrated also reflect the context of performance. Judgment-based assessments document the parents' and caregivers' perceptions of a child's performance. According to Kirshner and Guyatt (1985), an assessment can be "evaluative." An evaluative strategy is one that measures the magnitude of change in an individual over time on a specific dimension. The overall purpose of an assessment is to describe a child's strengths and needs to help design appropriate, individualized therapeutic intervention plans.

Approaches to Measuring Skills

In addition to classifying testing instruments according to their purpose, tools available to therapists can be classified according to how the information is obtained: informally, formally, or ecologically. *Informal* strategies gather information in a less structured format. Facility or therapist-made checklists, developmental skill level forms, and interviews are examples of instruments that obtain information informally. Informal measurement strategies are easy to administer, are flexible to meet a family's needs and schedules, and will often obtain information on the typical performance of the child. The information provided can be gathered by observation or through caregiver report. Due to the flexibility inherent in the informal classification, rigorous testing procedures that increase reliability and validity are often missing. However, using informal procedures initially will establish rapport with the family and delineate parental concerns.

Therapists are most familiar with *formal* measurement strategies. Norm-referenced, criterion-referenced, and curriculum-based measurement instruments are included in the formal classification. Formal strategies are most often used to discriminate those children who are showing atypical development or delays. Two advantages of formal instruments include an established criteria, and standardized administration and scoring procedures that increase the reliability, validity, and accuracy of the instrument. A commonly cited limitation of formal instruments is the lack of familiarity between the examiner and the child, which may limit the child's willingness or ability to demonstrate his capabilities (Greenspan & Meisels, 1993). Additionally, most formal tests do not take into consideration the context of performance. The Bayley Scales of Infant Development-II (Bayley, 1993) is an example of a formal, discriminative tool.

Ecologically based or naturalistic strategies are becoming more accepted by professionals as accurate methods to gather information regarding a child's behavioral repertoire. Ecologically based measurement strategies are designed to determine a child's ability to perform a functional activity rather than the child's capability to perform a skill. Ecologically based procedures take into consideration the physical, social, and psychological environment in which a task is performed. An ecological or naturalistic assessment provides qualitative and quantitative information about the child. Observing the child within the environment in which a skill needs to be performed increases the likelihood that the therapist will gain meaningful information. Also, naturalistic assessments provide opportunities for self-initiation, choice, and problem solving by the child. (See Williamson, Anzalone & Hanft, Chapter 8, this volume.) These capacities often are not observed during structured, formal testing. Evaluation or assessment strategies such as the Alberta Infant Motor Scale (AIMS) (Piper & Darrach, 1993), the Toddler and Infant Motor Development (TIME) (Miller & Roid, 1994), the Functional Outcome Assessment Grid (Campbell, 1993), and the School Function Assessment (SFA) (Coster, Deeney, Haltiwanger, & Haley, 1998) are consistent with the ecological classification, incorporating observation, family participation, and task-specific activities into the evaluation or assessment format. The ecologically based strategy is consistent with the contemporary view of motor development, recognizing the importance of context, task, and family or caregiver participation (Heriza, 1993; Gentile, 1987; Lyons, 1984). The naturalistic process emphasizes adaptive behavior and yields a description of a child's repertoire of behavior across skill domains. This type of measurement approach can be linked directly to program planning and is used primarily for assessment purposes.

Models of Measurement

This section discusses five models used to gather information about a child's sensorimotor performance. The bottom-up model is primarily used for evaluation purposes. Three of the models—top-down, routines-based, and arena—are more applicable for assessment procedures. The fifth model—the judgement-based approach—is used for both assessment and evaluation.

The Bottom-Up Model

Traditionally, therapists rely on a bottom-up perspective (see Figure 1a) to gather information about a child's motor performance (Campbell, 1993). The bottom-up perspective is a diagnostic prescriptive model where deficits are delineated in specific areas and a program is designed to remediate those deficits. This model is most appropriate for (a) evaluation, and (b) when designing interventions targeting impairments such as decreased joint range of motion or muscle weakness. This model is less helpful when designing functionally oriented intervention plans needed in early intervention and educational programs.

The Top-Down Model

As noted previously, assessment procedures are most often used for program planning. Therapeutic programs for children are functionally oriented and are geared to the accomplishment of outcomes. In the top-down model (see Figure 1b), desired outcomes guide the assessment process. Desired outcomes are statements that describe what the team (parents, caregivers, and professionals) would like to see happen with a child. Outcomes can be general ("I'd like to see Anna move around") or specific ("Ryan needs to walk from the bus to the classroom"). Assessment procedures that operationalize the

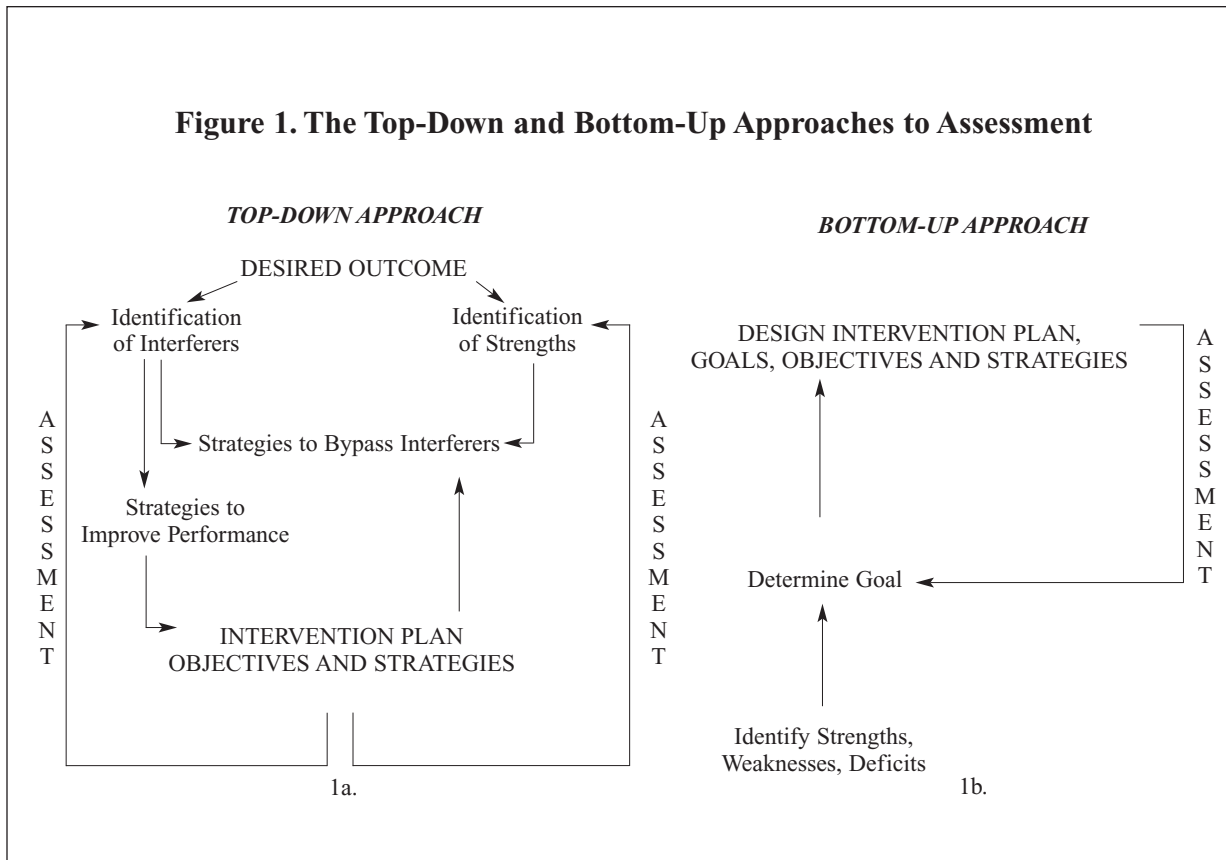
top-down approach answer the following specific questions (Campbell, 1993):

- What environmental factors and/or performance components are interfering with or facilitating a child’s performance of the desired outcome?
- Into what specific objectives can the outcome be divided to minimize the immediate and long-term negative effects of identified interferers?
- What intervention approaches, models, and strategies will be used to promote immediate and long-term attainment of the desired outcome?

Currently, there are only a few tools available that operationalize the top-down approach. Thus, research related to the rigor of these tools is lacking.

The Routines-Based Model

As part of the family-centered intervention planning process, McWilliam (1992) promoted the routines-based model of assessment. Consistent with the top-down approach, a routines-based assessment model judges the capabilities of the child within everyday routines and activities. A routines-based assessment identifies those factors (child-specific and environmental) that interfere with or promote the performance of a specific functional task within a specific routine. For example, a therapist would assess a child’s stair-climbing ability while the child is ascending stairs to go to his bedroom to take a nap or descending stairs to the basement playroom to obtain a toy, and would assess how a child scoops with a spoon during snack time. The use of routines to assess



behaviors is helpful for program planning because:

- Routines are meaningful to parents and caregivers
- The use of routines promotes the delineation of functional outcomes and intervention strategies
- Observation of a child across domains, contexts, and environments is most efficient when it involves naturally occurring routines

As noted in the top-down approach, the routines-based approach has strong clinical significance but lacks research supporting its use.

Arena Assessment

The arena assessment, primarily used in early intervention, is the simultaneous observation of a child by specialists in various disciplines. The purposes of an arena assessment are to:

- Obtain an integrated, holistic view of the child
- Determine the interrelationship of skills across domains
- Decrease handling of the infant/toddler by multiple professionals
- Decrease repetitive questioning of the family

The arena assessment consists of five components (see Box 1) (Foley, 1990).

The arena assessment can streamline case management and promote integrated service delivery. The arena assessment, however, can be time consuming. In order for all members of the team to gain the information they need, preassessment planning is needed. Also, the model requires a great deal of collaboration among team members.

Box 1. Components of an Arena Assessment

Team: Multidisciplinary team where members are determined from the desired outcomes. Team membership will vary across children depending on purpose of assessment.

Facilitator: The individual team member who interacts with the child. The facilitator is usually determined by the team based on the needs of child, purpose of assessment, and family desires.

Process: The process is family driven and naturalistic. Although the process may vary depending on the needs of the child and family, it should obtain information on the physical, social-emotional, and psychoeducational capacities of the child.

Staffing: A working meeting in which the team (which may include the family) synthesizes and analyzes the information gained from the assessment.

Outcome: A thorough arena assessment should yield a qualitative and quantitative description of the child, delineating strengths and needs.

Judgment-Based Assessment

The judgment-based assessment format enables therapists to obtain task-specific information about a child from those individuals who observe the child's performance on a regular basis. Thus, asking parents and caregivers to fill out a form or answer a series of questions regarding the child's behavior would yield information that parents and caregivers (a) find meaningful, and (b) consider typical behavior for the child.

Measurement Instruments

In Chapter 8, Williamson, Anzalone, and Hanft discuss many tests used to directly evaluate or assess children on motor performance, sensory processing, and praxis. To avoid redundancy, the following section discusses only those tools that are specific to neuromotor and/or functional performance, and that are designed specifically to assist with program planning and documenting change over time. Additionally, all these tests have been specifically designed to capture a unique aspect of performance administered in a manner consistent with contemporary views of motor development, motor performance, and functional outcome.

Alberta Infant Motor Scale

The Alberta Infant Motor Scale (AIMS) (Piper & Darrach, 1993) was designed to identify infants up to 18 months of age who have gross motor delays. It can be used as a screening tool or as part of an assessment to measure gross motor skill maturation over time. The authors of the AIMS clearly indicate that the test should not be used for older children with known disabilities who are functioning below the 18-months-old level or to monitor progress of therapy in children with known disabilities. The AIMS is a criterion-referenced, standardized instrument with strong psychometric characteristics. The AIMS can be administered by a variety of health care professionals who have a background in infant motor development. Although scoring and interpretation are facilitated by detailed drawings in the manual and on the score sheet, use of the test requires extensive knowledge in normal and abnormal motor development. Test administration involves the observation of 58 items, divided among four positions: prone, supine, sitting, and standing. Within each position, three components of

movement are evaluated: weightbearing, posture, and anti-gravity movements. Minimal handling of the child is required, and parents are encouraged to be the primary facilitators. Test administration typically requires 20 to 30 minutes to complete, but it can take as little as 10 to 15 minutes.

The AIMS is a practical tool and is efficient when performed by an experienced clinician. It yields information of clinical relevance to occupational therapists and physical therapists. The AIMS is unique in that it is one of the few tools that emphasize the *observation* of motor performance. This provides the child the opportunity to be evaluated in more natural environments, such as the home. It also allows the therapist to gather information on the child's typical motor performance.

Functional Outcomes Assessment Grid

The Functional Outcomes Assessment Grid (FOAG) (Campbell, 1993) is used by an interdisciplinary team to develop goals for children with disabilities in direct relation to the functional outcomes determined by the team, monitor change over time, and determine appropriate level of service. It is appropriate for all children with disabilities, regardless of their ages. The FOAG is based on the American Occupational Therapy Association's document, *Uniform Terminology for Occupational Therapy, 2nd Edition* (1994). Individualized observation of functional skill performance is conducted to determine which components (physical, environmental, behavioral, and sensory) are impacting positively or negatively on a child's performance of a skill. Each component is scored on a 5-point scale, from no problems to significant problems that impact on, or prevent, skill performance. Those factors that impact significantly on performance of team-established outcomes are targeted for intervention. The FOAG operationalizes the top-down model

of measurement as well as the routines-based model. It is highly useful for assessing children with complex needs whose development is known to be atypical and whose disability affects a broad spectrum of functional skills. It is most helpful when used as a collaborative team decision-making tool, facilitating integrated service provision. The FOAG directly links assessment to program planning and is individualized to meet the unique needs of the child.

Pediatric Evaluation of Disability Inventory

The Pediatric Evaluation of Disability Inventory (PEDI) (Haley, Coster, Ludlow, Haltiwarger, & Andrellas, 1992) determines functional capabilities and performance, monitors progress in functional skill performance, and evaluates therapeutic or rehabilitative program outcomes in children with disabilities. It can be used with children with and without disabilities who are from 6 months to 7.5 years of age. The PEDI is a norm-reference test with strong psychometric characteristics. The test is divided into subtests focusing on the three functional skills of self-care, mobility, and social function. Also, environmental modification and amount of caregiver assistance are systematically recorded. Information can be obtained through parent report, structured interview, or professional observation of a child's functional behavior. The PEDI is a reliable and valid assessment of functional performance in children with significant cognitive and physical disabilities.

School Function Assessment

The School Function Assessment (SFA) (Coster et al., 1998) is specifically designed to be used within the educational environment to assess function and to guide program planning for students with disabilities in kindergarten through grade six. Teachers and other

providers of services in the educational environment judge a child's performance on nonacademic tasks divided among those areas assessing level of participation, amount of task assistance or modification, and level of performance in cognitive or physical tasks. The SFA is a criterion-referenced test, and it specifically links assessment results to the development of an Individual Education Program (IEP). It uses a judgment-based format to gather information on the typical performance of a child from the variety of individuals involved in the student's education. It yields detailed information across domains and environments and, thus, requires collaboration from those that know the student well.

Toddler and Infant Motor Evaluation

The Toddler and Infant Motor Evaluation (TIME) (Miller & Roid, 1994) was developed to measure functional movements in an infant as observed in the infant's natural environment. The TIME was designed to be used with children 4 to 42 months of age with suspected motor dysfunction, and to identify those with mild to severe motor problems. It identifies patterns of movements, evaluates motor development over time, and assists in intervention planning and treatment efficacy research. The TIME is divided into eight subtests: five of the subtests have been standardized and norm-referenced. The test records the child's spontaneous movements in various positions, the child's sequence of movements, and any abnormal movements. The parents interact with, handle, and position the child according to the examiner's instructions and guidance. The TIME can be used as a comprehensive motor evaluation or assessment tool. As an evaluation tool, the TIME can be used to identify a child with a motor dysfunction. Repeated measures can be taken with the TIME, thus making it useful for assessing

motor development over time as well as assessing treatment efficacy and/or motor maturation. The TIME is a valuable clinical tool. It is a tool that incorporates dynamic systems theory in the assessment of motor functions and development. It links a child's function, quality of movement, and motor skills. The TIME is comprehensive and detailed, providing excellent visual descriptors of the motor components that are being assessed. It primarily uses naturalistic observation to gather data, recognizing the importance of evaluating typical movements as they are impacted by the child's environment.

Test of Sensory Functions in Infants

The Test of Sensory Functions in Infants (TSFI) (Degangi & Greenspan, 1988) was developed to screen and quantify sensory processing and reactivity in infants. The test includes five subdomains of sensory processing: reactivity to tactile deep-pressure, adaptive motor responses, visual-tactile integration, ocular-motor control, and reactivity to vestibular stimulation. Infants between 4 and 18 months of age can be screened using the TSFI. This criterion-referenced test is most accurate in identifying infants between 10 and 18 months of age without sensory processing disorders or with sensory dysfunction. This age range is appropriate because definitive sensory processing dysfunction does not emerge until late in the first to second years of life.

The TSFI was designed to identify infants with sensory dysfunction. It can also be used with infants who have a known regulatory disorder or developmental delay. Because limited normative data are available, total test scores are used to make screening decisions. The individual subtests, however, can be used in conjunction with other standardized developmental and neuromotor tests when making diagnostic decisions and recommendations (DeGangi & Greenspan, 1988). Abnormal or

at-risk scores on the TSFI indicate that a child has potential problems in sensory processing and should be referred for further evaluation or assessment.

The TSFI is the first test developed to screen infants for early sensory processing problems. Although additional data are needed in order to use the test as a diagnostic tool, individual subtests and test items can provide useful clinical information.

LINKING ASSESSMENT FINDINGS TO INTERVENTION PLANNING

Linking assessment findings to a specific intervention plan for a child with a neuromotor or sensorimotor dysfunction is a complex process. Use of traditional methods to gather information has often resulted in planning interventions for children with disabilities that are intensive, isolated, and deficit-based. Strategies based on a neuromaturational framework have dominated therapeutic intervention during the last three decades. Contemporary practice, however, is outcome oriented, with strategies that emphasize functional relevance. Planning intervention that is outcome oriented has four components. The first component is *assessment*. Through assessment strategies, the therapist determines what is facilitating or interfering with the child's acquisition of a specified outcome. Next, the therapist—in collaboration with the team—determines whether the focus of *intervention* should be remediation, prevention, promotion, compensation, or alteration. Third, the therapist determines the *model of service delivery*, which can be direct, monitoring, or consultation. Finally, the therapist determines the *type of strategy* that would best meet the child's needs. Because children with disabilities in sensorimotor or neuromotor skills have complex problems, a combination of approaches,

service delivery models, and strategies are most often used.

The purpose of intervention is fourfold. Therapists use a wide variety of strategies to (1) promote active movement, (2) promote functional skills, (3) prevent impairment, and (4) foster the integration of the child into society.

Most of the traditional strategies used by therapists (see Box 2) require direct, one-to-one application, which often take place in segregated settings such as clinics or assigned rooms in early intervention or educational programs. Although many of these strategies are useful in preparing a child for movement by relaxing tight muscles, strengthening weak muscles, or promoting motor milestone development, when used in isolation they have not been shown to increase function any more than nontherapeutic strategies (Warren and Horn, 1996). Additionally, generalization of skills practiced, facilitated, or learned during therapy has not been demonstrated using the traditional model of service provision.

Frames of Reference

A frame of reference often guides a therapist's selection of strategies used to treat children with sensorimotor dysfunction. The following discussion describes three broad frames of reference that therapists employ: neuromaturational, motor learning, and dynamical systems.

Neuromaturational

The traditional frame of reference used by most therapists is neuromaturational. Neuromaturational theory is based on the work of individuals such as Gesell (1945) and Shirley (1931). This theory promotes the concept that as a child grows and his central nervous system matures, skills or patterns of movement will unfold in a predictable, hier-

archical manner. Treatment strategies based on this theory attempt to promote skills in children by following the sequence of skill development documented in developmental scales. This theory assumes that skills will unfold naturally in a normally developing central nervous system. As the nervous system matures, adaptive behaviors and skills will become increasingly complex. An emphasis of treatment using this model is the promotion of central nervous system maturation. The analysis of reflex integration, facilitation of equilibrium and righting reactions, and promotion of the components of motor skills are integral to strategies developed from the neuromaturational model.

Learning-Based

Although strategies based on the neuromaturational model continue to be the most commonly used, the learning-based models are often integrated into a holistic treatment program. The learning-based models may be arrayed along a continuum from strict behaviorism as promoted by Skinner to the more widely accepted schema theory promoted by Schmidt (1975). Most therapists readily employ basic learning theory strategies, such as providing multimodal feedback, arranging the environment to promote skill performance, and repeating actions to increase the likelihood that the behavior will be retained. The schema theory proposes that motor development emerges from a set of "rules" used by the individual to evaluate, correct, and update memory traces for a movement. General motor programs are responsible for organizing the fundamental components of the movement. In order for the general motor program to produce a movement, recall and recognition schema are used. Recall and recognition schemas are memories of the relationships between past movement (recall) and sensory (recognition) patterns and the movement

Box 2. Strategies Used by Physical and Occupational Therapists*

Neurodevelopment Treatment (NDT): Direct handling of children. Specifically designed for young children with cerebral palsy to facilitate normal patterns of movement.

Myofascial Release (MFR): Specific techniques performed by a therapist to release the binding down of the fascia. Goal of MFR is to change structure to allow functional change. Promotes structural change techniques followed by functional activities. Little to no scientific research to determine effectiveness.

Craniosacral Therapy (CS): Therapist applies gentle pressure through the craniosacral system to promote movement of cerebral spinal fluid and rhythm. Gentle, noninvasive manipulative technique. Used for variety of conditions and promoted for use with infants including newborns to diminish effects of birth trauma. Little to no research on effectiveness.

Massage: Variety of specific tactile techniques from gentle laying of the hands to more vigorous Swedish and Indian techniques. Used for a variety of children, including babies born prematurely. Research has shown a variety of physiologic benefits including gastrointestinal functioning, improved blood and lymphatic circulation, and weight gain in preterm infants. Also shown are improvements in decreasing tactile sensitivity, parent-infant bonding, calming, comforting, and respiration.

Strength Training: Strength training using standard progressive-resistive exercise protocols may relate to improvement in function. Sound research on strength in children with cerebral palsy, but minimal research investigating the effects of strength in children without other developmental disabilities, such as sensorimotor dysfunction.

Mobilization: Based on concept that immobility affects all systems necessary to produce movement. Is indicated if extra-articular connective tissue abnormally restricts joint motion. Little research done with children to indicate effectiveness.

Sensory Integration (SI): Used with children with mild to moderate sensory processing dysfunction. Treatment uses specific tactile, vestibular, and proprioceptive activities to promote adaptive responses. Goal is to improve the ability of the central nervous system to process and integrate sensory inputs.

Conductive Education (CE): Intensive programming using rhythmic intention and sequenced facilitation to enhance organization and production of intentional movement within educational and life tasks. Performed by a specially trained and certified conductor. Research from the Peto Institute in Hungary is quite positive.

Movement Opportunities via Education (MOVE): Comprehensive, activity-based curriculum for children with severe neuromotor dysfunction. Teaches basic functional motor skills. Process designed to have children acquire skills necessary for sitting, standing, and walking. Team works on same set of skills so that skills are reinforced and consistent.

*These are only a selection of strategies used by therapists. Therapists also use, for example, assistive technology, splinting, bracing, remediation, and teaching of specific skills.

desired. In schema theory, the development of fundamental movement patterns is emphasized to generate the ability to develop more sophisticated patterns. For example, once the motor pattern for walking is established, individuals expand that pattern to walk on various terrains and at various speeds. Schema theory contends that children with disabilities may have difficulty initiating a movement, completing the movement with accuracy or precision, or stopping a movement because of a lack in recall or recognition schemas.

Children with sensorimotor dysfunction typically have problems in accurately producing a movement or controlling the execution of a movement. In schema theory, this would be due to poorly established recognition patterns. Schema theory promotes a use of practice that has clear implications for the treatment of children with sensorimotor dysfunction. Specifically, schema theory predicts that (a) variable practice of a skill or action promotes the establishment of a schema, and (b) varied practice works as well as repeated practice in promoting accurate performance of a novel action. Thus, treatment for learning motor patterns and schemas would be more effective if the child practices and repeats skills in various situations, under changing conditions. The integration of therapeutic strategies into daily caregiving routines operationalizes this concept. Daily caregiving routines ensure that a skill is practiced within a meaningful context for the child. Performing activities within the context where they will be used and are needed increases the likelihood that the child will be interested and motivated in performing the task.

Dynamical Systems

The dynamical systems theory (Heriza, 1991; Thelan, 1990) is the newest theory to emerge in the physical and occupational therapy literature as a way to explain how

development and motor change take place. The dynamical system theory proposes that a functional movement emerges from the interaction of a variety of subsystems with the environment. In the case of motor skills, these subsystems include sensory, neurological, musculoskeletal, emotional, psychological, and other variables. Thus, depending on the task, any one of these variables can create a barrier to the accomplishment of the task or be a facilitator of task development. In neuro-maturational theory, the development of skills is explained as a sequence of skills that build on one another and emerge in stages. The dynamical systems perspective, however, proposes that a change in behavior occurs as a consequence of a change in one or more of the variables that can impact the skill. Also, the dynamical system perspective emphasizes that change in motor behavior most likely will take place during times of transition. Treatment based on this perspective focuses on analyzing the variables that are preventing or promoting a specific skill; changing the combination of inputs, contexts, and tasks that are important to produce a specific task; and timing treatment to coincide with periods of transition. Intense therapeutic input during these periods of transition is suggested as the most effective treatment strategy to produce changes in motor skill acquisition. Because the dynamical system perspective emphasizes the interaction of multiple systems with the environment, the importance of family and caregiver interactions with the child cannot be overemphasized.

Approaches to Intervention

As with assessment practices, contemporary intervention theory encourages therapists to reassess practices and approaches to intervention. Dunn, Brown, and McGuigan (1994) describe five approaches available to

therapists. These approaches allow therapists to design intervention strategies that target the specific needs of the child and the desired outcomes of the family. The approaches also provide a framework for the therapists to determine the intent of the intervention. Depending on the needs of the child, a therapist will most often use a variety of approaches and expect to change approaches as the needs of the child change.

Remedial

The remedial (or restoration) approach is the most familiar to therapists and is the basis for many of the more popular treatment strategies. Based on the traditional medical model of intervention, the remedial approach enables therapists to identify performance deficits and to seek to resolve them by facilitating age-appropriate sensorimotor capabilities. This approach may be appropriate for some children; however, using only an approach that encourages “average” development and “typical” movements may prevent other children from developing functional skills.

Compensation

The compensation approach is often used with older children, especially those with orthopedic disabilities or significant neuro-motor dysfunction such as spastic type of quadriplegia. The purpose of the compensation approach is to use assistive technology, adaptive equipment, or other devices to allow a child to perform a skill that the child is not capable of performing or has yet to master. Compensation strategies also are used to prevent further impairment or disability as they are often used to bypass a barrier to the performance of a desired outcome. With young children, compensations are most often used in combination with other approaches. Compensation strategies also are used to promote development. For example, providing a

child who has minimal or no expressive language with an alternative communication system (e.g., sign, gestures, or a communication board) will promote the child’s receptive language development by providing him with the ability to communicate interactively.

Promotion

The promotion approach creates naturally occurring activities and routines to promote skill development. This approach is typically used in community-based activity programs designed for all children, and which are often based on the *Developmentally Appropriate Practice Guidelines* (Bredekamp and Copple, 1997). The environment and activities are designed to facilitate developmental skill acquisition. This approach is well suited for children with global developmental delays or weaknesses in specific skill performance areas. Enriched, stimulating child-care programs use the promotion approach and can easily integrate children with delays into the program. Other programs such as tumbling, dance, or library story time utilize a promotion approach.

Prevention

The purpose of the prevention approach is to prevent the development of secondary impairments or disabilities in children with known difficulties. For example, proper positioning of an infant with cerebral palsy is used to help prevent trunk malalignment, which the child has a high risk of developing. Encouraging small-object manipulation or coloring for toddlers and preschoolers who shy away from these activities may prevent them from developing visual-motor or hand-writing problems later on.

Alteration

The remedial approach emphasizes the facilitation of skills not yet acquired by a child.

The alteration approach, on the other hand, emphasizes the development of skills that are most functional for a child by providing the child with an alternative environment in which to foster skill development and use. The alteration approach requires that the therapist and team weigh the importance of changing a child's aberrant behavior or the lack of skill against any given activity or environment. For example, Andrew is a child with sensory-processing deficits who becomes behaviorally disruptive when in a highly sensory-charged environment. His intervention team, however, has identified his poor language skills as the most immediate concern. Since Andrew's behavior can interfere with his ability to benefit from the language enrichment offered to him, his team has several options. The team members can decide to teach Andrew behaviors that are age appropriate (remedial approach) within the sensory-charged environment; they can change the environment by decreasing sensory stimulation (compensation approach); or they may decide to move Andrew to a minimal-sensory environment (alteration approach). Although the first two options may be appropriate and necessary, it may be more functional to find a better environmental match for Andrew so that his intervention can focus on his language development, which is the identified area of concern.

Models of Service Provision

In addition to identifying the various approaches to intervention needed by a child, therapists also must decide on the most effective and efficient service delivery model. As noted above, the traditional intervention model—the remedial approach—promotes direct one-to-one therapeutic interventions. Contemporary practice, however, promotes the use of three models of service provision: direct, monitoring, and consultation (Dunn &

Campbell, 1991). These models allow the therapist to design a comprehensive intervention plan that takes into account the outcomes developed by the team, the individual strengths and needs of the child, family priorities, the environment, and other support factors.

Direct

Therapists most often use a direct service model of intervention. In this model, therapists provide one-to-one therapy, usually in a segregated setting (e.g., a clinic, a specially designed room within a childcare or educational program, or in a separate space within a classroom). Usually, the purpose of direct service is to provide intensive, remedial intervention to a child. Therapists use direct therapy to provide specialized therapeutic intervention strategies. Strategies are used to teach specific skills, introduce new behaviors to the child, change maladaptive behaviors, or to increase a child's tolerance to sensorimotor experiences.

Recent changes in research, legislative mandates, and societal attitudes about children with disabilities are creating a shift away from the provision of direct service to all children to an integrated service delivery program. Integrated programming is defined as:

- Specialized instruction
- Individualized to meet the unique strengths and needs of a child, within a naturally occurring environment
- With other children without disabilities
- Within the context that the skill is required (McWilliam, 1996)

Research comparing the benefits of integrated and direct service delivery has indicated little difference in the enhancement of skills in individual children (McWilliam, 1996). However, other benefits have been related to integrated therapy models. (See Advantages to Integrated Therapy, Box 3.)

Although changes in standardized testing scores were the same following interventions based on integrated or direct service delivery models, Cole, Harris, Eland, and Mills (1989) found that teachers preferred the integrated model. In teaching a child with severe motoric involvement how to use a microswitch, Giangreco (1986) found performance improved more during integrated programming than when teaching was conducted in isolation.

Obviously, more research needs to be done in this area, especially with children with various needs and conditions. It is clear, however, that the field is moving rapidly to develop programs that provide integrated therapy. In order to provide effective treatment within an integrated model, therapists require skills in putting into operation two additional service delivery models: monitoring and consultation.

Monitoring

Monitoring is a method to ensure that therapeutic strategies become infused into naturally occurring activities and are carried out throughout the day. Therapists monitor programming when they create and supervise the delivery of a plan that is carried out by someone else (Dunn, 1996). Monitoring can be used alone or in combination with direct service and consultation. Monitoring service provision may be as time consuming as direct service, especially initially. Therapists are required to ensure that any program or activity taught to another person is being carried out appropriately. Thus, monitoring requires therapists to

- Design the activities
- Teach the provider specific methods of integrating therapeutic strategies into existing routines
- Observe the provider performing the activities
- Adapt and update the activity as necessary

Box 3. Advantages to Integrated Therapy

- Active participation is enhanced because service to children is provided in a familiar, comfortable, nonthreatening setting.
- Developmentally appropriate, naturally occurring settings are enriching and therapeutic.
- Natural environments provide routine cues and opportunities to provide therapeutic tasks within context.
- Functional behavior is supported because the child's actions reinforced within the natural context and by peers.
- Generalization of skills is enhanced because learning is taking place within the environment in which the skills are expected.
- Normalization is valued and enhanced. All children recognize that each child has strengths and needs and that specialized services can be beneficial to all.

- Supervise the implementation, and *be responsible for documenting* the child's performance

Monitoring is beneficial because (a) it increases the amount of time a child is benefiting from a therapeutic strategy, (b) the strategy will promote generalization because it is being conducted within a naturally occurring activity, and (c) it provides continuous, ongoing reinforcement of the desired behavior.

Consultation

Monitoring service delivery requires that the therapist design the activities and therapeutic strategies that will be used by others to promote needed therapeutic skills. In consultation,

the consulting therapist assists another therapist in meeting jointly identified goals. The consulting therapist contributes her expertise to help solve a problem or dilemma for another provider of service to a child. Hanft and Place (1996) promote the use of collaborative consultation as the preferred method of consultation. Collaborative consultation is an interactive process in which various team members work together to generate creative solutions to a problem. As the field moves toward integrated, discipline-free program plans, collaborative consultation will help teams put into effect the plan for the child, within the structure of an inclusive setting. Collaborative consultation is also used within the traditional model of direct service delivery. Effective consultation has three critical elements: dynamic interaction among the team members, respect, and a belief that the consultation will help achieve a common goal. Consultative service provision accepts that children with disabilities present with complex problems and issues that can only be helped by creative use of the expertise provided by all team members. Collaborative consultants must free themselves from discipline-bound perspectives and be open to combining various systems and approaches to assist the child and family. Ideally, the solution to a specific challenge reflects a variety of approaches. Table 3 illustrates the use of the five service provision approaches and three models of service.

EFFECTIVENESS OF SPECIFIC MOTOR INTERVENTION

The effectiveness of therapeutic input for children with neuromotor and sensorimotor disorders has been of particular interest for the last 30 years. Generally, research that assessed specific developmental skill improvement has shown that therapeutic

intervention had little effect on motor development. However, research has documented other nonmotor benefits for children receiving specific therapeutic intervention and when studies use a single-subject design. One of the earliest studies assessing the benefits of physical therapy for children with cerebral palsy (Wright & Nicholson, 1973) indicated that, although neuromotor performance was not necessarily enhanced by intervention, nonmotor benefits such as family competency, child happiness, sociability, and confidence were seen. Thus, there has been a recent emphasis on examining broader issues in development and functional capacity in children with known disabilities. Additionally, early research into the benefits of therapy for children with motor disabilities has indicated that therapy only minimally affected impairments in children with significant motor dysfunction (Shonkoff & Hauser-Cram, 1987). Based on this limited research base, physical and occupational therapists are encouraged to examine disability or the inability to perform a functional activity rather than to examine individual impairments.

Types of Intervention

For purposes of this section, the term “intervention” is limited to specific approaches used by therapists that purport to influence the neuromotor and sensorimotor processes to improve function, reach targeted outcomes, or promote developmental skill acquisition. Functional outcomes include performance on tasks related to developmentally appropriate tasks, interaction within the environment, and purposeful activity. Functional outcomes deemphasize change measured on standardized, norm-referenced tests of developmental skills. Functional outcomes include nonmotor benefits, such as decreased need for assistance by caregivers,

Table 3. Examples of Service Provision Approaches and Models

Service Provision Approaches					
Service provision models	Remediate	Compensate	Alter	Prevent	Promote
Direct	Facilitate neck extensor muscles so child can look at friends when playing	Fabricate a splint to enable the child to hold the cup at snack time	Select a community preschool based on the level of noise the child can manage	Facilitate weight bearing during infancy to prevent possible delays in walking	Provide a play program for the community for all children to attend
Monitoring	Supervise the teacher's aide to facilitate tone for reaching during a game	Supervise a feeding program that minimizes the time for eating and enables socialization	Work with parents to identify which community locations will be best for their family outings	Create a "positions alternatives" chart for the aides to prevent skin breakdowns	Oversee the development of a morning preschool routine that optimizes early development possibilities
Consultation	Teach classroom staff how to incorporate enhanced sensory input into play routines during free time	Provide the team with information from skilled observations that enables them to select the best play partner for a child	Work with parents to identify which community locations will be best for their family outings	Teach a parent a range-of-motion sequence to prevent deformities	Assist the child care provider to develop a comprehensive curriculum

Adapted with permission from Dunn, W. (1996). Occupational Therapy. In R. A. McWilliam (Ed.), *Rethinking pull-out services in early intervention: A professional resource* (pp. 267-313). Baltimore: Paul H. Brookes.

caregivers' sense of competence and confidence in caring for the child, and other related improvements.

Although many types of intervention were listed previously in Box 2, the most common form of intervention used with children with primary neuromotor deficits such as cerebral palsy is a neurofacilitation type. The most common intervention of this type is neurodevelopmental treatment (NDT). Intervention for children with primary sensorimotor deficits, such as those on the autistic spectrum, is considered sensorimotor intervention, the most common being sensory integration. Contemporary practice promotes a more task-oriented approach based on the systems or motor-learning perspective. This approach is less diagnosis (or deficit) dependent, and is consistent with the emphasis on functional outcomes rather than on facilitation of developmental milestones.

The following discussion reviews research published in the 1990s and which is related to intervention in the neurodevelopmental, sensorimotor, and task-oriented approaches. Readers interested in prior studies are referred to 1980s reviews of meta-analysis (Ottenbacher, Biocca, DeCremer, Gevelinger, Jedovic, & Johnson, 1986; Ottenbacher & Peterson, 1985; Shonkoff & Hauser-Cram, 1987) and qualitative reviews (Harris, 1987, 1988).

Neurodevelopmental Treatment

Recent randomized, controlled trials (Law et al., 1991; Palmer, 1990) examining the benefits of NDT produced results that are consistent with previous studies. Studies that utilized a group experimental design found little definitive support that NDT is any more beneficial than other types of intervention (such as general stimulation) in enhancing the attainment of developmental skills (Palisano, 1991). However, families whose

children received this type of intervention were found to be more emotional and verbally responsive to their children and more confident in caregiving (Palmer et al., 1990). In this era of family-centered care and recognition of the importance of parent-child interactions, these findings support intervention. These findings are especially important for children with disabilities such as cerebral palsy. Studies utilizing a single-subject design, however, are more supportive of NDT in improving specific motor skills in children with cerebral palsy. Unlike traditional group designs, the single-subject design is concerned with individual performance on specific tasks, unique to the individual being treated. Embrey, Yates, and Mott (1990) found that improvement in specific components of gait could be seen in children receiving intensive intervention. Generalization of this single-subject design is limited, but the design shows promise as a strategy to indicate improvement in children whose disabilities make it difficult to identify them as a homogenous group.

The difficulty in establishing the efficacy of NDT is multifaceted. One primary problem is that NDT is an approach to treatment, rather than a series of activities. This approach, based on neurophysiological principles, is individualized to meet the needs of a specific child and is modified based on the response of that child. Thus, an assessment of the techniques is very difficult. Unlike medication or a specific surgical procedure, specific treatment techniques vary from therapist to therapist, further complicating the analysis of the approach. As noted, most studies examining the effectiveness of the NDT approach have used developmental skill acquisition tests or checklists to determine outcome. These tools may not be responsive to the changes produced by using NDT. Alternative measurement instruments, such

as the Gross Motor Function Measure (Russell et al., 1993), the TIME (Miller & Roid, 1994), or the use of goal attainment scaling (Ottenbacher & Cusick, 1989), may prove more helpful in determining if NDT can produce change over time in children with complex neuromotor dysfunction.

Learning-Based Models

Although there is only limited research on the learning-based (or task-oriented) approach used with children, available evidence indicates that this approach may be more useful in changing functional skills in children with significant motor disabilities. Horn, Warren, and Jones (1995) showed that developing activities targeting specific behaviors was successful in supporting the attainment of those functional behaviors. There also seemed to be a generalization effect in that movements not targeted, but assessed, improved. The benefits of this approach may be due to the principles of motor learning on which it is grounded (Larin, 1994). Motor learning indicates that motor performance is enhanced when children are afforded opportunities to experience and actively practice specific activities or tasks. The theoretical basis of the motor learning approaches provides evidence that should encourage therapists to examine the effects of integrating these principles into the development of motor skills, performance, and function.

Sensory Integration

Children with mild to moderate problems having a sensorimotor basis, such as dyspraxia or sensory-processing disorder, often receive sensory integration (SI). According to Ayres (1979), the theory of SI can be used to explain the relationship between sensory processing and behavior. For example, impaired sensory processing in children with autism has been linked to dysfunction in relating,

arousal, interactions with others, and goal-directed play (Greenspan & Weider, 1997; Koomar & Bundy, 1991). It is these relationships that provide support for the use of SI with children with autism, as well as other significant disabilities. According to the theoretical constructs, children who receive sensory integration should improve in the following areas (Parham and Malloux, 1996):

- Adaptive responses
- Self-confidence and self-esteem
- Motor skills
- Daily living skills and personal-social skills
- Cognition, language, and academic performance

As with NDT, there is little empirical evidence of the effectiveness of SI or other strategies with a sensory component commonly used by therapists for children with a variety of conditions (Ottenbacher, 1991; Vargas & Camilli, 1999). Also similar to NDT, the literature regarding SI demonstrates the many challenges faced in reaching any consensus as to its effectiveness. Children across studies vary, outcome measures do not focus on the same information, and there is little control of the exact treatment techniques employed. Another unique limitation is that SI is a complex construct that theoretically is presented as a whole. In reductionist-type research, the SI construct must be broken down into individual component pieces. Consequently, research is evaluating the effectiveness of each component of sensory stimulation rather than the overall construct of SI (Ottenbacher, 1991). Additionally, most of the research on SI has studied children with learning disabilities although many more children have sensory-processing disorders, which may be amenable to the effects of SI.

However, even with these limitations, support exists for activities that are considered sensory integrative. Humphries, Wright,

Snider, and McDougall (1992) found that children with learning disabilities who received SI showed improved motor planning. Using a single-subject, multiple-baseline design, Case-Smith and Bryan (1999) showed that preschoolers with autism improved on specific, individualized activities to gain mastery in play and engagement. As with NDT, there appears to be accepted, theoretical support for treatment based on sensory integrative principles, with minimal empirical evidence. Because the SI treatment approach is so widely used by occupational therapists (Watling, Dietz, Kanny, & McLaughlin, 1999; Case-Smith & Miller, 1999) it is of utmost importance that research be conducted to assess its attributes, effectiveness, and overall benefits to children with complex sensorimotor considerations and their families.

IMPLICATIONS

Children with developmental disabilities often have significant problems related to motor performance, even when their primary diagnosis is not motor-based. Motor planning, sensory processing, and motor delays are all seen in children on the autism spectrum or with mental retardation, learning disabilities, language processing difficulties, or other similar diagnoses. This is especially true in young infants because the lack of attainment in motor milestones is often the area initially seen as problematic. Consequently, physical and occupational therapists become the professionals who frequently provide the initial intervention. As early interventionists, they are in an ideal position to effect functional change by applying strategies based on sound theoretical principles in a functional manner.

Research on the effectiveness of intervention with children with significant sensorimotor disabilities is more successful when functional skills are targeted. According to

Wolery (1996), functional skills include those behaviors that are:

1. Useful
2. Enable the child to be more independent
3. Foster learning more complex skills
4. Allow a child to live in a less restrictive environment
5. Enable the child to be cared for more easily

Infusing NDT, SI, and the learning-based system approach into daily caregiving routines and embedding strategies into natural environments increase the likelihood that children will obtain and retain functional behaviors. Although limited, there are some initial research findings that lend support to this service delivery model. McWilliam, Tocci, and Harbin (1995) found that when parents of children who were receiving direct, individualized, clinic-based therapy were asked what they valued most from the sessions, the parents said it was the information they received from the therapists. These same parents, however, were not comfortable in discussing what they felt their child could do at home as a result of the therapy. These findings indicate that families value the information therapists provide and use this information in caring for their children. They are unsure, however, what functional change is directly linked to a specific intervention.

Clearly, research is needed to determine the effectiveness of these treatment strategies. Research should include a variety of strategies that focus on a variety of areas. Although widely accepted as appropriate theoretical constructs, the basis of the theoretical perspectives of various intervention approaches should be examined to validate their usefulness in explaining sensorimotor and/or neuro-motor dysfunction. This recommendation is especially relevant for the theoretical bases of NDT and SI. Both of these approaches and

their treatment techniques were developed from a neuromaturational view of development. Assessing their validity in light of the contemporary motor-learning and control theories, as well as in light of the systems perspective, may be helpful in establishing sound research hypotheses.

Clinical research examining the effectiveness of specific techniques must clearly describe the techniques and the intervention procedure. Because of the variation in treatment, concluding that an approach is effective or ineffective is misleading. Specific techniques may be more advantageous than others for certain populations of children. Additionally, the outcomes sought through treatment must be clearly defined in functional, measurable terms. Improvements in processing ability or postural control are goals that have little direct meaning to the child's daily caregiving. To be functional, outcomes should have a direct relationship to Wolery's five areas.

Finally, measurement tools need to be responsive to the changes seen during therapeutic intervention. Too often, standardized developmental tools have been used to determine change over time in children with known disabilities. As these tools were not developed to detect these kinds of changes, their value is limited. Use of functional tools such as the FOAG, the PEDI, or the SFA (as previously described) may prove more beneficial. Intervention outcome is linked directly to tasks on these systems; thus, relevance to the treatment strategies may be clearly identified.

SUMMARY

Significant changes in therapeutic interventions provided to children with sensorimotor dysfunction have occurred during the past 20 years. These changes have primarily occurred in methods of gathering information about a child's functional status and delivering

appropriate, functionally oriented services. Therapists are revising traditional service delivery models to reflect the growing emphasis on providing integrated therapeutic services within inclusive settings. The physical and occupational therapists' expertise in neuro-motor development, the effects of sensorimotor skills on function and other developmental areas, and the therapists' ability to task analyze all contribute to contemporary service delivery. In recognition of the overlap among service providers, integrated, discipline-free programming is becoming more common.

This chapter outlined models of information-gathering that therapists use to evaluate and assess infants and young children. It also reviewed several recently published measurement tools used by pediatric physical and occupational therapists. Instruments are used as one component of the measurement process to (a) screen children for potential developmental concerns, (b) evaluate children to determine diagnosis or eligibility for services, or (c) assess children to plan therapeutic intervention or to determine the effects of intervention.

Therapists should be aware of the purpose of each tool and the information they would like to gain from the tool prior to selecting an instrument. Therapists may need to use a variety of tools and strategies to meet their screening, evaluation, or assessment objectives.

In addition to the measurement instrument used to gather information, a comprehensive measurement strategy should encompass the principles developed by ZERO TO THREE, National Center for Infant, Toddlers, and Families (Greenspan & Meisels, ZERO TO THREE Work Groups on Developmental Assessment, 1996) (see Chart 1).

These principles recognize that the development of infants and young children is complex and requires an appreciation of the child's abilities within a functional context. The therapist needs to appreciate that

Chart 1. Principles of Assessment

1. Assessment must be based on an integrated developmental model.
2. Assessment involves multiple sources of information and multiple components.
3. An assessment should follow a sequence.
4. The child's relationship and interactions with his or her most trusted caregiver should form the cornerstone of an assessment.
5. An understanding of the sequence and timetables in typical development is essential as a framework for the interpretation of developmental differences among infants and toddlers.
6. Assessment should emphasize attention to the child's level and pattern of ongoing experience and to functional capacities, which represent an integration of emotional and cognitive abilities.
7. The assessment process should identify the child's current competencies and strengths as well as the competencies that will constitute developmental progression in a continuous growth model of development.
8. Assessment is a collaborative process.
9. The process of assessment should always be viewed as the first step in a potential intervention process.
10. Reassessment of a child's developmental status should occur in the context of day-to-day family and/or early intervention activities.

From Greenspan & Meisels with the ZERO TO THREE Work Groups on Developmental Assessment (1996). In S. J. Meisels & E. Fenichel (Eds.) *New visions for the developmental assessment of infants and young children*. Washington, D.C.: ZERO TO THREE, National Center for Infants, Toddlers, and Families.

the assessment or evaluation of neuromotor development can be influenced by the interaction of the child with significant others, the environment, and the infant's own neurobehavioral state. This is especially critical when establishing intervention priorities, outcomes, goals, and strategies. Collaboration with other professionals, family members, and caregivers of the child will increase the likelihood that the therapist's findings will reflect the child's capabilities across environments and her current capacities and strengths, as well as identify barriers to optimal development. Individualized assessment of a child's neuromotor skills should capture the child's movement patterns, components of movement, and the use of movement within a functional activity, as well as the

child's sensory processing and developmental skills acquisition.

The chapter also discussed treatment of children with sensorimotor dysfunction. An emphasis was placed on service delivery approaches and models reflecting the evolving context of service delivery for all children. These models and approaches allow the therapist to develop a variety of treatment strategies that best meet a child's needs and reflect evolving frameworks on sensorimotor development and behavioral change. ■

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Appendix

ADDITIONAL MEASUREMENT INSTRUMENTS USED BY PEDIATRIC PHYSICAL THERAPISTS AND OCCUPATIONAL THERAPISTS

Name	Purpose	Areas Assessed	Age Range	Clinical Relevance
Ages and Stages Questionnaires, (Squires, J., & Bricker, D., 1999)	<ul style="list-style-type: none"> • Determine development through parental report 	<ul style="list-style-type: none"> • Communication • Gross motor • Fine motor • Adaptive • Personal-social 	4-60 months	<ul style="list-style-type: none"> • Cost effective monitoring system for high risk infants
Assessment, Evaluation and Programming System for Infants and Children (Bricker, D., 1993)	<ul style="list-style-type: none"> • Determine level of functioning • Develop intervention plans • Monitor effects of intervention 	<ul style="list-style-type: none"> • Fine motor • Gross motor • Adaptive • Cognition • Social • Communication 	1 month to 3 years	<ul style="list-style-type: none"> • Administered during naturally occurring events, routines, and activities • Direct link to programming • Allows for observation or direct testing • Takes into consideration task adaptations/modifications
Batelle Developmental Inventory (Newborg, L., Stock, J. R., & Wnek, L., 1984)	<ul style="list-style-type: none"> • Determine level of development • Determine eligibility for educational intervention 	<ul style="list-style-type: none"> • Personal-social • Adaptive • Motor • Communication • Cognition 	1 month to 9 years	<ul style="list-style-type: none"> • Includes adaptations for children with disabilities • Screening component • Limited number of items in each domain
Bayley Scales of Infant Development-II (Bayley, N., 1993)	<ul style="list-style-type: none"> • Determine level of development • Determine eligibility for early intervention 	<ul style="list-style-type: none"> • Cognition • Motor • Behavior 	1-42 months	<ul style="list-style-type: none"> • Predictive value is moderate • Most widely used tool in infant research

Continued

Name	Purpose	Areas Assessed	Age Range	Clinical Relevance
<p>Bayley Infant Neurodevelopmental Screener (Alyward, G., 1993)</p>	<ul style="list-style-type: none"> • Screen for potential delay or neurological impairments 	<ul style="list-style-type: none"> • Neurologic • Receptive • Expressive • Cognitive 	<p>3-24 months</p>	<ul style="list-style-type: none"> • Incorporates neuromotor items into developmental scale • Takes into consideration caregiver report • Especially relevant for NICU follow-up
<p>The Carolina Curriculum for Infants and Toddlers with Special Needs (2nd ed.) (Johnson-Martin, N. M., Jens, K. A., Attermeier, S. N. & Hacker, B. J., 1991)</p>	<ul style="list-style-type: none"> • Determine level of performance across dimensions 	<ul style="list-style-type: none"> • Cognition • Communication • Gross motor • Fine motor • Self-help 	<p>0-36 months</p>	<ul style="list-style-type: none"> • Criterion-referenced • Curriculum cross-referenced to measurement instrument
<p>Movement Assessment of Infants (MAI), (Chandler, L. S., Swanson, M.W., & Andrews, M. S., 1980)</p>	<ul style="list-style-type: none"> • Provide a uniform approach to the evaluation of high risk infants 	<ul style="list-style-type: none"> • Muscle tone • Reflexes • Automatic • Reactions • Volitional movement 	<p>0-12 months</p>	<ul style="list-style-type: none"> • Lengthy, great deal of handling of the infant • Risk profile for 4-month-old
<p>Peabody Developmental Motor Scales (Folio, M., & Fewell, R., 2000)</p>	<ul style="list-style-type: none"> • Determine developmental level 	<ul style="list-style-type: none"> • Reflexes • Gross motor • Fine motor 	<p>0-72 months</p>	<ul style="list-style-type: none"> • Scoring allows crediting of emerging skills • Activity cards available but of limited use