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Learning Disabilities

Stanley F. Kukish, Sharon A. Cermak, and Anne Henderson

OUTLINE

KEY TERMS

LEARNING OBJECTIVES

After reading this chapter the student/learner will be able to:

1. Recognize specific terms, concepts, and terminology used in the field of learning disabilities.
2. Be aware of characteristics typically displayed by children with learning disabilities.
3. Describe the historical perspective of brain dysfunction theories in the field of learning disabilities.
4. Be aware of current thinking in regard to theories and research in the field of learning disabilities.
5. Become familiar with members of the specialized team and service providers for children with learning disabilities.
6. Be aware of the motoric component of the learning disabilities and motor deficits.
7. Identify areas of evaluation to effectively assess motor deficits in the learning disabled child.
8. Become familiar with theories of etiology and treatment techniques for the hyperkinetic.
9. Understand the lifelong ramifications for the individual with learning disabilities.

AN OVERVIEW OF LEARNING DISABILITIES

Characteristics

The disabilities in learning may manifest themselves as various combinations of impairment in perception, conceptualization, language, memory, and control of attention, impulse, or motor function.[1,2] The neurobiology of a child with learning disabilities is internal and various. As the symptoms are not present in all children, and the symptoms that are present vary in degree of severity from child to child.

The most commonly recognized deficits in learning pertain to academic success. In most instances, attention has been given to deficits in verbal learning, including deficits in the learning of reading, in the acquisition of spoken or written language, and in arithmetic. Deficits in nonverbal learning, however, are equally important, such as disturbances in dimensional concepts (e.g., right and left, up and down) and body orientation, in the meanings of facial expressions and the behaviors of others, and in music and rhythm.[3,4,5]

In addition to problems in the processing of conceptual, language, or academic tasks, children with learning disabilities frequently have associated behavioral disorders that include hyperactivity, lack of attention, and general maladaptive behavior.[6,7] Each of these symptoms or impairments experienced by children of the child with learning disabilities can impact

activity, perceptual motor impairment, emotional lability, general coordination deficits, disorders of attention, impulsive behavior, disturbances in memory and thinking, hyperactivity, perceptual distortions, specific learning disabilities, developmental aphasia, and adjustments to specific aspects of speech and hearing, and soft neurological signs.[5,6,7]

Definition. The heterogeneity of the learning disabled population has made agreement on a single definition difficult. Despite a wide variety of proposed definitions, the issue of ensuring a single, workable definition has not been resolved.[8] Within the definitional debate, for example, the National Advisory Committee on Handicapped Children in 1968 defined specific learning disabilities as follows:

> Children with specific learning disabilities exhibit a disorder in one or more of the basic psychological processes involved in understanding or in using spoken or written language. These may be manifested in disorders of listening, thinking, talking, reading, writing, spelling, or arithmetic. They include conditions which have been referred to as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, developmental aphasia, etc. They do not include learning problems which are primarily the result of visual, hearing, or motor handicaps, of mental retardation, of emotional disturbance, or of environmental disadvantage.[9]

This definition of learning disabilities has been the target of its application to various groups of individuals has been criticized. Critics have argued that a definition to qualify the learning disabled as a heterogeneous group of disorders can rather imply a homogeneous condition.[10] In the absence of a good definition," wrote one observer, "the perpetuation of class labels and stereotypes, although it does recognize that serious disabilities do exist, causes many problems in teaching and in parent relations, assists in maintaining unrealistic attitudes of parents and professionals, and may lead to inappropriate placements and inadequate programs. Such labels may be a consequence of another handicap."[11] The National Joint Committee for Learning Disabilities (NJCLD) attempted to address these criticisms in developing a revised definition in 1981:

> Learning disabilities is a generic term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual, presumed to be due to central nervous system dysfunction, and may occur across the life span. Problems in self-regulatory behaviors, social perception, and social interaction may exist with learning disabilities but do not by themselves constitute a learning disability. Although learning disabilities may occur concomitantly with other handicapping conditions (e.g., sensory impairment, mental retardation, social and emotional disturbance) or environmental influences (e.g., cultural differences, insufficient or inappropriate instruction, psychogenic factors), it is not the direct result of those conditions or influences.[12]

Due to extensive knowledge of cognitive processes associated with learning problems and continued definitional debate, Congress created the Interagency Committee on Learning Disabilities in 1985 for the purpose of providing a synthesis and overview of present knowledge in the area of learning disabilities.[13] In 1987 the committee suggested a definition somewhat broader than the NJCLD definition to include learning disorders in adulthood:

> Learning disabilities is a generic term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual and presumed to be due to central nervous system dysfunction. Even though a learning disability may occur concomitantly with other disabilities (e.g., sensory impairment, mental retardation, social and emotional disturbance), or environmental influences (e.g., cultural differences, insufficient or inappropriate

[illegible] psychosocial differences, and currently [illegible] nervous system [illegible]; all of which may cause learning problems. A learning disability is not the direct result of these conditions or influences, [illegible].[illegible]

This latest revision is expanded to include deficits in social skills that have been noted in the learning-disabled population. It also embraces the relationship of attention deficit [illegible] learning disabilities, indicating that attention deficit may accompany learning disabilities or cause learning problems.[illegible] The [illegible] committee has suggested that this latest definition be used for epidemiological studies, diagnostic research, [illegible], and [illegible]. The [illegible] of one accepted definition is essential to consistency in diagnosis, research, and treatment of the learning-disabled population.

Incidence and prevalence. The inconsistencies in the definition of learning disabilities also affect the ability to determine its incidence and prevalence, although both have increased rapidly. Incidence refers to the number of new cases of a disease identified within a given time period; prevalence is the total number of cases in a population at a given time.[illegible] The estimated prevalence of children with learning disabilities ranges from 1% to 30% of the school population, depending on the criteria used to determine the disability.[illegible] A more conservative estimate has been made by the National Advisory Committee on Handicapped Children, which estimated children with significant learning disabilities constituted approximately 1% to 3% of the school population.[illegible] Whichever estimate is used, it is clear that a large number of children are involved. The number of identified cases has grown tremendously, with a [illegible] gain between 1976 and 1986, whereas the incidence of all other handicapping conditions has increased by only [illegible]%.[illegible]

Students diagnosed as learning disabled constitute the largest percentage of enrollment in special education programs, ranging from about 25% to 55% of the total handicapped students.[illegible] Most researchers agree that learning problems are far more common in boys than in girls. In general, learning disabilities occur from two to five times more frequently in males than in females, although some writers have estimated the ratio as high as 10 to 1.[illegible]

Subtypes. The search for a single description of learning disabilities has not been successful. [illegible][illegible] has stated that "the confusion that abounds in the literature dealing with the group of clinical problems known as learning disabilities is, in many ways, a direct reflection of the failure of many scientists and practitioners in the field to acknowledge and address the heterogeneity and diversity extant among the learning disabled population."

The identification of subgroups within learning disabilities is currently a major focus of research.[illegible] Work continues on trying to classify, with common symptoms that constitute subgroups, and to identify the underlying origin of the disability. There is growing evidence that children with learning disabilities show different patterns of disorder.[illegible] Although a number of [illegible] have been found in grouping the learning disabled by patterns of academic achievement, the categorization appears to vary with the orientation of the [illegible] researcher, the types of assessments and diagnostic tests, and the age and characteristics of the sample.[illegible]

In one of the early studies on classification of subgroups within learning disabilities, Denckla and Rudel[illegible] determined that approximately 30% of the [illegible] children in the research by neurological examination could be classified into three recognizable subgroups. The other 70% showed an [illegible] diagnostic picture or signs. Of the first, the first subgroup was described as children having specific language disabilities. These children, who were failing in reading and writing, showed a pattern of inadequacy on repetition, sequencing, memory, language, and other tasks, all of which required [illegible] language. The second group had what was termed a specific visuospatial disability; they were children with at least average performance in reading and spelling who were poor in mathematics and particularly inadequate in drawing and copying, and who were often socially and/or emotionally maladjusted. The third group manifested a "dyscontrol" syndrome and included children who had poor motor and impulse control, who were behaviorally immature, and who were poor in language and perceptual processing.

[illegible] and others,[illegible] [illegible][illegible] and others[illegible] have [illegible] further in attempting to delineate subgroupings within the learning-disabled children based on language [illegible], as [illegible] by neuropsychological research.[illegible] [illegible] and [illegible][illegible] suggested that the way in which the reading disability was defined and assessed influenced the formation of subtypes. For example, poor reading ability could be [illegible] from inadequate phonetic [illegible], deficient reading comprehension, or slow reading speed.[illegible] Each of these would have implications for academic performance, yet would require different remediation strategies. This [illegible] stresses the importance of identifying specific functional deficits rather than lumping groups of [illegible]. Currently, however, reliable categorization of subgroups within the learning disabled population is not possible.[illegible]

Nevertheless, much research into subgroups may be beneficial within the learning disabled population. [illegible][illegible] has examined different patterns of cognitive performance and neuropsychological functioning. Initially, he drew from research on adult patients with brain damage. He used the Wechsler Adult Intelligence Scale (WAIS) to yield a Verbal IQ (based primarily on language skills) and a Performance IQ (based primarily on visuospatial and nonverbal skills). Research on adults with brain damage found that patients with left hemisphere[illegible]

* References [illegible], 53, 56, 58, 68, 87, 72, 82, 85, and 126.

dysfunction tended to show a low verbal, high performance WAIS profile and language deficits. Those patients with right hemisphere dysfunction presented the opposite profile of high verbal, low performance on the WAIS and exhibited predominantly visuoconstructive deficits. Based on patterns of scores on the Wechsler Intelligence Scale for Children (WISC), children ages 9 to 14 were placed into similar subgroups.[illegible] The performance of the high verbal, low performance group was superior for tasks that primarily involved verbal, language, and auditory perceptual skills. In contrast, the high performance, low verbal was superior on tasks that primarily involved visuoperceptual skills. This investigation suggests that the WISC verbal-performance discrepancy reflected differential integrity of the two cerebral hemispheres in older children with learning disabilities. These same patterns, however, were not identified in the younger children with learning disabilities. Some researchers believe that it is difficult to make inferences about brain dysfunction in children based on behavioral responses as the relationship between performance on neuropsychological tests does not correspond to specific types of CNS dysfunction in the same way as in adults.

Rourke and colleagues have continued to evaluate these subtypes and have found similar patterns using the Wide Range Achievement Test (WRAT) to assess patterns of academic performance.[illegible] They identified three distinct patterns of academic achievement. The first group consisted of students who have depressed scores in both reading and arithmetic. Subgroup two performs much better in arithmetic relative to reading and spelling, but is still deficient in all areas. The third group exhibits a specific arithmetic deficit, with reading and spelling in the normal range of performance. This latter group also showed delays in psychomotor and tactile-perceptual skills yet possessed superior verbal skills and auditory-perceptual skills. This group also demonstrated difficulties in understanding nonverbal cues, as well as having a greater frequency of emotional problems as reported by their parents.[illegible] This last group of children exhibit many of the same characteristics as the child with motor planning problems referred for occupational and physical therapy services.

Recent studies have replicated similar subgroups with continued emphasis on academic performance. The impact of using more homogeneous subgroups within research is now being explored. Siegel and others[illegible] performed a study where they substantiated the need for subgroups within research. When looked at as a homogeneous group, reading-disabled children scored more poorly on tests of phonological and memory processing than normally achieving children. When the group was separated by reading disability and arithmetic disability, however, the reading-disabled child performed lower on these tasks but the arithmetic group scored similarly to the normal control. This has significant implications for future research and remediation.[illegible]

It appears that subgrouping within learning disabilities is essential for both research and remediation. A review of studies suggests at least three appropriate groups—reading disabled, reading disabled with delays in arithmetic, and arithmetic disabled. It is of concern, however, that researchers have used varied methods for determining academic performance. Continuity and standardization of methods of learning disabilities must also be addressed through subtype analysis.[illegible]

Various disciplines may continue to identify patterns of strengths and weaknesses in the learning-disabled population. Both clinical observation and research suggest that learning disability is not a unitary syndrome but rather a heterogeneous one.[illegible] This has resulted in numerous categorization systems. The relationship between these various systems has been explored only minimally [illegible]. At some time it must be recognized that children with learning disabilities need to be classified into subgroups to best plan appropriate treatment interventions.*

Summary. A great deal of attention has been focused on the definition of learning disabilities, and many attempts have been made to identify different types of learning disabilities. Research has attempted to relate these differences to more direct types of learning disabilities. According to Gaddes[illegible] an important problem is whether and to what extent dysfunction at the level of the cerebral hemispheres causes learning disabilities. Biological correlations of learning disabilities have been found to underscore the nature of developmental cerebral dysfunction and have had practical implications.[illegible] Several theories about learning disabilities have been proposed. These are discussed in the following sections, with greatest emphasis given to those theories that consider the role of brain function.

Brain dysfunction theories

Numerous hypotheses have been proposed about the causes of learning disabilities. Although some researchers have emphasized emotional and social causes of learning disabilities, the majority of recent research has focused on the role of neurological factors in learning disabilities. In [illegible], [illegible] and [illegible][illegible] hypothesized that children with reading disabilities were experiencing difficulties as a result of [illegible]. [illegible] stated that there is a type of dyslexia caused by [illegible] which [illegible] results from a [illegible] relationship between the cerebral hemispheres.

Other researchers hypothesize that learning disabilities result from an interaction of organic and nonorganic

* References 11, 12, 22, [illegible], 127, and 2[illegible].

lesions.[58] Kolb[59] suggested that if premature children may have a "developmental dyslexia" due to perinatal damage, then normal variations in cerebral organization during development may be responsible for the learning disorder called developmental dyslexia.[60] Other investigators suggested that situational influences also are important. One is dealing with children who have damage and they may be suggestive that the brain is not the ultimate determinant of their ability to learn or to perform in school. Children are greatly influenced in practice by what they are emotionally prepared to achieve and how they are motivated.[61]

Despite the magnitude and variety of cases reported, certain learning disabilities may be observed in children who are apparently normal in all respects and have no history of brain damage or dysfunction. Diverse causes have been suggested, ranging from all sorts of genetic disorders[62,63] to psychogenic factors.[64] Hagberg et al.[65] found a correlation between mild perinatal damage and dysfunction from causes such as high injury, perinatal anoxia, jaundice, fetal malnutrition, encephalitis, or head trauma and epilepsy.[66] Gillberg[67] found that children with developmental disabilities and multiple disorders, as well as mentally retarded children, had more frequent perinatal factors such as hemorrhage and abnormal birth weight and maturity than normal children.[68,69]

Because learning disability is a heterogeneity rather than a single disorder, it is difficult to find a single cause. Many children with learning disabilities do not have any neurological abnormalities, and many children with neurological abnormalities do not have learning disabilities. Some children with learning disabilities have a history of perinatal damage, but many do not. Some children with learning disabilities have a family history of learning disabilities, but many do not. Some children with learning disabilities have a history of emotional disturbance, but many do not. Some children with learning disabilities have a history of environmental deprivation, but many do not. Some children with learning disabilities have a history of poor nutrition, but many do not. Some children with learning disabilities have a history of poor medical care, but many do not. Some children with learning disabilities have a history of poor parenting, but many do not. Some children with learning disabilities have a history of poor schooling, but many do not. Some children with learning disabilities have a history of poor socialization, but many do not. Some children with learning disabilities have a history of poor self-esteem, but many do not. Some children with learning disabilities have a history of poor motivation, but many do not. Some children with learning disabilities have a history of poor attention, but many do not. Some children with learning disabilities have a history of poor memory, but many do not. Some children with learning disabilities have a history of poor perception, but many do not. Some children with learning disabilities have a history of poor coordination, but many do not. Some children with learning disabilities have a history of poor language, but many do not. Some children with learning disabilities have a history of poor reading, but many do not. Some children with learning disabilities have a history of poor writing, but many do not. Some children with learning disabilities have a history of poor spelling, but many do not. Some children with learning disabilities have a history of poor arithmetic, but many do not. Some children with learning disabilities have a history of poor social skills, but many do not. Some children with learning disabilities have a history of poor emotional control, but many do not. Some children with learning disabilities have a history of poor impulse control, but many do not. Some children with learning disabilities have a history of poor frustration tolerance, but many do not. Some children with learning disabilities have a history of poor self-concept, but many do not. Some children with learning disabilities have a history of poor motivation, but many do not. Some children with learning disabilities have a history of poor attention, but many do not. Some children with learning disabilities have a history of poor memory, but many do not. Some children with learning disabilities have a history of poor perception, but many do not. Some children with learning disabilities have a history of poor coordination, but many do not. Some children with learning disabilities have a history of poor language, but many do not. Some children with learning disabilities have a history of poor reading, but many do not. Some children with learning disabilities have a history of poor writing, but many do not. Some children with learning disabilities have a history of poor spelling, but many do not. Some children with learning disabilities have a history of poor arithmetic, but many do not. Some children with learning disabilities have a history of poor social skills, but many do not. Some children with learning disabilities have a history of poor emotional control, but many do not. Some children with learning disabilities have a history of poor impulse control, but many do not. Some children with learning disabilities have a history of poor frustration tolerance, but many do not. Some children with learning disabilities have a history of poor self-concept, but many do not.

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patients with lesions in the left inferior [illegible] cortex [illegible] showed improved performance [illegible] cross-modal tests, particularly Birch's [illegible] tests. Some dyslexic [illegible] studies supported the theory [illegible] with studies [illegible] [illegible] lateralization of language and linguistic auditory [illegible] in the left hemisphere.[illegible] Researchers found that some readers did not show the normal pattern of [illegible] [illegible] hemisphere superiority for [illegible] tion.[illegible]

However, these studies may be [illegible] by the nature of the task and by the [illegible] differences [illegible] and the use of language.[illegible] They have also been criticized for presenting only the words within the visual field [illegible], and in subsequent studies where the stimuli was presented vertically, these results were not replicated.[illegible] In fact, the results from the Yale-[illegible] study[illegible] suggested that poor readers might have difficulty processing information in the right hemisphere or transferring the information from the right to the left hemisphere. [illegible] researchers believe there is little evidence to support the theory that children with learning disabilities have a developmental delay in cerebral lateralization.[illegible]

Lack of hemispheric specialization. [illegible] research [illegible] in brain function have been [illegible] evidence [illegible] that certain functions are specialized within each hemisphere. Semmes[illegible] [illegible] the left hemisphere has a more focal, precise organization, [illegible] functions [illegible] each other, which may facilitate [illegible] [illegible] for speech. The right hemisphere is considered [illegible] more diffusely organized, allowing dissimilar information to be synthesized [illegible]. This type of organization would be advantageous for spatial processing and visual perception. The left hemisphere is thought to process information in a sequential, linear fashion, and is more efficient in analyzing details. The right hemisphere processes [illegible] in a more holistic manner, [illegible] the overall [illegible] of a pattern.[illegible] [illegible] the left hemisphere is [illegible] to be important [illegible] reading comprehension, performing [illegible] calculations, and [illegible] and analyzing language. The right hemisphere processes nonverbal [illegible], such as environmental sounds [illegible] [illegible], synthesizes mathematical reasoning [illegible] [illegible] as well as [illegible] functions. In [illegible], we can see that [illegible] in the method of organization of input, they each participate in certain functions [illegible] such as writing and mathematical calculations. [illegible] neither hemisphere [illegible] [illegible] specialized [illegible] of [illegible]. [illegible] of the [illegible] hemispheres is generally considered [illegible] neural basis for learning.[illegible]

Historically, the issue of whether a possible cause for learning disabilities is the failure of one hemisphere to specialize for language and the other for [illegible] has long been controversial. Ayres[illegible] suggested that in some children with learning disabilities, the two hemispheres do not specialize in their functions and thus compete [illegible] functions, with neither hemisphere being as effective. [illegible] and others[illegible] [illegible] a number of studies [illegible] the hypothesis that [illegible] of language function in both hemispheres [illegible] at the expense of the development of visuospatial perception. [illegible][illegible] hypothesized that learning-disabled children [illegible] representation for verbal function rather than representation of spatial functions in the right hemisphere [illegible] [illegible] [illegible], she suggested that the left hemisphere does not exhibit the "normal" focal organization but rather exhibits the right hemisphere type of diffuse organization as described by Semmes.[illegible] As a result, children with learning disabilities tend to [illegible] [illegible], [illegible] [illegible]. This [illegible] [illegible] [illegible] [illegible] [illegible] analysis.

[illegible] of hemispheric specialization [illegible] [illegible], [illegible] arguments [illegible] [illegible] by the [illegible] of dyslexia [illegible] the heterogeneity of the learning disabled population. Research does suggest that [illegible] some children with learning disabilities show different patterns of cerebral organization than normal children.[illegible] A strict left-right dichotomy is oversimplified and does not take into account many [illegible] of functional [illegible] [illegible].[illegible] For example, Luria's[illegible] [illegible] theory of brain [illegible] proposes that basic functions arise within the brain's [illegible], [illegible], and [illegible]. According to this theory, [illegible] [illegible] functional units [illegible] in many ways [illegible] [illegible] involved with the performance of any behavior. Within this system of organization, the subcortical unit is responsible for [illegible] [illegible] level of [illegible] and arousal; the posterior cortex plays a major role in the reception, analysis, integration and storage of sensory and motor information. The anterior unit [illegible] executive function [illegible] planning [illegible] and is thought to be responsible for future [illegible] [illegible]. This model clearly indicates that the cerebral [illegible] is highly specialized [illegible]. The [illegible] of [illegible] behavior [illegible] reflects the complexity of the functioning of the brain.[illegible]

Inadequate interhemispheric communication. The importance of adequate communication between the two sides of the brain, including between the cerebral hemispheres, has been emphasized frequently in theories that propose that [illegible] is a process that requires the active participation of both hemispheres and the transfer of information between them. [illegible][illegible] suggests that [illegible] aspects of [illegible] [illegible] dysfunction [illegible] reflect

*[illegible] [illegible], [illegible], [illegible], [illegible], [illegible].

deficits in the "binding" of information between various sensory modalities in the brain. Nonetheless, some researchers have argued that the primary cause of some learning disabilities may be a deficit in the ability to integrate information between the hemispheres of the brain. This deficit is detected cognitively by the child's inability to combine verbal learning (left hemisphere) with nonverbal learning (right hemisphere) tasks. Physiologically, this deficit has been measured by prolonged latencies in the right hemisphere to process visual information compared to the left hemisphere.[15] Studies of children with dyslexia have also suggested that the perceptual asymmetry may reflect inattention to the left visual field rather than a deficit in the right hemisphere.[16] Other studies have found that children with dyslexia show delayed processing of information presented to the left ear, but not the right ear, when dichotic listening tasks are used.[17] Some researchers have suggested that the presence of abnormal cerebral dominance may be a marker for a subgroup of children with dyslexia who have a genetic predisposition to the disorder.[18]

Support for the hypothesis of auditory lateralization as an explanation for some learning disabilities comes from studies that have found that children with dyslexia show a left ear advantage on dichotic listening tasks.[19] Some studies have found that children with dyslexia show delayed processing of information presented to the left ear, but not the right ear, when dichotic listening tasks are used.[20] Other studies have found that children with dyslexia show a left ear advantage on dichotic listening tasks.[21] Some researchers have suggested that the presence of abnormal cerebral dominance may be a marker for a subgroup of children with dyslexia who have a genetic predisposition to the disorder.[22]

Another hypothesis of auditory lateralization has also been considered. Tallal and Piercy[23] found that children with reading disabilities had difficulty processing brief auditory stimuli. They found that children with reading disabilities had difficulty processing brief auditory stimuli. They found that children with reading disabilities had difficulty processing brief auditory stimuli.

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Sensory integration. Ayres[25] originally defined sensory integration as "the ability to organize sensory information for use." She sought to describe the specific relationships between visual functioning and sensorimotor abilities and learning disabilities. Subsequent studies[26,27] have found that children with learning disabilities have difficulty integrating visual and auditory information. This difficulty may be manifested by problems in the ability to organize and interpret sensory information. This dysfunction has been termed sensory integrative dysfunction. Ayres[28] suggested that higher level perceptual processing and organization depend on the ability of the brain to integrate sensory information. Neural development depends on the integration of sensory, particularly tactile and vestibular, information. Sensory integrative dysfunction may result in impaired perceptual-motor skills, poor self-esteem, and poor academic performance.

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Summary. Various researchers have speculated on the underlying nature of learning disabilities. Some theories of learning disabilities have been proposed, including neurological and environmental factors. The majority of theories have suggested that learning disabilities are the result of some type of brain dysfunction, which may be due to a combination of factors. However, there is very little research to support any of these theories. There is very little research to support any of these theories.

A multidisciplinary approach to assessing disabilities

Service delivery models. Evaluation and treatment of the learning-disabled child are usually provided by professionals from the following disciplines: psychology, education, speech and language, occupational therapy, and medicine. The multidisciplinary approach to assessing disabilities is based on the assumption that no single professional group can provide all the information needed to understand the child's learning problems. The multidisciplinary approach to assessing disabilities is based on the assumption that no single professional group can provide all the information needed to understand the child's learning problems.

or professionals are grouped into the four categories: education, medicine, psychology, and social services, and may have specialized subspecialties and professions could be compared. The number of personnel professionals is enormous. Although the expertise of a variety of professionals is essential for identifying the strengths and weaknesses of children with learning disabilities, the problems experienced by these specialists because of lack of communication and isolated practices is tremendous. The solution here is the use of consensus conferences among specialists. The interdisciplinary approach requires a team process. When the needs of a child are met individually, the team shares results of their evaluations and develops an individual program. Communication with parents is through team meetings, where progress is discussed and Individual Education Plans (IEP) are developed and revised. The interdisciplinary approach also requires collaboration between primary therapists who are responsible for providing academic instruction and child psychotherapy to all developmental areas. The other team members are consultants to the primary therapist. The interdisciplinary approach is the most effective way to provide early intervention services and the concept of developmental therapy services needs to be stressed.

The label of learning disability is assigned to a child if he or she receives primary instruction or consultative services in the management of learning disorders most commonly takes place in the school setting. While the setting is the most common form of service delivery, the interdisciplinary team approach is recommended as a program for assessment and intervention, regardless of the setting. Other settings, such as private practice, hospitals, and community mental health clinics, may also provide learning disability services.

Types of specialists working with children with learning disabilities

Counselor
Classroom teacher
Teacher of the deaf
Learning disabilities specialist
Teacher of the visually impaired
Vocational counselor
Speech and language therapist
Physical therapist
Occupational therapist
Psychiatrist
Psychologist
Social worker
Pediatrician
Neurologist
Ophthalmologist
Audiologist

Psychology
Clinical psychologist
Neuropsychologist
School psychologist
Child psychologist
Developmental psychologist
Educational psychologist

Special services
Occupational therapist
Physical therapist
Speech and language pathologist
Psychologist
Audiologist
Optometrist
Vocational counselor
Social worker
Psychiatrist/child psychiatrist
Recreational therapist

Some children with learning disabilities are given all their instruction in the special classroom with a small group or other learning disabled children. A special education teacher or learning disability teacher is in charge of the classroom. Most commonly, the child is placed in a regular classroom and leaves only for special instruction for some part of the day. The child may go to a resource room. Here a special education teacher provides regularly scheduled remedial assistance for children with a variety of learning problems. The child may receive tutoring from a reading specialist or a private tutor.

With increasing awareness of learning disabilities and the importance of the early years, more and more preschools and day care centers are developing. These classrooms are integrated, with children with learning disabilities and children without learning disabilities in the same classroom. The child is not labeled or stigmatized. Children are educated in the same school and classroom as their peers. Other services for handicapped children, such as transportation, are also provided. Children are not only educated in the mainstream of school but in the mainstream of society. Consequently a greater number of special education classrooms were created, and it became the responsibility of the regular classroom teacher to be trained in special education techniques.[7]

Although there is much support for the mainstreaming of children, it requires that members of the team work closely together with the regular classroom teacher to ensure that there is an understanding of the child's special learning

needs, as well as a level of comfort with incorporating therapeutic approaches into the regular classroom or part... and the best learning environment. Within the model of treatment, therapy services will be provided through a variety of approaches including direct service, consultation, and monitoring. It is important that therapy services not be provided in isolation from the child's natural environment. This means that regardless of the choice of service provision, the therapist must, at the very least, observe the child within the classroom and make appropriate environments so that therapy addresses the functional issues of the child within the educational setting.

Specialists. Because the roles are well known to most of the various medical specialists and of primary care providers, these specialists will not be described here. School nursing is mentioned, however, because it is a specialty within nursing. The school nurse is usually the key health professional in a school system and is responsible for maintaining information about the child's health history, current health status, medication, home environment, family background, and family problems. The school nurse is the primary liaison between the child and the community health center and major information from the school to medical professionals.

Psychologists have two distinct and often separate roles in the management of learning disorders. The first role is in psychodiagnosis. Psychodiagnostic testing is essential in the determination of specific learning problems and may be done by clinical psychologists, school psychologists, or clinical neuropsychologists who specialize in disorders of learning. [illegible] The second role of psychologists is to provide mental health services. Children with learning disabilities often have problems with self-esteem and peer relationships, resulting from either primary behavior problems or reactions to failure.

A learning-disabled child with a primary behavior problem, such as impulsiveness, oppositional behavior, or hyperactivity, may receive special treatment for the behavior disorder. A behavior modification specialist may be working with parents and teachers to help the child control his or her behavior. The child may need psychotherapy from a psychologist or psychiatrist, or family therapy may be provided by a social worker, psychologist, or psychiatrist. These latter interventions are usually provided by public or private mental health clinics. Learning-disabled children with social adjustment problems or peer relationships are often treated within the school setting. [illegible] The school psychologist, in addition to the diagnostic role, may offer psychological counseling to students and may help plan [illegible] classroom management. Alternatively, the [illegible] of the school program be a psychiatrist or psychologist.

Among the professionals listed in the box on p. 509 as providing special services, a number are concerned with motor and perceptual-motor education. The physical therapist is primarily concerned with, although not limited to, the gross motor and postural functions and efficient use of the body. The occupational therapist is also concerned with the [illegible] basis of movement but covers fine motor skills, sensory integration, visual-motor and perceptual functions, and activities of daily living. Within the school system, physical educators address gross motor skills and physical fitness. Adaptive physical education teachers primarily work with children with motor handicaps. Finally, optometrists, whose special interest is visual function (such as visual acuity, visual perception, visual memory, and visual motor learning), may provide perceptual motor training programs.

In the area of function, speech and/or language therapists [illegible] problems with stuttering, [illegible] word finding, sentence [illegible] sequencing, memory [illegible] as well as the comprehension and processing of complex language. Audiologists are concerned with hearing, auditory perception, and auditory training. A related area of language study is psycholinguistics, which combines psychology and linguistics in the study of how language is acquired. This has also been applied to the educational setting.

The liaison between the child's family and the various service organizations may be a social worker. Social workers may also provide family therapy in schools or private organizations. Finally, recreational therapists or vocational education specialists may be available to provide their special services.

While a single child is rarely seen by all of these professionals, a child with multiple problems may see many specialists. As an example, we describe the program of [illegible], a learning disabled child, in Case [illegible].

Coordinating multiple interventions. Learning disabilities are complex, multifaceted problems. The varied symptoms that present in the child with learning disabilities [illegible] the attention of many disciplines. Over the years, the number of professional disciplines involved in the assessment and therapeutic management of learning disabilities has steadily increased. However, the involvement of so many specialists is both a problem and a benefit. The skill and interest of these disciplines contribute to the benefit. However, the view that the more services the better may result in a service delivery overkill, as was the case with [illegible]. According to Kenny and Burka,[illegible] because our society values highly trained specialists, it is in danger of overpaying itself in the "form" of organic chaos.

A [illegible] study [illegible] indicated that one of the main problems confronting the child with learning disabilities was the lack of a true interdisciplinary approach. Each discipline has traditionally been concerned with its own viewpoint of the learning disability, [illegible] of learning problems have been limited in scope. According to Wiener,[illegible] efforts to educate

CASE

[illegible]

disabled child. This aspect, however, has been selected for the focus of this chapter because physical and occupational therapists working with learning disabled children generally deal with the motor problems. Gordon[27] reported that across the entire spectrum of developmental disabilities, the most frequent signs leading to medical referral are those related to motor output. Selection of this aspect, however, is not meant to imply that the motor deficits are the paramount problems of the learning disabled child or that motor deficits should receive priority over other symptoms. It is crucial for the therapist who works with the learning disabled child to be aware of the overall strengths and deficits of the child and of the various other [illegible] of the child's educational program in order to plan optimal intervention strategies.

Terminology. The concept of developmental motor disorders is not new. Documentation of such problems was done [illegible] as early as the 1900s, when Collier used the term congenital maladroitness.[89] Orton[105] later adopted the term *developmental apraxia* (*dyspraxia*) to refer to these children. He recognized that disorders in praxis and gnosis resulted in clumsiness, a physical performance, which he described as similar to a right-handed person trying to write with his left hand and considered the child awkward from early on. The child with learning disabilities and motor incoordination is most commonly described as being "clumsy"[illegible] in the literature. The term *clumsiness* has been defined as "the inability to perform skilled, unwieldy, ... requiring fluent coordinated movements not [illegible] by general neurological or demonstrable neurological disease" ([illegible] p. 375). The term *motor coordination* appears to be used interchangeably with *clumsiness*. Other terminology includes *perceptual motor deficits*,[illegible] *developmental apraxia*,[illegible] and *sensory integrative dysfunction*,[illegible] all of which generally connote a more specific set of motor coordination problems.

In this chapter the terms *motor dysfunction*, *motor disorders*, or *incoordination* are used as general terms that encompass all disorders that have a motor component. We identify two classes of motor function, which we term *motor coordination* and *somatosensory function*. Motor coordination refers to functions that are more closely and traditionally defined as movement and include gross motor and fine motor and [illegible] functions. Gross motor coordination is defined as motor behaviors concerned with posture and locomotion, ranging from early developing behaviors to fundamental balance.[illegible] Fine motor coordination includes motor behaviors such as manipulation, discrete finger movements, and eye-hand coordination. Praxis and motor planning are used only in the specific sense to denote the ability to plan and execute skilled, nonhabitual tasks.[illegible]

Although visual-motor function is clearly an aspect of motor coordination as we have defined it, it is predominantly used in the literature as a synonym for visual constructional abilities and refers to the ability to reproduce forms or to [illegible] visual stimuli. Visual-motor functions so classified [illegible] the [illegible] of the spatial [illegible] of the [illegible] occupational therapist and are described and discussed in another chapter of this book. Therefore the emphasis in the discussions of evaluation and treatment is on motor coordination deficits.

Prevalence. The documentation of the prevalence of motor deficits within the learning disabled population is made difficult by the inconsistencies in definition of what constitutes a learning disability, and further how to define the cutoff for inclusion into the category of motor dysfunction. As discussed within the definition of learning disabled children, with motor dysfunction do not form a homogeneous group.[illegible] The resulting definitions as well as the comparisons are extremely varied. The problem may be further compounded by the fact that [illegible] is not necessarily benign.[illegible] Other factors influencing prevalence rates include differences in types and methods of testing, reliability of the tests used, and characteristics of the test sample.[illegible]

Within the normal population the prevalence rates of motor clumsiness tend to fall between 5% and 15%.[illegible] Johnston and others[illegible] screened [illegible] 5 year olds and [illegible] 7 year olds and found the prevalence of poorly coordinated children to be 6.9% and 7.5%, respectively. In this study boys outnumbered girls by [illegible] in a sample of [illegible] boys. [illegible] found [illegible] to be physically awkward or clumsy.

Various researchers have attempted to identify the incidence of motor problems in learning disabled children. A National Collaborative Perinatal Project [illegible] of the more than [illegible] children with "minimal brain dysfunction" ratings had the symptom of poor coordination.[illegible] Other frequently noted signs were abnormal reflexes, abnormal gait, mirror movements, and impaired position sense.[illegible] [illegible] and [illegible][illegible] reported that about 50% of the children with learning disabilities have motor coordination and visual-motor deficits. Gubbay[illegible] reported that 75% of children with minimal brain dysfunction showed gross motor deficits, [illegible] others reported the estimated motor prevalence range [illegible].[illegible] These figures are greatly affected by the criterion used to determine motor dysfunction. Some of the variables for inclusion include [illegible] on [illegible] motor [illegible], choreiform movements, gait [illegible], and apraxia.[illegible]

Descriptions of motor deficits in the learning disabled child. Although many children with learning disabilities have disorders of motor control, there is no consistent association between motor dysfunction and learning disabilities.[illegible] Because motor functions are the result of complex neurophysiological mechanisms and because the concept of learning disability is unclear, each dysfunction is considered and its overall [illegible]. It is difficult to make a definitive determination from the study of the relationship between a complex function and a not well defined concept.[illegible]

The motor deficits of the learning disabled child are considerable and [illegible] appear to be any single motor deficit pattern.[illegible] [illegible] movements [illegible]

[illegible] by age, [illegible] and the environment.[1??] For example, [illegible] has indicated that younger [illegible] children [illegible] signs more frequently and in [illegible] than older [illegible] children.[??,1??]

Because there is not a single pattern of motor deficits, two approaches are being used to describe the characteristic motor deficits. This serves to increase the therapist's awareness of the varied symptomatology and may form the basis for therapy with the focus on type of deficit that various disciplines provide. The first approach is [illegible] and [illegible] approach and [illegible] the general characteristics of the motor problems. These characteristics are frequently reported by parents and teachers. The second approach, or the neurological approach, focuses primarily on so-called soft neurological signs. These signs include both [illegible] and [illegible] signs. When evaluating the learning-disabled child, the pediatric therapist generally looks for soft neurological signs as part of the examination.

Descriptive/behavioral approach. Although many [illegible] may be [illegible] child at [illegible] for evaluation until they reach school [illegible] years [illegible] learning disability [illegible] difficulties.[1?] [illegible] frequently, particularly breaking things and dropping things [illegible] than [illegible]. Although [illegible] milestones such as rolling, sitting, standing, and walking may be within normal or close to normal limits, there is often a history of [illegible] in [illegible] skills. The child often appears [illegible] and [illegible] of [illegible], and [illegible] history of [illegible], [illegible] learning [illegible]. Feeding, including handling a spoon, fork, and knife, is often [illegible]. Play skills, such as learning to ride a tricycle and bicycle, skipping rope, and catching a ball, are often achieved at a [illegible] age and seem to take extra effort for the child to perform.

Fine motor coordination problems are also evident. They may be manifested by reluctance to engage in, or [illegible] in, small motor tasks such as block building or constructive manipulatory play and in [illegible] and cutting with scissors. Deficiencies of fine motor performance may manifest themselves subsequently in the [illegible] of the ability to write or draw. [illegible] drawing ability is characterized both by poor motor control and spatial disorganization. Handwriting is often labored, and [illegible] problems are evident. Letters are irregular in shape and poorly organized on the page. To compensate for inadequate pencil manipulation, the child may resort to an [illegible] grip that [illegible] making writing prolonged and laborious. [illegible] are often avoided, possibly because of the [illegible] of the demands of [illegible].[??,1??]

Although poor motor coordination may be present in difficulty with total-body balance, problems may be most apparent when complex motor activities are attempted. [illegible] often [illegible]. A [illegible] described her motor problems as follows: "When the [illegible] to do something, I understand exactly what he means. I even know how to do it inside. But my body never seems to do the job."[1?]

Children with motor coordination problems are often kept apart from other children in sports. They often prefer to play more sedentary games, or play alone, or play with younger children. They are often described as different, and other children [illegible] them [illegible]. These children often get into fights.

A number of researchers have also noted that the motor coordination problems, especially in [illegible], are [illegible], as [illegible], [illegible], apraxia, [illegible] problems, [illegible] discrimination problems, [illegible], and [illegible] behavior problems.[??,??,1??] (See [illegible] page [illegible].)

Neurological approach/soft neurological signs. Although children with learning disabilities have [illegible] that are [illegible] similar to those exhibited by the adult with brain damage, for the most part, they do not [illegible] problems identified by [illegible] neurological examination.[1?] [illegible] more than [illegible] neurological signs.[??,??,1??] These signs suggest minor [illegible] in the [illegible] of the CNS.

Studies that have attempted to link soft neurological signs with the diagnosis of learning disabilities and mild motor dysfunction have had varied results. Many studies suggest that a high percentage of children with learning disabilities exhibit certain soft neurological signs [illegible] of [illegible].[1??] [illegible] a greater number of [illegible] signs has a high likelihood of [illegible] and [illegible] on developmental [illegible]. In general, it appears that a composite of signs is more predictive of dysfunction than single signs. [illegible],[?] however, did not find the total number of soft signs predictive of learning disabilities in a study of [illegible] learning-disabled children. [illegible] neurological signs [illegible] were [illegible] than [illegible].[?] [illegible] learning-disabled [illegible] with a normative sample for the presence of [illegible] signs and found that [illegible] of the signs significantly discriminated between the groups.

Research has suggested that soft neurological signs could be more predictive if they were subgrouped, but at present no one sign or discrete group of signs presents a consistent relationship to learning disabilities.[?] Touwen[1?] suggests the need for further research in relating specific soft signs to precise behavioral deficits. [illegible][?] states, "The phenomenon [illegible] for many years that children who have great difficulty learning a variety of cognitive tasks, who otherwise appear healthy, are much more likely to show minor motor-sensory dysfunctions than normal ones, should be [illegible]" (p. 315).

Although a higher percentage of children with learning disabilities manifest soft neurological signs than does a normal control group, neurological involvement is not a

CASE 2 Paul (continued)

The following is a mother's description of her child, Paul, who had motor coordination problems and was learning disabled:

[illegible]

[illegible]

[illegible]

necessary concomitant of learning disabilities.[illegible] Most of the neurological evaluations of learning disabled children are not designed to identify a specific site of neurological lesion or to evaluate sensory functions or finer reflexes. Rather, they emphasize the examination of how the signs may affect a child's functional performance in tasks involving motor skills, spatial understanding, perceptual tasks, and the integration of sensory motor functions for adaptation to demands in the environment. Kinsbourne[illegible] proposed the need to view soft signs from a developmental perspective and stated that soft signs differed from hard signs in that the child's age is the factor that determines whether the sign represents an abnormality. According to this framework, at a certain age the sign would be considered normal. Touwen[illegible] divides soft signs into two groups: developmental and neurological. These developmental signs imply a state of immature neurological function that would be considered normal in a younger

normal child. These include associated movements, [illegible] ambulatory [illegible] or [illegible], motor overflow and impersistence, persistence in [illegible] extinction to double simultaneous stimulation, [illegible] and mild coordination difficulties. Neurological soft signs such as [illegible] asymmetrical [illegible] that do not occur at any time during normal development, and are [illegible] but not necessarily evidence of brain damage. Tupper[illegible] has added a third category of signs that results from causes other than neurological damage.

The [illegible] lists soft neurological signs frequently used to assess this population. The reader is referred to Tupper,[illegible] Touwen and Prechtl,[illegible] and Levine and [illegible][illegible] for more information on the evaluation of soft neurological signs.

Social and emotional consequences of motor deficits. Poor motor coordination often results in significant social

Common soft neurological signs used in assessment of children with learning disabilities and motor deficits

Athetoid movements and dystonia

Extinction of simultaneous stimuli
Finger agnosia
Choreiform movements
Tremor
Perseverated associated movements
Right–left confusion

Dysdiadochokinesia

Dysgraphia (poor writing)
Impaired graphaesthesia (tactile writing)
Mirror writing
Hemiataxia
Overflow (mirror movements)

Poor visuospatial awareness

Clumsiness
Spatial confusion (confusion of position)
Constructional difficulties (drawing, building)
Visual agnosia
Difficulty in copying geometric designs and figures
Impaired graphaesthesia (tactile writing)
Difficulty in judging distances
Poor body awareness (poor knowledge of body parts)

Reflexes

Persistence of primitive reflexes
Hyperreflexia
Exaggeration of associated movements

Note: Not all children with learning disabilities will have soft neurological signs, and not all children with soft neurological signs will have learning disabilities. However, the presence of soft neurological signs is more common in children with learning disabilities than in children without learning disabilities.

and emotional consequences. Play, which in the early years is the major activity, is essential to psychosocial aspects of development, including self-concept and peer development.[6] As Curry et al. 1972, Mosston[7] and Gallahue[8] indicate, motor movement is the basis for personality in relation to stimulation that comes from socialization and play is essential to the development of motor behaviour.[9] Thus the child with poor physical and motor skills has limited ways

Development in gross and fine motor skills is crucial to a child's ability to master body movements, enhance feelings of competence and confidence. To be excluded due to a child's emotional or motor difficulties paradoxically reduces opportunities for [illegible].[10,11,12] Children with learning disabilities may be impaired by their peers. A recent study points that boys with learning

or more coordinated children demonstrated significantly less effective cognitive strategies than those not participating in a domain of "learning."[13] Such research implies that poor motor coordination may have a profound impact on a child's perception of self-worth and competence.[14] Studies of attitudes and opinions of children with physical disabilities have indicated that children with physical disabilities were more likely than children without disabilities to be rejected by their peers.[15] Skinner and Piersel[16] found that peer preference for interaction was significantly related to physical competence and not to academic performance. Similarly, Weiss and Weiss[17] found that physical competence was a significant factor in peer acceptance. Being unable to participate with peers socially and physically in games, dances or other activities may result in the child's feeling isolated, rejected and withdrawn.[18] Such feelings may be manifested by hyperactivity, aggressive behaviour, poor self-concept, poor motivation, and poor academic performance.[19] Children with learning disabilities may also exhibit poor social skills, such as inappropriate responses to the emotions of others.[20] Emotional behaviour may result in poor performance which can, because it is exhibited in the classroom, be misinterpreted by teachers as laziness or lack of motivation.[21] Children with learning disabilities often exhibit poor self-concept, poor motivation, poor academic performance, and poor social skills.[22] Such behaviour may result in poor performance which can, because it is exhibited in the classroom, be misinterpreted by teachers as laziness or lack of motivation.[23] Children with learning disabilities often exhibit poor self-concept, poor motivation, poor academic performance, and poor social skills.[24]

Statements like these highlight the close relationship between motor skills, achievement, self-image, and social acceptance.

Evaluation of motor deficits in the child with learning disabilities

Descriptive Interview Evaluation. The principles of physical education, adaptive physical education, physical therapy, occupational therapy, recreation, and optometry can be included in the evaluation and training of motor dysfunction in learning-disabled children. Techniques of evaluation have been developed by persons representing these disciplines and there may be considerable overlap in areas that can be assessed. Unfortunately, there is no universally accepted battery of tests that can be used by all professionals. It should be noted that most tests that are used for evaluation may resemble another superficially, there are differences between professions in their assessment and rationale for evaluation and treatment. The unique training of the individual professional influences the choice of tests and the emphasis placed on the various components. Some tests require a one-to-one relationship, while others can be administered to groups. Clinical observation of motor performance

Some of the differences in professional orientation and emphasis in evaluation are as follows. Physical education and adaptive physical education specialists will take necessary background information. Some of the variables

in ball throwing, kicking and catching, jumping, running and climbing. These procedures are concerned with the child's physical fitness. Physical therapists also evaluate the child's gross motor development and physical fitness, but they assess neuromuscular and neurodevelopmental factors as well. The physical therapy evaluation includes observations of muscle strength and tone, posture, alignment, reflex integration including automatic reactions, and sensorimotor functions. Occupational therapists evaluate sensory integrative functions that underlie motor skill development, as well as more refined motor skills. The occupational therapist emphasizes fine motor and visual perceptual motor functions in assessment and is particularly concerned with the impact of motor deficits on functional abilities. The special emphasis of the developmental optometrist is on eye movement functions as they relate to visual-perceptual motor skills. The developmental optometrist measures the relationship between vision and movement in space, posture, and eye-hand coordination.

The areas assessed and the particular ways chosen by a therapist depend on the makeup of the professional team serving children in a particular setting and the referral concerns. Careful planning is required in designing an evaluation protocol. Unnecessary duplication of assessment must be avoided, but the child's [illegible] therapist's [illegible] ascertained. Free exchange of information between professionals by sharing test information or discussing assessment results can aid the understanding of the child's underlying problem [illegible] evaluation. The therapist must be aware of information on motor function that is available from other professionals and of information that should be shared with those professionals.

Assessing motor deficits: areas to examine. The learning-disabled child with motor dysfunction can often perform motor tasks with a level of strength, flexibility, speed, and coordination that is virtually normal by the standards of evaluation used by neurologists or by therapists experienced in a population of more severely handicapped children. The child's difficulty with skilled, unilateral, or manipulative tasks or with static or balance activities may not be readily apparent in the classroom. This appearance of normalcy, which leads to expectations of [illegible] performance, can create problems and frustrating situations for these children. Therefore identification of subtle motor handicaps is very important.

Areas of assessment commonly used in physical therapy, such as muscle strength, range of motion, and ambulation, those used in occupational therapy, such as sensory integration and fine motor function, and those used in other professions, such as evaluation of [illegible] and [illegible] tests, are appropriate. It is important, however, to be aware that the assessment techniques for the most part have been developed for children with marked neurological impairments. For learning-disabled children, levels of expected performance in these areas may encompass

neurologic function. For example, a child might show a normal gait, but less efficient running [illegible], or be unable to tandem walk with the eyes closed. Careful clinical observation becomes of paramount importance, as the deficit in these children is often qualitative rather than quantitative.

To acquire a complete picture of the scope and severity of motor deficits in learning-disabled children, the following areas of assessment are important: (1) *postural control and gross motor development*, including muscle tone, strength, functional range of motion, reflex integration, righting, equilibrium, and protective reactions, automatic postural reactions, and gross motor skill development; (2) *fine motor and visual-motor performance*, including prehension, manipulative movement patterns, eye-hand coordination, handwriting, and fine motor skill development; (3) *motor planning abilities*, including ideation, planning, and execution; (4) *sensory integration*, including sensory modulation and sensory discrimination; and (5) *other motor factors*, including muscular strength, endurance, and [illegible]. Each of these interrelated functions is discussed here as an area of clinical assessment. Because the motor dysfunction of learning-disabled children is subtle, however, a greater reliance on tests with normative data may be necessary, especially for the new therapist or one without experience with neurologically [illegible]. Information on assessment tools [illegible] is [illegible] sources. [illegible] information [illegible] "formal" tests and [illegible] appears in Appendix. A possible source of normative data that can be used as guides for clinical assessment.

Postural control and gross motor performance

Muscle tone and strength. Low muscle tone and poor joint stability have been identified as characteristic of some learning-disabled children.[illegible] Increased tone is less common in children with learning disabilities and may be indicative of minimal cerebral palsy. Learning-disabled children with low tone may develop postural compensations for low tone called *fixing patterns*. These patterns may include elevated and internally rotated shoulders, internally rotated hips, and pronated feet. To the observer, these patterns may look like slightly increased tone as the child holds himself or herself stiffly for increased stability. Assessment of muscle tone is difficult and subjective, even for experienced therapists.[illegible] It depends on the clinical experience of the therapist and on a knowledge of normal performance. Judgments of [illegible] are primarily made through clinical observations. On observation the child may look "floppy," presenting with an open mouth, lordotic back and sagging belly, with knees often hyperextended when standing. Muscle groups may be poorly defined and feel "mushy" or soft on palpation, and joints may be hypermobile. A common method for assessing muscle tone and proximal joint stability involves placing the child in a quadruped position and observing for inability to maintain the position without locking elbows, winging of the scapulae, or sagging of the trunk. The therapist can determine joint stability by asking

the child [illegible] "[illegible]" [illegible] and then [illegible] to move the head sideways and downward. [illegible] [illegible] [illegible] [illegible] [illegible] in the quadruped position. Although manual muscle testing can provide detailed information about the strength of individual muscles, it is [illegible] used in the [illegible] population unless there are concerns of a possible [illegible] disease. More often strength is [illegible] by the [illegible] ability to move against gravity. Within [illegible] assessment the therapist [illegible] range of motion against gravity [illegible] during [illegible] and throwing, and kicking. The therapist [illegible] also frequently have the child attempt to hold positions against gravity to assess strength and endurance.

Integration of primitive postural reflexes. [illegible] [illegible] [illegible] for the development of [illegible] patterns of motor [illegible]. Their presence [illegible] [illegible] and [illegible] [illegible] [illegible] [illegible] purposeful [illegible] [illegible] [illegible] [illegible] [illegible] pathology and [illegible] [illegible] in the learning-[illegible] child [illegible] [illegible] [illegible] [illegible] that might be [illegible] in this population are [illegible] and [illegible] [illegible] in [illegible] tasks. Some [illegible] children [illegible] [illegible] asymmetrical tonic neck reflex (ATNR) and [illegible] tonic neck reflex (STNR).[illegible] It is important [illegible], [illegible] full integration of these postural reflexes [illegible] [illegible] child [illegible] [illegible] years of age[illegible] or even later.[illegible] Assessment of [illegible] reflex patterns [illegible] [illegible] [illegible] [illegible] [illegible] functional aspects of performance. The lack of full integration of postural reflexes may be observable in the quadruped position,[illegible] but it is more important to view the effect of lack of integration in tasks such as [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

To assess for the persistence of the ATNR in the quadruped position, the [illegible] [illegible] the [illegible] the head is passively or actively turned [illegible] degrees, [illegible] [illegible] [illegible] of the arm on the skull side is measured with a goniometer or [illegible] device. [illegible] [illegible] age expectations can be found in research studies.[illegible] Observations of STNR may be seen by passively or actively flexing the neck in this position and looking for elbow flexion or extension. [illegible] ATNR also may be observed during the [illegible] years of age, but older children should be able to maintain [illegible] [illegible] with [illegible] [illegible] [illegible].

[illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] the [illegible] of functional [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] for [illegible] [illegible] or [illegible] tasks. The ATNR influence might be [illegible] [illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] [illegible] [illegible] side [illegible] in extension. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] difficulty maintaining [illegible] [illegible] [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] ability to [illegible] [illegible] [illegible] [illegible] head movements will influence extension of the face side [illegible]. [illegible] [illegible] of [illegible] ATNR can be seen when the child is asked to [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]. If [illegible] [illegible] is [illegible] function the child may [illegible] [illegible] [illegible] [illegible] [illegible] changes in head position. Although [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] tasks, many other components are [illegible] in these tasks that will need consideration as well.

Balance, equilibrium, and righting reactions. Righting and equilibrium are [illegible] [illegible] [illegible] for the development of upright posture and smooth transitional movements. Righting reactions provide the [illegible] for [illegible] movements between body positions.[illegible] Equilibrium reactions are continuous automatic adjustments that maintain the center of gravity over the base of support and keep the head in an upright position. [illegible] [illegible] righting reactions [illegible] [illegible] and equilibrium reactions [illegible] [illegible].

Assessment of equilibrium reactions is [illegible] in each of these positions. When testing equilibrium, the child's center of gravity is quickly tipped off balance. The [illegible] in response is one of [illegible] of the [illegible] side and [illegible] extension and [illegible] of the [illegible] limbs. In [illegible] [illegible] [illegible] of the [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] small changes in the center of gravity.[illegible] Assessment of righting and equilibrium reactions, therefore, should encompass functional performance in gross and fine motor activities.

The vestibular system plays a role in the [illegible] [illegible] [illegible] of equilibrium reactions for the development of balance.[illegible] [illegible] righting and equilibrium reactions occur in response to changes in the center of gravity that [illegible] the [illegible] and [illegible] [illegible] of the vestibular system. This stimulation [illegible] [illegible] extensor muscle tone to elicit compensatory [illegible] and limb movements, which [illegible] to [illegible] head [illegible], [illegible] [illegible] [illegible] [illegible]. [illegible] input of [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] in balance [illegible].[illegible] [illegible] [illegible] assessment of equilibrium and balance, it is important to consider these combined sensory [illegible]. The [illegible] tests balance with both eyes open and closed. Traditional tests of vestibular function include (1) the Romberg position—standing with feet together and eyes closed; (2) Mann's position—standing with feet in tandem position (heel to toe) with eyes closed; and (3) standing on

one leg with eyes open and eyes closed. The Sensory Integration and Praxis Tests[illegible] includes a 16-item test of standing and walking balance. Refer to Chapter 28, Balance Disorders, for a thorough discussion.

Assessment can include tests that isolate visual, proprioceptive, and vestibular discrimination such as balancing on an unsteady surface (dense foam or a tilt board) with and without visual input.[illegible] DeQuiros and Schrager[illegible] used a changing consistency board to demonstrate vestibular proprioceptive dissociation. The board is a wide walking beam in which irregular lengths of polyurethane foam are alternated with wood to provide an inconsistent, yielding surface.

Postural insecurity, postural tone/holding. [illegible] is a component of some learning disabled children's problems.[illegible] The quality of movement is affected both by decreased strength and endurance of the trunk musculature and by diminished [illegible] to maintain a dynamic upright posture. The relationship between posture and muscle tone is also important to consider. A child has adequate trunk stability when control of the trunk is sufficient to maintain an erect posture, shift weight in all directions, and use rotation within the body axis[illegible] (Fig. [illegible]). These areas are often deficient in the learning-disabled child with motor dysfunction, which affects both gross and fine motor performance.

In gross motor play the child may fatigue quickly and fall often. Other body parts may be used for additional support and to assist postural adjustments, such as placing the head on the ground when crawling up an incline or resting on the forearms when climbing or jumping on a swing. These children may also exhibit lordosis well beyond the age it normally disappears, and hyperextension of the knees is common. In sitting at school, a child with poor postural control will fatigue quickly, either leaning on his or her hands for additional support or moving frequently in and out of the chair. This affects the child's ability to perform fine motor tasks or to attend to cognitive learning, as so much effort is spent on sitting up. It is important to observe the effects of fatigue, as both sitting and standing posture may deteriorate over the course of a day. Proximal control also is important for the development of fine motor skills because the arms are connected to the trunk, which provides a base of support for distal movements.

Gross motor skills. Learning-disabled children with [illegible] or sensory integrative dysfunction may attain reasonably high degrees of motor skills in specific activities. However, these motor accomplishments remain highly specific to particular movements or to a series of movements and do not generalize to other activities, regardless of their similarities. Whenever variation is required in the motor sequence, the [illegible] breaks down and the motor behavior becomes imprecise and disorganized. Sugden[illegible] found that movement time for complex sequences was much longer for these children. Thus although the learning-disabled child sits, stands, and walks with apparent ease, he or she may be awkward in skills such as rolling, jumping, skipping, running, and hopping. The child may be unable to balance on his or her knees or to alternate his or her feet when climbing stairs.

Therefore, evaluation of motor skills should include novel motor sequences as well as age-appropriate skills. For example, the child can be asked to include a skipping sequence or maneuver around a variety of obstacles. Developmentally earlier skills should be assessed as well, and the quality of performance is paramount. It is important to look at the child's ability to make transitions within and between developmental positions, as well as [illegible] sequencing of motor acts.[illegible] Learning-disabled children often can perform skill tasks such as skipping, but may do so with increased effort, decreased sequencing and endurance, and a greater amount of associated movements. Gilfoyle and others[illegible] report unusual qualities or differences in gross motor skills by describing and photographing [illegible], one of which was [illegible] while the other demonstrated motor dysfunction. [illegible] and Riley[illegible] have described several [illegible] tests useful in evaluating gross motor skills. [illegible] of balance, such as those described in the section on vestibular function, and in the standardized tests, are [illegible]. The Test of Motor Proficiency by Bruininks[illegible] and the Peabody Developmental Motor Scales[illegible] are examples of standardized assessment of motor skills (see Appendix A).

Fine motor performance

Fine motor skills. It is not uncommon for a child with learning disabilities to be referred for an occupational therapy evaluation because of fine motor concerns. Areas of difficulty frequently include in-hand manipulation of small objects or avoidance of small manipulatives; immature grasp and manipulation of tools such as a pencil, spoon, or knife; and delays in activities of daily living requiring bimanual hand use such as buttoning, zippering, and shoe tying. Assessment should include both standardized assessments and structured clinical observations as discussed earlier.

Fine motor assessment. Fine motor evaluation should include assessment of proximal control and distal movements because the control of upper extremity reach and manipulation patterns are thought to be controlled by dual systems.[illegible] Proximal control is important because movements of the trunk and shoulders have a direct effect on distal function.[illegible] Trunk control and shoulder stability affect the accuracy and control of reaching patterns and provide a stable base from which both hands can be used for bilateral skills.

Distal control includes the manipulative movement patterns that allow the fingers to move independently and with precision and speed.[illegible] The assessment of distal control involves looking at wrist stability, development of hand arches, and separation of the two sides of the hand, which provide a structural basis for the control of fine move-

ment in terms of qualitative descriptions of motor dexterity skills. Exner describes manipulation movements as translation, shift, and rotation. Translation involves finger motions to move objects into and out of the palm of the hand. Shift is an alternation of radial and ulnar thumb and finger generally used to adjust the position of an object. Rotation involves turning an object within the hand. The reader is referred to Exner's works for further explanation of these concepts and Pehoski for more information on developmental trends.

Although standardized assessments such as the Test of Motor Proficiency by Bruininks and the Peabody Developmental Motor Scales have fine motor subtests, they do not adequately measure manipulative elements or dexterity of skills. Careful clinical observation of movement components during a variety of fine motor tasks is necessary for qualitative analysis. The clinician must have a strong base of reference in normal development for accurate assessment. Soft neurological signs including diadochokinesis, sequential thumb to finger touching, and stereognosis can provide further qualitative information. Several excellent sources provide normative information on age-appropriate performance.

Eye-hand coordination and handwriting. The evaluation of eye-hand coordination is best achieved by using standardized assessments such as the Bruininks-Oseretsky Test of Motor Proficiency, Gubbay's Test of Motor Proficiency, the Motor Accuracy Test of the Sensory Integration and Praxis Tests, and the [illegible]. Supplemental clinical observations include descriptions of ball catching and throwing, fine motor tasks such as bead stringing and block building, and written accuracy tasks such as drawing or coloring within a boundary.

Handwriting requires complex integration of fine motor control, sensory feedback, motor planning, and visual motor integration. Refinements of accuracy and control have been documented up to the age of 14 in normal children. Although there were developmental changes in the child's finger and hand position during writing, the actual type of grasp on the pencil did not significantly affect the speed and legibility of written work. More important to success is grasp pressure (as measured by the angle of flexion in the index finger) and forearm position. Children who experience difficulties with handwriting most commonly exhibit sloppy work with irregular letter formations, letter reversals, inconsistent size and heights of letters, variable slant and poor alignment, and irregular spacing between words and letters.

Motor planning. Motor planning involves the ability to carry out a new or unusual motor act when there is essentially adequate cognitive and motor skill to do so. The child with motor planning deficits has difficulty with performing in and acting on the environment. Related concerns may include difficulties in performing motor actions, inability to figure out new activities, disorganized approach, poor anticipation of his or her actions, difficulties with new situations, and frustration. The child with motor planning problems can often clearly see the differences between his or her performance and others doing the same task, which has significant implications for self-esteem. Kaplan describes clumsiness, as well as difficulty adapting to changes in external conditions, as being a reflection of a child's inability to plan new motor movements. Children with motor planning problems often have difficulties in situations characterized by changing demands, such as unstructured group play. Transitions also may be difficult because they involve the creation of a new plan or a change in the situation the child is following.

According to Ayres, "Praxis is the neurological process by which cognition directs motor action. Motor or action planning is the intermediary process which bridges ideation and motor execution to enable adaptive interaction in the physical world. ... Motor planning is a consciously directed, internal process [illegible] between idea and motor execution" (p. [illegible]). It involves ideation or generating an idea of what one wishes to do in the environment, organizing a program of action, and execution of the sequences of the motor act.

Standardized assessments of praxis include the tests of Postural Praxis, Sequencing Praxis, Praxis on Verbal Command, Oral Praxis, Constructional Praxis, and Design Copying of the Sensory Integration and Praxis Tests (see Appendix A for description of tests). The FirstSTEP by Lucy J. Miller is a screening tool for preschoolers that has a section on assessment of planning abilities. Clinical observations can add valuable information about the child's ability to set the occasion for action, organize and sequence the actions for success, and anticipate the outcome of an action. Children with dyspraxia may enter a therapy room filled with equipment and have limited capacity to experiment and play. Other children may move from one activity to the next without truly exploring variations or completing a task. At times, children with dyspraxia may quickly engage in play with the equipment with little regard for safety. Observations of typically developing children show an incredible amount of variation in play and spontaneous additions to motor sequences as well as exploration [illegible]. These characteristics are important to look for when assessing the child with potential motor planning problems.

Sensory integration. Our system is bombarded with a tremendous amount of sensory information from the world around us and our own bodies. The process of organizing all this information while maintaining our systems at a functional state of arousal is called sensory integration. Deficits in registering and organizing sensory input may be responsible for poor performance noted in motor functioning in learning-disabled children. Sensory information is essential for movement control and adaptation. [illegible] however [illegible] speed, accuracy and efficiency [illegible] in the [illegible]

sensory experiences to be efficiently registered, remembered, and integrated to form a clear understanding of the qualities of objects in the world, as well as the quality of bodily movements within those objects. Such sensory modalities as touch, vision, and hearing are thought to play important roles in perceptual motor behavior.[2]

Kinesthetic perception appears to have a significant effect on motor performance. Laszlo and Bairstow[3] have developed a Kinesthetic Sensitivity Test (KST) that measures acuity, perception, and memory. Their initial results in a study of 40 developmentally normal children indicated that 30% of the children had deficits in processing kinesthetic input.[3] Laszlo, Baker, and Bairstow[4] found a correlation between KST scores and writing speed. They suggested that some children with poor kinesthetic sensitivity may have difficulty in developing automatic movements in writing.[4]

Assessment of sensory integration can be best accomplished through the use of the Sensory Integration and Praxis Tests[5] and The Motor Assessment for Preschoolers,[6] a clinical observation of motor responses to sensory input and activity to organize motor impulses. The word praxis means additional information in the integration of sensory input.

Physical Fitness. The health-related performance of a person's body, organs, and skeletal muscles can be objectively measured to participate in a task. The level of physical fitness (muscular strength, muscular endurance, flexibility, and cardiorespiratory endurance) may be partly neurological in nature. Testing of a group of "clumsy" children by Cratty[7] showed a marked deficit in flexibility and the group would have received a rating of "poor" on the basis of fitness tests for cardiorespiratory capacity, "positive" strength, and muscular endurance, even when the tests were selected to minimize demands on motor coordination.[7] Tests of flexibility indicated that "clumsy" children performed at both ends of the range, scoring greatly above the 75th percentile. One task of the physical therapist is to differentiate between poor physical fitness secondary to low motor activity and problems of low muscular endurance. Poor performance on endurance tests may reflect a developmental lag or deviation in motor function. Collaboration among the physical education, the adaptive physical education, and the physical therapist to appraise impairments more accurately is essential for children with motor problems.[8]

Standardized screening and diagnostic tests for assessment of motor deficits. Several examples of partially standardized tests of motor function have been used to evaluate children with learning disabilities. The use of a combination of sensory tests may help to examine the general developmental status of a child and identify patterns of disability that underlie clues to a defining disabilities.[9] A selection of standardized tests is described in Appendix A with particular attention to studies that have evaluated the performance of learning disabled children and indicates the uses and limitations of the individual tests and subtests. These tests, which should be performed by persons who have had training and experience and understanding of the nature of the test and administration of standardized tests in general. Furthermore, because of an individual's inconsistent performance in motor tasks, the examiner should always be thoroughly familiar with the requirements and scoring procedures of a test and should comply with the recommendations for testing conditions as the test manual. Administration of a test in a nonstandard manner may invalidate the test results and limit the examiner's ability to compare the sensory integration and praxis test results with standardization.

In the test descriptions included in the Appendix, normative or normally expected performance and reliability and validity information for a particular standardized test is not included. Rather, selection criteria for clinical use have been emphasized. The clinician's knowledge about aspects of motor deficit and their functional implications should be the basis for [illegible] of a test battery.[10] The test batteries described here may rely on the patient's ability to read the test items. Test results and the clinical judgment of the examiner is important in the selection of tests for a particular patient. The examiner may choose to use screening instruments of specific areas of concern and then administer more comprehensive tests. Within the overall frame of reference for the evaluation and assessment of children with motor dysfunction.

Setting goals. After assessment, the therapist must appraise areas of strength and weakness and address the functional implications of identified deficits. Deficit areas are usually affected by the child's functional performance within the general environment and classroom may be examined. The treatment process begins with a statement of the child's specific difficulties and with consideration of the [illegible] of the [illegible] of [illegible] as a result of changes in [illegible], the therapist must [illegible] goals to be achieved through [illegible].

It is not simple to [illegible] [illegible]

delay problem areas and remediation goals. It may be necessary to interpret test results in light of the child's motivation to succeed, as well as the need for further evaluation to measure refined goals. This qualitative assessment may involve general testing or investigation of therapy activity strategies. All therapists must have an open mind as therapy progresses to the value and methods of achieving these goals.

Setting goals for the handicapped child with motor problems is not an individual decision but a consultation of a variety of factors, including:

1. Referral information, age of the child
2. Medical, developmental, and sensory processing factors
3. Primary and secondary presenting problems and strengths and demands and priority concerns
4. Educational information
   a. Make a checklist you need to know
   b. How to use questions and interviews with teachers and school professionals
   c. Current services being received
5. Child's peer relationships, activities, play skills, and social skills
6. Environmental considerations, such as the child's home and school, that influence the overall assessment, both standardized and nonstandardized
7. Parents' expectations and priorities for the child and family

Goals for the learning disabled child can be stated in terms of long-term and short-term objectives. According to Aitchison and Shelton,[1] "Long-term objectives indicate a commitment to the future of the child with identified needs. Short-term objectives are the steps that must be taken to achieve the long-term objectives."

> Effective task analysis is a vital part of activity planning. Systematic observation by a peer, a teacher, or a therapist is necessary to identify the sequence of skills that must be mastered to achieve a goal. Task analysis is a process of breaking down a complex skill into its component parts.[1]

Short-term objectives should be written in observable terms. Behavior or skill behaviors must be stated within a predetermined time frame or therapy, usually 3 months or 1 year. Burtner[1] writes that well-written objectives are realistic and show how a client will be different in some meaningful way as a result of intervention.[1] Behavioral short-term objectives are specific and complete in three parts: (1) the behavioral statement, (2) the specifics of what will be accomplished by the child, (3) the condition statement, provides details regarding time limit, or number of trials, or environmental cues. (4) the performance statement describes how the child will be measured for success. The most important consideration in developing short-term objectives is that the objectives are relevant to the child's functional daily performance and are meaningful to all those who are working with the child.

Jonathan was a 5-year-old referred for occupational therapy evaluation by his parents and teacher regarding poor fine motor development. Assessment revealed several areas of clinical deficit including poor discrimination of tactile qualities and movements in space, diminished postural control and balance reactions, poor planning of fine motor activity and coordination of bilateral fine motor activities, and delayed visual motor integration that affected handwriting. Jonathan's mother reported that he was extremely active, constantly moving, and "tripped over himself" and that Jonathan seemed unaware of activities near his peers and personal possessions such as sticking his tongue out and not knowing how to use the bathroom independently, requiring assistance with clothing.

In determining appropriate long-term objectives for Jonathan, it was important to look at the areas of functional independence such as playing successfully in short recess periods, peer interactions, and participation and independence in activities of daily living. In discussion with Jonathan and his parents, it became clear that these were immediate areas of concern. "Small" activities are viewed by children as important tools for play with peers. The parents were then interested in more competence and less embarrassment in play at home and at school. It was clear that through identification of sensory processing and motor deficits Jonathan could develop improved motor control and planning abilities, which would lead to greater success in peer interactions and improved feelings of self confidence. From these considerations, goals were established.

One of the general long-term goals became to improve Jonathan's gross motor and endurance. Jonathan was interested in learning to ride a bicycle without training wheels, and his parents were hopeful that he would become more confident on the neighborhood playground. It was decided that short-term, appropriate behavioral objectives that would promote the development of greater strength and endurance in the deficit areas of poor discrimination of skills leading to poorly planned postural control and balance reactions and deficient motor planning. The following objectives were written:

1. Jonathan will independently climb the ladder and come down the slide on playground equipment, pumping legs in alternation, on 3 of 5 trials.
2. Jonathan will develop the ability to ride his bicycle without training wheels in a straight line and turning corners. (Note: Successfully riding a bicycle becomes a performance measure of behavior in this objective.)

To address *improvement in independence for self-care skills* the following objectives were written:

- Jonathan will put on his coat independently in correct orientation and successfully zipper it four out of five times.
- Jonathan will successfully tie his shoes without assistance each day within a timely manner.

To address *greater success in peer interactions* the following were considered appropriate:

- Jonathan will participate in a structured game for 10 minutes with successfully following the rules.
- Jonathan will play outside while interacting with the children in the neighborhood without conflict for 1 hour at a time.

Although strictly motor objectives could have been written to address the sensorimotor dysfunction [illegible] for therapists working with him—for example, balance and postural control could be addressed by an objective stating that Jonathan would stand on one foot for 10 seconds, but the functional implications would not have been clear, and Jonathan and his parents and teachers had a [illegible] measure that was meaningful and measurable to them [illegible] would have [illegible] the efforts of everyone [illegible] toward a common goal.

When working as a member of a team within the school, behavioral objectives will have implications for the child's performance in the school environment. In Jonathan's case specific objectives that were meaningful to the classroom situation included: ability to [illegible] in his seat to complete written assignments for 15 minutes and improved accuracy of letter formation, size, and spacing on written assignments. The other goals established for areas such as motor control and peer interactions also were influential to Jonathan's success in school; but if specific objectives were to be written pertaining to school, then functional outcome measures would have been chosen from areas within the school environment such as gym class, playground interactions, and classroom expectations.

Under Public Law 94-142 occupational and physical therapists are considered supportive services, and the need for them should be based on academic relevance for the child.[38] Statements of goals and specific objectives are included in the Individualized Education Plan that is written as a team process. The parent should be considered an integral part of the team, and objectives should be [illegible] professionals involved with the child so that there is [illegible] duplication of effort [illegible] team members. Among the many resources available on writing goals and objectives and functional outcome measures are Arnheim and Sinclair,[illegible] Dunn and Campbell,[illegible] [illegible] and [illegible],[illegible] and LeVesque and Bleasdale.[illegible]

Treatment of the learning disabled child with motor deficits

What is remediation? In treating the deficits of the learning-disabled child, an important question is: do you try to improve brain function, or do you teach the child the specific academic, cognitive, and motor skills? Direct therapy is teaching the child what you want him or her to learn and indirect therapy is changing the brain.[illegible]

Indirect therapy techniques are based on the assumption that learning disabilities result from dysfunction of the CNS and that the CNS dysfunction affects one or more basic perceptual, motor, or language processes. Treatment is directed toward the improvement of the underlying abilities. Proponents of the treatment of learning-disabled children [illegible] developed techniques directed toward the improvement of underlying perceptual, perceptual-motor, and psycholinguistic abilities.[illegible] Direct therapy techniques follow a behavioral orientation. The presence of CNS dysfunction is not denied, but training of underlying abilities is not considered useful. Treatment approaches emphasize academic instruction, programmed and criterion referenced instruction, and direct teaching of skills.

The direct technique of teaching the child specific cognitive and academic skills has been recommended by [illegible][illegible] who believes that one should teach to the child's strengths and at the same time develop methods to improve the weak [illegible]. The child should be encouraged to be aware of [illegible] his or her own weaknesses by developing an awareness of the problem and by using his or her intellectual ability to consciously approach his or her [illegible] problems and develop compensatory mechanisms. [illegible] believes that [illegible] of the child's strengths is more effective than working the perceptual skills and looking for transfer.

Sensory integration procedures are an example of the indirect therapeutic approach. According to Ayres,[illegible] the [illegible] perceptual program [illegible] perceptual-motor training for learning-disabled children. The objective of sensory integration procedures is modification of the neurological dysfunction interfering with learning rather than dealing with the specific behavior associated with the dysfunction.[illegible] This approach emphasizes the role of [illegible] as the brain [illegible] mechanisms [illegible] integrated [illegible]. The goal of therapy is to improve sensory integration at all levels of the CNS. According to Ayres,[illegible] "If the brain develops the capacity to perceive, remember, and motor plan, the ability can then be applied toward mastery of all academic and other tasks, regardless of the specific content." A sensory integration approach to treating learning disorders differs from many other procedures in that it does not teach specific skills such as matching visual stimuli, learning to discriminate [illegible]

sequence of events or movements, or determining one motor response from another. Rather the objective is to enhance the child's ability to learn how to do these things. Rules are applied. However, the actual interaction pattern is not as rigid as would be implied by a traditional program. Instead, stimulation of sensory and motor functions that underlie more complex skills is the current approach.

These descriptions of the approaches to Sood[47] and Ayres[48] illustrate direct and indirect sensorimotor techniques used primarily in the remediation of perceptual and cognitive deficits. The actual differentiation between the remediation of motor deficits. The next section considers whether one can identify and treat the underlying problem of dyslexia or only to develop specific skills. Often the objective of the learning brain disorder is directed to the developmental framework of building foundations. For example, we know that sensorimotor theory holds that by increasing organizational levels of the nervous system, particularly at subcortical levels, we increase the cognitive responses to perceptual stimuli as well as to neurodevelopmental therapy (NDT) and sensorimotor integration facilitation (SIFT) techniques are directed toward the NDT theory assumption that we all increase opportunities for more immature responses or reflexes to occur, paving the way for more complex skills.

One of the concerns of proponents of indirect techniques is that children who lack the specific motor skills required in everyday life (e.g., work in the development of gross motor skills) may not have the skills not because the skills did not have the potential to develop (e.g., postural reactions or movement patterns) but because they have not been allowed by the child but by the child's environment. For example, in the case of a child who gets tired of playing because he or she cannot develop a school skill. Research has indicated that this has also been done and has a negative influence on the child's ability to participate in other learning and skills.[49]

In theory any compensatory skill can be used to improve specific skill. For example, working with patients with poor stability foundations of equilibrium reactions and in the inactivation from the environment. However, there is a point in a child's life at which learning skills, such as crutch walking, is both necessary and appropriate. Therapists should be aware of this fact and provide appropriate equipment or methods that allow for the use of the skill, but that prevent the development of maladaptive patterns.

A second visual motor function is orientation. This is the ability to perceive objects in relation to oneself and to other objects in the environment. Both types of information are important in the assessment of visual perceptual problems and in the development of treatment programs. For example, equilibrium reactions, postural reactions, and physical education activities focus on the development of gross motor skills, for example, running, jumping, and throwing. Fine motor development, motor control programs begin with the early skills, there are many differences between direct and indirect therapeutic approaches.

The initial focus of these techniques was developed originally by Cratchfield[50] who identified the role of the developmental approach with an emphasis on the individual. The specific approach was the gestalt model. Cratchfield's psychotherapy model provided and suggests that "the goal of therapy and education resulting in the school system should be to create an atmosphere in which models can develop in a supportive relationship that encourages risk-taking."[51]

In conclusion, how much can indirect therapy or principles of remediation be necessary before specific deficits of any one perceptual motor area are not yet best demonstrated.[52] If we are to develop successfully with learning disabled children, we may need to have an efficacy procedure for the management of dysfunction using sensorimotor approaches and indirect therapy and relevant to the child's age and the severity of his or her disability.[53]

Occupational and physical therapy approaches to treatment of dysfunction must be individualized to the needs of the child. Each child, therefore, the treatment is unique and presents a new challenge to the therapist to set up a plan and achieve functional outcomes. A sensorimotor approach includes the evaluation of the ability, the child is referred to the therapist. The therapist selects the treatment methods to use to help the child's presenting problems and the goals and objectives are a part of the treatment plan.

The treatment methods presented in the following section are some of the options available to occupational and physical therapists. Some of these methods, such as sensory integration and praxis, have been developed by occupational therapists. Others, such as neurodevelopmental treatment and sensorimotor integration, have been developed by physical therapists. Although each profession has its own philosophy and approach to treatment, there is a great deal of overlap between the two professions. Both professions use a variety of techniques to facilitate normal movement patterns and inhibit abnormal movement patterns. Both professions also use a variety of techniques to facilitate normal movement patterns and inhibit abnormal movement patterns. Both professions also use a variety of techniques to facilitate normal movement patterns and inhibit abnormal movement patterns.

For convenience, occupational and physical therapy approaches to the remediation of motor deficits in children with sensorimotor dysfunction are classified as sensory integration, sensorimotor approaches, neurodevelopmental treatment, and physical therapy approaches. Each of these approaches is discussed in the following sections.

treatment approaches, such as medical training and physical fitness represent a more direct approach.

Sensory Integration theory of Ayres. The sensory integration theory was developed and articulated by Ayres,[1,2,3,4,5,6] an occupational therapist and psychologist, who died in 1988. It includes concepts drawn from neurophysiology, neuropsychology, and developmental psychology[7] and proposes that abnormal processing or integration of incoming sensory input from the body and environment and certain motor responses and performance "learning" problems among school children with normal intelligence.[8] Sensory integration theory is based on the premise that higher cortical functions depend on adequate neural organization at subcortical levels. The theory postulates that new learning is dependent on the ability of a person (individual) to take in sensory information derived from the environment and from movement of his body, to process and relate these stimuli within the central nervous system, and to use the sensory information to plan and direct motor behavior.[9] Specifically, Ayres[10] views learning and behavioral problems as stemming from inadequate, inefficient, or disordered sensory integration and motor planning.

In her theory Ayres[11] suggested that children with learning disabilities may have underlying sensory integrative problems caused by impaired neurophysiologic organization through controlling vestibulation. Later, she proposed that vision provided with appropriate input[12] is enhanced thereby leading to the control of meaningful activities with meaningful cognitive outcomes, and CNS processing and integration of sensory inputs could be improved. Improved sensory integration would in turn enhance perception and motor learning.[13] Certain functions, for example, are more apparent to depend on brainstem functions. Ayres[14] suggested to remember that the brain stem performs and prepares for processing, and both central and subcortical processing continue to sensory integration.[15]

Sensory input is provided on a planned and controlled manner, while clinician selective responses enhance the organization of neural structures. "Behavior or adaptive response includes sensory integration and, in turn, the ability to produce an adaptive response requires sensory integration" (p. 11).[16] The therapist moves in the sensations that are self-motivating and helps the child's brain develop more efficient interactions among all parts of the child's body. The therapist works toward the success of the theory with the act of "playing" with the child. The goal of sensory integration treatment is to elicit responses that reflect better organization of sensory stimuli as opposed to improving motor skill for its own value. It is hoped that skill will generalize to functional activities in the child's natural environment.

For this treatment technique to be appropriate, the main dysfunction observed in a child with learning disabilities should be visual perceptual or other sensory integrative dysfunctions which do not respond adequately to traditional educational approaches. Studies[17,18,19,20] prove clearly that sensory integration procedures are designed to remediate sensory integrative dysfunctions which do exist, but only some aspects of learning disorders. Further research is needed to identify therapy subtypes of children with learning disabilities and sensory integrative dysfunction who will benefit maximally from this type of treatment.

Although there are general principles for sensory integrative treatment, each child's problem must be more distinctly focused on the nature of the motor and responses to sensory input in the therapy situation. Typically, the vestibular-proprioceptive and tactile sensory inputs used in therapy are passive, and motor responses with caution. The motor and behavioral responses of the child must be carefully monitored. The therapist should be knowledgeable about sensory integration theory and literature before using these procedures. Monitoring of behavioral responses after the therapy session also is considered to be a critical factor to monitor carryover. Treatment procedures are elaborated in Ayres[21] and Kimball and Bundy.[22]

Ayres[23] proposed a theory of sensory integration as a result of neural analysis, organization, and utilization of sensory information. Ayres[24] has described certain characteristic responses to sensory integrative dysfunctions in processing certain sensory systems. These types of sensory integrative dysfunctions have been associated with deficits in the ability to perform academic tasks. It should be emphasized that these patterns are not exclusive. Considerable overlap exists and each child cannot be fitted exclusively into one category. The patterns that have emerged most consistently in research and clinical practice include CNS disorder in sensory modulation, visual-perceptual disorganization influencing postural-vestibular movement and visual integration and sequencing, dyspraxia or somatosensory discrimination resulting in visual-dyspraxia, CNS disorder in sensory modulation including tactile defensiveness and gravitational insecurity, difficulties in focal and ocular perceptual processing, disturbance in motor planning, vestibular-bilateral, and CNS auditory-language problems, poor bilateral integration. Ayres[25] has described a sensory integrative dysfunction that she has closely associated with minor dysfunction, and has not discussed here. A therapist must understand the type of a problem, such as the integration of sensory information might be CNS that is being underpinned in the most basic sense, the motor output is the means of assessing what and how to change in sensory integration.

Studies of vestibular-proprioceptive stimulation in learning-disabled children have been inconclusive and unsupportive. Children with learning problems often exhibit deficits in vestibular-proprioceptive dysfunction, but the relationship between vestibular stimulation and improvement in academic performance has not been established. Certain indicators of inadequate vestibular function have been noted in the learning-disabled child. One of the most frequently used measures of vestibular function is the

postural synergies suppress the normal head movements of the eyes in viewing motion. This response is a manifestation of the vestibulo-ocular reflex but is abnormal adaptive response designed to reestablish the original fixation on the visual field.[4] Several authors have noted hypersensitive (shimmering) motion or synergistic learning disabilities. DeQuiros[3] and Ayres[4,5] found that more than 30% of the learning disabled children they studied had vestibular-bilateral deficits. The significant percentage of learning disabled children seem to have a maturational lag in the development of postural synergies. Several mechanisms have been suggested to explain this observation.[14]

It should be emphasized that dyslexia is only one manifestation of sensorimotor dysfunction. Certain other perceptual motor problems and motor problems may be commonly associated with vestibular bilateral dysfunction.[15] The vestibular system plays a primary role in the development of postural control and equilibrium. Many learning-disabled children have immature or poorly developed equilibrium and delayed automatic postural reactions. Walking balance is often impaired.[16] Persons (children) with dyslexia and may be more impaired than normals in their ability to maintain upright posture when the eyes are closed (no visual input) and must rely on vestibular and proprioceptive input.[16,17] The child has the characteristic inability to coordinate and maintain postural synergies during movement and tends to assume rigid postural groups. It has been suggested that they may present inadequate vestibular processing.[18] Other indicators of vestibular dysfunction may be unilateral muscle weakness, poor motor planning,[19,20,21] delayed motor responses, poor eye movements,[22] and poor muscle tone.[23] Adequate muscle tone implies the body to be poised for movement.[24]

The vestibular system also has been implicated in ocular control. Through its connections with the cerebellum, medial longitudinal fasciculus, and vestibular system, the vestibular system helps to maintain eye movements during head movements. Damage may be present and

A person who has vestibular dysfunction is thought to be the basis for clumsy, ungraceful, and awkward movements.[24] Clinically, the deficit is characterized by difficulties in coordination of the individual's sense of balance, the body motions, postural responses, and posture functions. Fine skill, and possible sight-feel coordination. Behavioral problems resulting from difficulties may be problems in learning with poor fine eye-hand coordination, poor motor planning. The child may have to expend more energy on motor tasks than other with the entire body to avoid crossing the midline of the body (i.e., the right hand on the right body side and the left hand on the left body side). This may interfere with the development of a preferred motor hand. These children may have difficulties sequencing and projecting their body movements in space. They may appear awkward, uncoordinated, and imprecise movements of their own bodies in relationship to the environment. This problem can be

organized in motor tasks requiring sensorimotor coordinating a series of tasks.[25] It may also be detected in tasks where the child must follow directions for body movement in a moving project, such as marching to the music or moving at normal speed, running and starting a moving ball.

Somatognosia. Somatognosia refers to the awareness of children with visual perceptual problems that are not present in their bodies. It is commonly presented in body image terms and proprioceptive discrimination.[24] Somatognosia may be an important developmental process of where the body is in space and body schema. "If the information that the body receives is not precise, the body cannot be precise in its movements in order to carry out the body scheme" (p. 1961). The scheme is developed by sensory channels included in the tactile-kinesthetic, vestibular, and visual systems. Dysfunction in these systems can disrupt the body's relationship to the environment through the visual system and can cause awareness of the outer body. The child also observes the nature of objects through active manipulation. Positive input is provided from the muscles, tendons, joints, and vestibular system associated with the movement and position of the outer body and how it moves. Sensory input from the skin and muscles is essential. "From the skin may be gained valuable information about the nature of objects touched, and from the muscles, tendons, joints, and vestibular system comes information concerning the movements and position of the outer body. The child also observes the nature of objects through active manipulation. Positive input is provided from the muscles, tendons, joints, and vestibular system associated with the movement and position of the outer body and how it moves. Sensory input from the skin and muscles is essential. From the skin may be gained valuable information about the nature of objects touched, and from the muscles, tendons, joints, and vestibular system comes information concerning the movements and position of the outer body" (p. 1961). It is suggested that dyslexic children receive inadequate or inadequate amounts of tactile and proprioceptive input.

According to Ayres,[17] motor planning deficits are due to inadequate body scheme and an inadequate sensing one's relationship to the environment. "The body scheme which provides the substrate for praxis is a product of numerous sensations" (p. 1961). Motor planning depends on the adequate integration of somatosensory, vestibular, proprioceptive, and visual information for such disorders in motor planning are manifested in poor praxis, dyspraxia. Somatognosia appreciation is important in the ability to plan motor movements and sequences. Children with dyspraxia can learn specific skills with practice, but they do not have the general motor skills or motor planning ability. Kimbey[26,27] refers to the child with developmental dyspraxia as the "clumsy child." Movements are performed with an excessive expenditure of energy and with inaccurate judgment of the required force, timing, and emphasis.[28]

Hemisphere inability to maintain dominance of motor activity. Ayres[29,30] has suggested that dyslexia is more than just motor planning. Rather, it involves maintaining a course of action that includes the ability to organize sensations and to develop strategies. The dyslexic problem in praxis in the course of action are often disorganized and have poor sequencing—characteristics that frequently accompany developmental dyspraxia.

Motor reactions at most motor planning entry are apparent at early developmental. Dressing is often difficult. The child needs to plan movement in how to move his or her body in relation to other. Positions and often unmotivated to act

sometimes manipulatory play, such as unscrewing or cutting and pasting. Similarly, learning how to use items such as a knife, fork, pencil, or scissors is difficult. The dyspraxic child often needs guidance with handwriting. As ... practice ... through repetition of a task, however, there is little generalization of the learned skill to similar tasks.

Critique of sensory integration theory. Sensory integration theory is immensely complex, because it is derived from neurophysiologic and psychological knowledge, and it is shaped by ongoing research and therefore is changing and developing. Most critics of sensory integration theory are general in their criticisms. Schaffer has questioned the theory based on the lack of clinical signs of vestibular malfunction in learning-disabled children and the lack of clarity in the process by which sensory stimulation is supposed to foster integration in the brainstem. This criticism may result in part from the use of the term *brainstem* as a synonym for subcortical structures. The hypotheses about their functioning, however, are not directly testable. This other criticism of the theory is directed at the lack of replicated studies and the absence of corroboration with known facts. Although various individuals have criticized sensory integration because the research has not shown why it works, it is clearly very difficult to demonstrate why sensory integration is effective through the research tools and methodologies now available because these issues are highly theoretical and difficult to measure. According to Fisher, however, it is inappropriate to conclude on the basis of this difficulty that the theory is not correct. Ottenbacher states that the purpose of early research in a field, particularly in a treatment field, is to demonstrate whether the given treatment is or is not effective. As the research progresses, researchers start examining factors that influence the effectiveness of therapy. Later they examine why therapy works.

Research on the effectiveness of sensory integration procedures. Many articles have been written on the effectiveness of sensory integration therapy. Within the field of occupational therapy it is the most well documented treatment procedure. Examination of some of the reviews of sensory integration effectiveness and other related literature* indicates that consensus regarding the effectiveness of sensory integration treatment is lacking. Clinicians who are using sensory integration procedures are convinced that it is effective. There are many testimonials from parents of children who have received occupational therapy using sensory integration procedures. Sensory integration treatment principles are probably the most frequently used in the treatment of learning disabled children with motor deficits. The knowledge and use of this approach continue to become more widespread, with national and international conferences held on sensory integration theory and treatment.

Nevertheless, the empirical data continue to raise questions about who, how and when sensory integration treatment is effective. Ottenbacher used eight studies for a meta-analysis, which included learning disabled, mentally retarded, and at-risk children. A study by Densem and others included subjects with identified disorders of a handicapping condition, including mild mental retardation, learning disabilities, mild cerebral palsy, and epilepsy. Clark and Pierce found 25 effectiveness studies that included four different ... approaches, including sensory integration procedures, systematically applied vestibular stimulation, multisensory input and perceptual-motor training. In reviewing effectiveness studies, Cermak and Henderson identified at least six different outcome measures including academic measures, language, motor, reflex integration, ... and behavioral outcomes. Looking at the tremendous variation in the approaches within several studies, it is easy to see the consensus on treatment effectiveness is lacking.

Ottenbacher's meta-analysis of eight studies found that the average child receiving sensory integration performed better on academic measures than three fourths of the control children. He also found a moderate effect size for a motor reflex category. In summary, Ottenbacher states that "the meta-analysis of the ... literature did provide suggestive support for the effects of SI therapy" (p. 30), although the size and the number of research studies meeting the criteria for inclusion was quite small. Humphries and others found that subjects treated with a sensory integration approach showed an advantage in motor planning. Densem reported sensory integration procedures to be more effective than ... physical education in improving some of perceptual-motor and fine motor tasks.

Two recent studies have suggested that sensory integration treatment is not more effective than more traditional skill-based therapies. Part of the difficulty is in how we measure the outcomes of improved sensory integration. Continuing problems may not be ... changes in organization, responsivity, and learning ... children with sensory integration therapy consistently appear to make. Cermak and Henderson suggest that "organization, learning, arousal, attention, activity level, behavior, biological rhythm (sleep-wake cycles), sensory responsivity, play skills, self-esteem, peer interactions and family interactions" (p. 7) are domains that may change with sensory integration treatment. They also stress the need for research on these other effects of sensory integration treatment, which have, for the most part, been unreported in literature.

In reviewing sensory integration research with learning disabilities, Henderson concluded that "the studies ... provide preliminary evidence of the value of sensory integrative therapy for children with learning disorders" (p. ...), and that "collectively they provide sufficient evidence to warrant further investigation of the effects of sensory integrative therapy" (p. ...). In a more recent review of

*References [illegible].

sensory integrative activities as Ayres and Kimball[24] suggest that "sensorimotor mechanisms include sensory modality integration, sensory discrimination, and motor activity control hypotheses." The complexity of the theory of sensory integration, the individualized approach and treatment activities, and the use of novel outcome measures are some major challenges in designing appropriate and relevant research studies.

Neurodevelopmental Theory of Bobath. Neurodevelopmental treatment (NDT) is a treatment that was introduced by the Bobaths[25,26] to enhance the development of gross motor skills, increase quality of movement, and inhibit primitive reflexes and abnormal postures.[27] To provide the data for treatment, tone is considered the primarily important symptom underlying NDT.[28] Tone is defined as the resistance offered by muscle to passive movement.[29] Tone is considered to be abnormal when it interferes with functional movement.[30] Many factors are considered to underlie movement problems, including control of posture, influence of primitive reflex patterns, altered development of flexibility and oscillation, restriction of range of motion, inability to combine movements, and deficits in sensory input. It is thought that the quality of movement depends on steady postural control, and deficits in postural control underlie many movement problems.[31]

Treatment techniques were designed primarily for preschool and school-aged children with cerebral palsy who have lost the ability to move spontaneously because of abnormal tone. The goals of NDT are to facilitate the development of normal postural control, inhibit abnormal tone, and facilitate the performance of functional skills.[32] Treatment techniques include the use of specific sensory input to facilitate or inhibit tone, the use of key points of control on the body,[33] Bobath's theory is universal to the development of motor control.

The common goals of NDT treatment in the preschool years are normalization of tone, inhibition of primitive reflexes, and facilitation of postural reactions to encourage the acquisition of normal movement patterns necessary for learning more daily living skills.[34] As our theory has grown and we have demonstrated the need to promote better movement within the context of functional task performance, we have greatly emphasized[35] This NDT principle is working toward using movement patterns as functional components of practice tasks (Personal communication, Mary Fowler, April 22, 1994). The model is defined as a "dynamic and interactive process of motor development, learning, and control."[36] This model is consistent with developmental theory and treatment.

Research on the efficacy of neurodevelopmental therapy. Neurodevelopmental therapy is based on principles of motor control and motor development. Its goal is to facilitate the development of normal movement patterns. The techniques involved are from sensorimotor and motor control theory. The system of therapy is often presented as a problem-solving approach. Although the approach is well established, there has been little research to support its effectiveness. A lack of consistency with changing treatment guidelines is given for NDT's continuing acceptance and resistance to more objective measures. Two studies[37,38] on the use of standardized assessments have shown improvement in children with spastic diplegia, but neither study has controlled for spontaneous improvement. In the study of infants and toddlers with Down syndrome, Ulrich et al[39] used NDT techniques. Each infant received 30 minutes of treatment per week for 6 months. According to the findings of the treatment group, 60% of the children achieved developmental milestones, 20% of the comparison group achieved milestones, and 20% of the comparison group showed regression. The authors suggested that the findings support the appropriateness of these tests in assessing the outcomes of early intervention techniques associated with NDT treatment.

Of the 4 studies primarily identified by Casey and Dewhurst[40] for a review of NDT treatment effectiveness, only one conducted a study was performed.[41] In 1986 Cusick and Russell[42] used a multiple-baseline design of 3 children with cerebral palsy. The results showed that the effect size was small due to the small number of samples. Changes in the quality of movement and posture were difficult to measure, and personal factors, including motivation, were unexplored. The authors suggested that using measures of range of motion, strength, and other impairment variables rather than those of the subjects' functional activities would be more sensitive.

Abercrombie, Ayres, and Herbert[43] suggested that the effectiveness studies had methodological problems as manifested in the lack of clinical or postural measures, some were on single clinical observations, and small sample size. It is possible that functional measures are not sensitive enough to detect the subtle changes shown in studies including motor and postural control. Only with certain techniques is there a basis for the use of NDT with children with learning disabilities and minor deficits. Bowen and

[illegible] organization may also be used to improve the theory of NDT by answering questions about whether the observed changes with NDT intervention are the effect of the NDT or are related to other therapeutic variables or events.

Motor learning and motor control theories. As the pendulum swings in the psychology of the nervous system, as interest in cognitive processes have been challenged by explanations of stimulus-response relationships, motor learning and motor control theories have been proposed and evolved. The reader is referred to Shepherd[3] and Carr[4] for more extensive discussions of these models. This discussion focuses on those aspects of the theories that are relevant to the treatment of hemiplegic school children with motor deficits.

The theoretical models of motor learning and motor control, and their derivatives, have been built on research findings in a variety of movement disciplines, from neurophysiology, motor control, motor learning, motor development, cognitive psychology, and sports medicine. Motor learning refers to the process of acquiring ability to produce skilled movement.[1,2] The acquisition of skilled movement is considered to depend on changes within the nervous system and can be permanent or experience-based processes or require long-term storage.[1,2] A central assumption of the motor control models is that the neural events that can be studied (movement) must be explained by variables that can be studied (movement). The organization of the musculoskeletal system, governed by the physical laws governing movement,[1,2] (p. 25). Due to the difficulties of environmental factors, task-oriented intervention is considered essential in the development of motor control. The person with a movement dysfunction needs to learn how to perform the required motor tasks for effective function in daily life.[1] One of these distinctions[1,2] is between the "internal components" of "self" and "external" movement patterns and "environmental variables."

Schmidt[1] structured these concepts with the premise that "purposeful movement is considered to have some problem to solve" (p. 52). Motor problem solving arises from the interaction of the various environmental challenges on the neuromuscular system. Because Schmidt considered the human sensorimotor system had a large number of degrees of freedom in movement that needed to be controlled. For example, in the upper extremity degrees of freedom occur within each joint, with the shoulder being able to move in three planes of movement (flexion-extension, abduction-adduction, internal-external rotation). The coordination and flexibility complexity are common in the normal patterns of human movement, but in some activities, such as handwriting, demands suggest that individuals reduce the degrees of freedom by limiting the number of muscles and joints involved. Limiting the number of freedom through stereotyped, automatic behaviors ensures the ease of motor control or ability to use the body efficiently.[1] This has led to the evolution of the motor control view that motor [illegible] movements depend on the organization and correction of errors from sensorimotor feedback such as kinesthesia (e.g., perception of movement, degree, or direction of limb movements, or awareness of limb position in space).[1,2] Motor learning depends on the ability to detect and correct errors in the performance. Performance is the system that is responsible for producing movement, and before you can change it you must know what it is doing. The work of Bobath and McMillan[5] includes the neural organization of the central nervous system. A person's movement patterns are influenced by the environment.

Conceptions of these theories of motor control appear particularly relevant to the treatment of a hemiplegic-involved child with motor deficits. Sensorimotor activities have been a key premise in development theory. When engaged in interaction with the child, objects in the environment, when [illegible] are manipulated by the child, objects in the environment become meaningful to the child. Interventions that are meaningful to the child can help the child learn more meaningful motor patterns. Motor learning does not occur in a vacuum of activities but is dependent on the environment.

Practice variables seem to be considered. Include consistency, feedback, and the focus of attention. Practice of movements and skills in developing the motor control of motor action. These children often lose interest in repetitive activities and need to be motivated. Developmental theories presented here, as well as hypotheses, are those children are expected to develop skills with needs and needs based on [illegible]. Feedback would be essential in the development of positive motor responses directed to the central nervous system. Sensorimotor treatment where the child has actively engaged and simply movements to gain specific information to [illegible] subject. Shaffer[6] compared normal and motor children on a series of simple and complex movements and found that motor impaired group had a longer reaction time and movement time on complex movements. Hypothesized that motor children have a deficit in programming the motor tasks as a result, they need to rely more heavily on feedback for movement control.

Theorists can test their theories of motor control include [illegible] and biomechanical analysis. Much consistency in [illegible] the person's skilled movement [illegible] the environment.[1,2] For an analysis of a person's task or skilled movement, the child must conform to the social and functional demands of the environment.

visual and verbal cognitive strategies are used to assist the individual in performing the movement more appropriately. At times specific movement components of a task might be practiced, but they are combined in the context of the entire movement. [illegible] the specific goal and product of the task. At times the therapist needs to communicate the goal of the task to the child, but independent problem solving is encouraged. It is felt that the planning, execution, and termination of a movement experience are important to make the movement-related kinesthetic and visual information most effective.[illegible] (p. 525).

Concepts of motor control theories. Current motor control research involves a multidisciplinary effort including neurophysiology, anatomy, muscle physiology, biomechanics, and behavioral sciences.[illegible] Because of the great number and variety of theories presented to explain motor control, limited consensus exists about theoretical terminology and definitions, which impedes the ability to adequately test and compare these theories. It also makes it difficult for researchers to understand each other's work and research and limits the ability to search for underlying neural mechanisms of dysfunction.[illegible]

Sensorimotor therapy. The practice of sensorimotor treatment techniques evolves from the premise that adequate motor performance requires the child to organize sensory information from the environment for use in executing motor actions.[illegible] The goal of sensorimotor therapy is typically seen in terms of a [illegible] single, unified [illegible].[illegible] Most of the systems of sensorimotor therapy that have been developed for learning-disabled children are a combination of perceptual-motor, neurodevelopmental, motor control, and sensory integration procedures.[illegible]

In a sensorimotor therapy approach, tasks are chosen for their innate sensory and motor components. The child is directed to actively attend to [illegible] environmental strategies such as spatial and temporal sequencing within the context of a motor activity. The therapist thereby attempts to meet the child's developmental levels and encourage practice of [illegible] skills. Play interactions are considered important because they ensure that the interaction is within the context of meaningful interactions with persons and objects.[illegible] For example, the child may propel himself or herself on a scooter board in a race through an "obstacle course" looking for matching shapes.

The goal of this type of treatment is typically function oriented, with emphasis on the development of age-appropriate perceptual motor and gross motor skills. The treatment is developmental, utilizing motor responses that encourage acquisition and practice of certain skills. Gross motor outcomes of improved muscle strength, postural control, balance, equilibrium, and planning are promoted. For example, the learning-disabled child with sensory dysfunction [illegible] but may demonstrate inadequate postural reactions in lying, sitting, or standing positions. Therefore these positions are encouraged. The child may be having difficulty keeping up with the skilled activities in [illegible] class such as skipping or rope jumping. Components of these activities will be encouraged with emphasis on sequencing and timing. The therapist may use a heavier jump rope to provide more sensory information.

For further discussion of sensorimotor therapy, the reader is referred to [illegible],[illegible] [illegible] and [illegible],[illegible] [illegible],[illegible] Ayres,[illegible] and [illegible] and [illegible].[illegible] These sources also describe many therapeutic activities for the development of [illegible] functions in learning-disabled children.

Research on sensorimotor therapy. DeGangi and colleagues[illegible] identify a gap between theoretical thinking about sensorimotor therapy and current research. Studies [illegible] treatment techniques are limited. In a [illegible] DeGangi and others[illegible] found that children provided with structured sensorimotor therapy made greater gains in gross motor skills, developmental functions such as self-care, and sensory integrative functions than children who engaged in child-centered activity.

Functionally relevant motor skill training. Sensorimotor therapy includes training in motor skills that are basic, that is, those that develop in [illegible] the first several years. [illegible] skill training programs are usually at a higher level and functionally relevant to the child's daily performance. The [illegible] difference is in the approach used. Motor skill training involves the learning of skills and subskills sequenced by the age at which they are accomplished or by steps from less demanding to more demanding skills. Evaluation identifies the point at which a child fails; treatment then progresses through the [illegible] [illegible].[illegible]

Arbor describes the motor skills training approach: "One can [illegible] break down the skills into their simplest forms and give the child an opportunity to practice each in as many [illegible] ways as possible, so that he does not learn one isolated splinter skill" (p. [illegible]). As an example, Arbor suggested that a child with poor balance in standing practice balance in all positions—standing, all-fours, sitting, and prone—and on both stable and mobile surfaces. Arbor uses multiple approaches, including neurodevelopmental therapy, [illegible] and gymnastics.

[illegible][illegible] has developed a structured approach for developing skills that span a progression from early postural reactions to perceptual skills, noting that learning-disabled children are often exposed to learning experiences for which they are not developmentally ready. The development of [illegible] skill is organized around the use of five basic pieces of therapeutic equipment: [illegible] a carpeted barrel, a [illegible] board, inflated equipment, and suspended equipment. [illegible] plans are provided with activities given for [illegible] level of accomplishment. [illegible] especially emphasizes the close relationship between cog-

[illegible] assessment and treatment procedures and provides an evaluation system that basically consists of qualitative descriptions of a child's response to the items on equipment. Thus the overall plan provides a graded system that includes an ongoing evaluation of performance.

In general, the recommended approach for motor skill training includes both sensorimotor as well as motor skill development.[illegible] However, much of the treatment is directed toward the acquisition of basic skills as described by [illegible]. A basic principle is to provide a great variety of motor activities at the child's developmental level and to promote motor generalization. The activities recommended include balance, locomotion, body awareness, and hand-eye coordination. The functional relevance of these skills areas include being able to move [illegible] within the classroom and complete written work as well as greater success in sports games such as baseball.

A final area of skill that should not be ignored is that of activities of daily living. Clumsy children are frequently delayed in the acquisition of skills of using utensils, using a knife and fork, and clearing their trays as well as a general inefficiency in dressing for school.[illegible] Inadequacy in [illegible] beyond seven years results with difficulty and teachers and therapists should be aware of a child's need to learn these basic skills.

Maintaining physical fitness. In addition to the deficits in sensorimotor functions, motor skills, and activity of daily living functions, a learning-disabled child is at risk for poor posture, poor endurance, and physical fitness. Physical fitness as defined here includes strength, endurance, agility, flexibility, and cardiorespiratory endurance.

Arnheim and Sinclair[illegible] point out that there is a vicious cycle in the relationship between motor ability and physical fitness. The child with poor motor ability avoids physical activity, and the poor fitness that develops from lack of exercise lowers motor ability.

The physiologically based poor posture and [illegible] body [illegible] by a secondary disability. The child's poor self-concept may be reflected in a slouched, withdrawn posture and the avoidance of any physical activity beyond that needed in everyday activities. This same pattern can also be found in learning-disabled children without significant motor disabilities.

The physical therapist should monitor and prevent [illegible] of movement in the joints of the neck and spine and work with the physical educator to ensure that a child receives sufficient exercise to maintain his or her physical fitness. Arnheim and Sinclair[illegible] describe graded levels of activities for fitness including levels of strength and muscular endurance, flexibility, agility and large muscle coordination, and cardiorespiratory endurance. The reader is referred to Arnheim and Sinclair[illegible] and Larkin and Hoare[illegible] for further discussion of physical fitness and a development [illegible] for children with problems in motor coordination.

Summary. Children with learning disabilities often also present with motor deficits. These deficits may be subtle and difficult to pick up using neurological evaluation or standardized testing. Nevertheless, deficits may have a significant impact on the individual's development of age-appropriate motor skills, which may further affect self-esteem, peer relations, and functioning in the classroom, sports, and leisure. Whether or not motor [illegible] achievement directly is an issue of debate. [illegible] freedom of movement for the child to explore and learn within his or her environment, or to encourage the child to participate in [illegible] tasks. Motor deficits may be a [illegible] manifestation of [illegible] have yet to be confirmed in the development of each individual's capacities. [illegible] stated that:

> [illegible]

Motor performance is certainly an important aspect of the child's total development. It is important that the motor deficits in children with learning disabilities be assessed by the special education team with consultation provided by the team members as appropriate for individual functional abilities.

Many theoretical models have been developed in an attempt to explain the etiology of motor deficits observed in the learning-disabled population, as well as to provide frameworks in which to develop treatment programs. All have certain relevance to this population and perhaps to each individual child. Many of the approaches share common assumptions, although the [illegible] assumptions and the treatment approaches for remediation may vary markedly. Several theories and treatment approaches have been presented in an attempt to give an overview of alternatives for use with this population. Each child presents a unique blend of clinical signs and functional deficits, and the therapist's challenge is to assess the child appropriately to identify strengths and weaknesses, and to formulate a treatment program that best addresses both the underlying deficits in foundation skills and the functional weaknesses in daily life tasks. The experienced therapist will combine knowledge from many areas of motor development and remediation to facilitate the best treatment for each child.

Organization of occupational and physical therapy services. Traditionally, occupational and physical therapy was provided in clinics that were completely separated from educational services or in special schools or classes for orthopedically or multiply handicapped children. In 1975

...ervices are classed, the therapists work with teachers but ... a child's capacity in the classroom setting. The services ... optimal for in-school therapy programs are: intensive one ... exercises are mainly concentrated on one problem, and the ... session has the potential for maximizing educational and ... benefits for the child. Each of these factors can ... provide a most "natural" treatment for the child. It also ... opens with the teacher and the child's parents to facilitate ... carry-over of the therapeutic activities into the child's ... environment.

Although in some states occupational and physical ... therapists have provided services for multiply handicapped ... children in public schools for many years, many of the ... children with minor motor deficits, such as the learning ... disabled child, is a more recent. During the last 15 years, ... occupational therapy services for the mildly disabled children ... have become increasingly common. However, the ... learning disabled child has been even more recently ... considered and is still less common. However, the Education ... Amendments of the Education for All Handicapped Act (PL ... 94-142) and the Individuals with Disabilities Education Act ... (IDEA) is rapidly changing the needs of therapy in public ... school systems. The provision of related services, including ... occupational and physical therapy as well as special ... education, is now mandated as part of the educational process. ... Responsibilities include the performance of functional ... assessments of motor, sensory, and perceptual skills; ... treatment to improve the child's level of motor performance, ... sensory integration, and perceptual skills; consultation ... services to staff and parents; and the development of ... Individualized Education Programs (IEPs).

PL 94-142 and recent court decisions have ... established the principle that children with special needs ... are entitled to receive the kinds of services provided to ... children with special needs. The educational and ... psychological advantages of occupational therapy for ... handicapped children have been documented in the literature. ... Many of the children who have been identified as learning ... disabled have been found to have sensory integrative ... dysfunction, and therapeutic intervention has been ... recommended to improve the child's level of sensory ... integration. Can learning disabled children be referred for ... occupational therapy services?

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Educational reform is moving rapidly toward a model of ... full inclusion, where children with severe physical ... disabilities attend the regular education classroom. Not ... only the learning disabled child, this includes but ... is not limited to, children with cerebral palsy, ... spina bifida, muscular dystrophy, and traumatic brain ... injury. Each of these children may require related services ... such as occupational therapy, physical therapy, speech ... therapy, and psychological services in order to benefit ... from their educational program. Occupational therapy ... services can provide direct "hands on" treatment for the ... child's motor deficits and work with the child's parents to ... facilitate carry-over of the child's progress into the home ... environment. Occupational therapy services can also ... provide consultation to the child's teacher regarding ... sensory integrative techniques that can be used in the ... classroom to help the child participate more successfully ... in academic activities. Occupational therapy services can ... also provide direct "hands on" treatment for the child's ... motor deficits and work with the child's parents to ... facilitate carry-over of the child's progress into the home ... environment.

Sullivan and Deitcher[47] have summarized the role of ... therapists in the physical or occupational therapist in the ... educational environment. They include:

1. Screening and assessing children with motor deficits ... of fine and gross motor

2. Program planning based on evaluation results and ... consultation with the primary classroom teacher, ... parents, and relevant experiences
3. Treatment activities designed to meet program goals
4. Consultation or coaching with school personnel and ... parents around carry-over of services into the classroom ... and home programming
5. In-service training for individuals such as the ... effective use of handicapped children

Numerous sources of more information are readily ... available to the physical therapist who provides ... developmental services for children. Treatment services must ... be coordinated through consultation with parents, teachers, ... and physical educators. The child's motor development needs ... can sometimes be met simply by working with the child ... through the physical education program. The therapist can ... evaluate the child and suggest appropriate activities that ... would be easily incorporated into an effective physical ... education program.

Walsh and Greenheck[48] point out the necessity of ... integrating therapy into the educational process and by ... adapting therapy to enhance educational goals and activity ... participation rather than isolating classroom activities. The ... therapist must be knowledgeable of the curriculum and ... capable of teaching therapy goals while preparing and using ... inexpensive adaptive equipment. The teacher's assistant ... can help all of the children in the classroom participate ... and be kept in mind. Before proceeding with the ... implementation of a therapy intervention, the therapist must ... be assured that the child's parents give their consent. ... Parents must be informed of the therapy goals and ... procedures and must be willing to participate in the ... program. Parents must be willing to provide transportation ... to and from school, if necessary, and must be willing to ... allow their child participation in the therapy program.

Providing physical therapy services in the classroom ... can often be handled effectively in small groups, and ... occupational therapy and physical therapy aides can often ... assist. It is important to plan activities carefully so that ... the child is not removed from the classroom unnecessarily ... or for an excessive duration. It must be recognized that ... what may be considered "optimal therapy" within a medical ... model may not be possible in an educational model. It is ... important that principles of normal motor development ... and the possible adverse consequences of abnormal ... movement be understood well by the therapist.

The therapist should become a participant in the IEP ... process.[49] It is essential for the therapist to participate ... in the IEP meeting to communicate with other members of ... the team. Because the educational philosophy that ... guides teachers and other educational personnel is ... different from that of the medical model, the therapist ... must be aware of the legal responsibilities of the public ... school system.[50] When a specific goal or objective is ... written, the therapist needs to know what ... [illegible] ... Within the framework of special education, service delivery is being ... modified. The therapist must be creative in finding ... solutions for

educational research and must write evaluation and [illegible] reports [illegible] medical reports. Instead, the [illegible] should become a participant in the educational process.[illegible] Comprehensive discussions of occupational and physical therapy in public school systems are presented in a number of publications.*

BEHAVIORAL AND EMOTIONAL SEQUELAE OF LEARNING DISABILITIES

Although the majority of the literature about learning problems has been addressed to the identification, diagnosis, and remediation of academic deficits, behavioral and emotional problems often accompany a learning disability and may sometimes become of even greater importance than the learning disability itself.† [illegible] stressed that there is no single behavior pattern prevalent in all children with the learning disability but that there are some commonalities, the most frequent of these being a poor self-image. Although the child with a learning disability may initially be an integral part of the social and educational milieu, because of poor academic progress, disruptive behaviors, and the necessity for special attention from the teacher, guidance counselor, or resource person, the learning-disabled child perceives himself or herself and is perceived by others as being "different."[illegible] A self-defeating cycle may be established: the child experiences learning problems, the school and home environments become increasingly tense, and disruptive behaviors become more pronounced. These [illegible] further affect the child's abilities to learn. Lack of success produces more failure, and the child anticipates failure in almost every situation.[illegible] The learning-disabled child is often discouraged and fearful; emotions are [illegible] and negativistic, and motivation may be lost. Self-concept, self-confidence, and peer relationships are often affected. Research has confirmed that these children tend to be rejected more often by their classmates and are more [illegible] than [illegible] peers in regular classrooms.‡ The child's frustration and impaired learning ability generate a state of perpetual anxiety for the entire family.[illegible]

Life-span learning disabilities

Research with learning-disabled adolescents and adults has indicated that, for the most part, children do not outgrow learning disabilities and that these problems tend to persist in some or all of the following areas: attention or activity, neuromaturation, motor skills, cognition and academic performance, emotional adjustment, and social interactions.

Follow-up studies of hyperactive children indicate that although hyperactivity itself becomes less of a problem as children get older, many other problems exist. [illegible] and [illegible][illegible] found that of [illegible] teenagers who had been hyperactive as children, [illegible]% had failed one or more grades in school, many had low self-esteem, and several had been involved with the police or courts. [illegible] of hyperactive children, Weiss and others[illegible] found that [illegible]% had repeated at least one grade as compared to 15% of matched control subjects. The chief complaints of the children's mothers included distractibility and poor concentration, although [illegible] hyperactivity itself had declined. Hoy and others[illegible] did a [illegible]-year follow-up study of hyperactive children and found that as adolescents, in addition to learning deficits, the hyperactive children still had attentional and cognitive processing difficulties that affected both their academic and social functioning. Overall, results indicated that childhood hyperactivity seems to be predictive of continued academic failure, poor concentration, impulsivity, low self-esteem, and poor conduct.

Research has also indicated that there are long-term academic effects of learning disabilities during the school years, [illegible] a worsening of academic progress in learning disabilities. [illegible][illegible] tested 177 kindergarten children on standardized tests and assigned each student to one of three categories of potential risk. Students were retested on academic achievement tests in first through fourth grades. Fewer than 10% of the students assigned to the highest-risk group ever performed above the fiftieth percentile. Only [illegible] of the lowest risk group ever performed below the twenty-fifth percentile.

[illegible][illegible] reviewed follow-up studies of children with learning disorders and found that both academically and behaviorally, learning-disabled teens were noted to have a much higher frequency of problems than control subjects. In addition, persistent deficits in learning skills (e.g., reading achievement) along with deficits in attention and information processing were noted.

Even within the motor domain, there is increasing evidence that children do not outgrow their deficits despite some impression to the contrary.[illegible] [illegible][illegible] pointed out that although many clumsy children do later master certain motor skills, they fall below age appropriate levels. The same appears to be true in many domains.

Learning disabilities appear to have a persistent effect on self-concept. Of the adolescents and adults with learning disabilities or hyperactivity studied, [illegible] have low self-esteem.[illegible] Depression, thoughts of suicide, and low expectations for the future also seemed to be more prevalent in the learning-disabled adolescent.[illegible]

The finding that learning disabilities are associated with behavioral problems has resulted, in recent years, in an interest in the relationship between learning disability and juvenile delinquency. A high rate of [illegible] and [illegible] are frequently found in follow-up studies of children with

*References [illegible].
†References [illegible].
‡References [illegible].
§References [illegible].

learning disabilities.[4,6,8] Learning as well deficiencies are considered an element in a significant number of these groups.[7,9] Several surveys of the types, incidence, and psychosocial characteristics of children with learning disabilities[10] and Wallach[11] revealed that 20% to 30% of juvenile delinquents in the sample exhibited various learning disabilities. Another study[12] found that the major common problem components were lack of social awareness and poor social communication skills. It was concluded that the social skills of learning disabilities students would be a risk for antisocial behavior and that the social-emotional problems may be related to deficient social functioning in the community.[13]

Study of social skills among disabilities is a fairly recent area of concern. Among such concerns are the cognitive errors and deficits in children of various ages. Many of the current models of learning disabilities include the concept of social skills deficiencies as a primary characteristic. Other researchers have found that learning disabilities children are at risk for social rejection and isolation.[14] Some of the social and psychological problems that may be associated with learning disabilities include poor self-concept, low self-esteem, and poor social skills in the community.[15]

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Because of the nature of intervention with learning disabilities, the current emphasis on the cognitive deficits may not be possible to generalize to the learning disabled adult or adolescent in the vocational world of the future.

What psychologists know about the learning disabled today is largely anecdotal and in the form of case histories. Documentation has usually been sketchy. Few research studies have systematically reviewed the vocational effects of learning disabilities in adolescence and adulthood. It appears that unrecognized learning disabilities in children and adolescents can be expressed throughout the life span by persistently poor performance and inappropriate behavior. The basic problem is that the person's vocational adjustment is not commensurate with his or her intellectual ability.[16] The basic vocational problems experienced by learning disabilities persons are poor self-concept, poor interpersonal relationships, poor work habits, poor attendance, poor motivation, and poor work performance.[17] Learning disabilities persons have difficulty in establishing and maintaining satisfactory interpersonal relationships and demonstrate inadequate social skills in most vocational settings. Learning disabilities persons have difficulty in establishing and maintaining satisfactory interpersonal relationships and demonstrate inadequate social skills in most vocational settings. Learning disabilities persons have difficulty in establishing and maintaining satisfactory interpersonal relationships and demonstrate inadequate social skills in most vocational settings.

Summary

Meeting the needs of the learning disabled child places new challenges in assessment and program development. A model of the emerging learning disabilities adolescent and adult is presented. The model includes the major components of the school environment, including services and programs that require changes in the nature of services and may especially be necessary in the areas of vocational education, job training, psychological and social adjustment, and employment. The model also includes the major components of the adult environment and the major areas of concern.

Comprehensive vocational therapists must become responsible for learning disabilities children. Vocational therapists must make sure that the learning disabilities child is not overlooked in the vocational education process. The vocational therapist must be sure that the learning disabilities child is not overlooked in the vocational education process. The vocational therapist must be sure that the learning disabilities child is not overlooked in the vocational education process.

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A letter from an adult with a learning disability

[illegible]

[illegible] by [illegible] management of this problem [illegible] reduces the pressure to perform" (p. 157). In an environment in which parents, teachers, peers and the child recognize the nature of the deficit and its consequences [illegible] some children accept their motor disability [illegible] and alternative forms of recreation assume greater importance.

As this review has indicated, evidence supporting the effectiveness of treatment of motor deficits in learning-disabled children is as yet fragmentary. Learning-disabled children present highly variable patterns of disability that make it difficult to predict or measure response to therapy. Thus formal research and careful documentation of clinical outcomes are needed to explore and define the dimensions and significance of motor disorders in learning disabled children that are relevant to therapy. Only then can we better assist these children, improve the precision of treatment and validate treatment theory.

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298. Swanson HL and Trahan M. Learning disabilities, intelligence and the standardization sample of the K-ABC: A methodological analysis. *Journal of Psychoeducational Assessment* 8:153–165, 1990.

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APPENDIX A SUMMARY OF STANDARDIZED MOTOR TESTS

1. Bruininks-Oseretsky Test of Motor Proficiency
2. Test of Motor Impairment—Henderson Revision
3. Peabody Developmental Motor Scales
4. Quick Neurological Screening Test
5. Miller Assessment for Preschoolers
6. FirstSTEP
7. Test for Motor Impairment in Children
8. Sensory Integration and Praxis Tests
9. Beery Test of Visual-Motor Integration
10. Developmental Test of Visual-Motor Integration
11. Test of Gross Motor Development
12. Gross Motor Ability Tests—Revised
13. Fine Motor Skills Test

1. Bruininks-Oseretsky Test of Motor Proficiency (BOTMP)

Authors: Robert H. Bruininks
Publisher: American Guidance Service, Inc.
Circle Pines, Minn. 55014
Ages: 4½ to 14½ years
Administration: Individually or in groups of two
Equipment: Various supplies
Description: The Bruininks-Oseretsky Test of Motor Proficiency is the most recent revision of the Oseretsky Tests of Motor Proficiency first published in Russia in 1927. The Oseretsky tests were first adapted by Doll in 1948 and then by Sloan in 1955 as the Lincoln-Oseretsky Motor Development Scale. As with the earlier versions, the Bruininks-Oseretsky Test yields quotient equivalents based on standard scores and percentile ranks are also available. Seven areas of motor functioning in eight areas, each with standard scores and percentile ranks are also available. Seven areas of motor functioning in eight areas, each with standard scores and percentile ranks are also available. The test consists of:

1. Running speed and agility	Three 15-meter pace up-back-and-forth runs
2. Balance	Eight items ranging in difficulty from standing on one leg to walking backward on a balance beam
3. Bilateral coordination	Seven items such as tapping the fingers of one hand as rapidly as possible, alternating fingers on the two hands, and jumping and clapping your hands in synchrony with your feet
4. Strength	Three items requiring knee jumps, sit-ups and push-ups
5. Upper-limb coordination	Five items such as throwing a tennis ball at a target, bouncing and catching a tennis ball, and drawing a circle around a printed circle
6. Response speed	Placing pennies in a box as rapidly as possible
7. Visual-motor control	Placing pegs in holes, copying shapes, and tracing mazes
8. Upper-limb speed and dexterity	Three items such as tapping pencils on a block, placing pennies in a box, and stringing beads

Standardization and reliability: The Bruininks-Oseretsky Test was based on a nationally representative sample of children stratified by geographic region and community size. Test-retest reliability coefficients for the subtests ranged from .32 to .89 and for the total battery were .87 for boys and .86 for girls. Interrater reliability coefficients were .63 for the subtests and .98 for the total battery. With the exception of "response speed," the subtests and composites generally showed adequate reliability.

Comment: The Bruininks-Oseretsky Test of Motor Proficiency appears to be one of the most carefully standardized tests of motor performance available. However, many of the items can be used for screening purposes only. A more systematic, careful observation must be made to differentiate the underlying problems. For example, a child who cannot balance on one leg may not have poor balance per se but may have poor vision and be unable to see the beam clearly enough to balance. Similarly, poor throwing skills may be the result of poor balance while standing on one leg rather than poor eye-hand coordination. Poor eye-hand coordination could also underlie poor pencil skills. These kinds of problems could be identified by observing a child's errors. Another problem with the test is that a single item that is disproportionately difficult or easy for a child's age could affect the child's overall score. Nevertheless, this is an excellent test for monitoring the gross coordination of a child's movements.

2. Movement Assessment Battery for Children (Movement ABC) (1992)[33]

Authors: S.E. Henderson and D. Sugden
Publisher: Psychological Corporation
Ages: 4 to 12 years
Administration: Individual; 20 to 30 minutes
Equipment: Test kit required
Description: The Movement ABC is a revised and expanded version of the Test of Motor Impairment (TOMI)—Henderson...

Revised. The Movement ABC includes nine aspects for scoring and evaluation. The Movement ABC Checklist provides observation sections of movement skills. Test for screening for severity of motor impairment (movement ABC). Test Manual: Age Band 1 (Movement ABC Test similar to the TOMI) provides a more comprehensive assessment and includes both normative and qualitative measures of movement competence. The test is divided into two age bands for children 4–6 years, 7–8 years, 9–10 years and 11–12 years. Treatment: The manual provides guidelines for organizing intervention programs.

The Movement ABC Test includes eight categories, with a single item for each and in each category.

1. Manual dexterity 1	Speed and accuracy of movement by each hand
2. Manual dexterity 2	Dexterity of the two hands working together
3. Manual dexterity 3	Dexterity and coordination of the preferred hand
4. Ball skills 1	Ball skills requiring accuracy and aiming
5. Ball skills 2	Ball skills requiring catching and throwing
6. Static balance	Balance task
7. Dynamic balance 1	Balance task emphasizing overall coordination
8. Dynamic balance 2	Balance and responding to external stimulation

Characteristics and reliability: Standardization: The Test was developed on a sample of 1,000 children who were tested in the United Kingdom. Normative data on the test were collected on 1,234 children in the U.S. The sample was approximately representative of the general population of children in the U.S. in terms of gender, region, and racial origin. Test-retest reliability for consistency of individual test scores with children ages 5, 7, and 9 showed a median correlation of approximately .80 and ranged from .60 to .95. Percent agreement for total impairment scores ranged from 72% for age 9 to 87% for age 5. Interrater reliability for age 5 was 72% and for age 9 was 77%. Percent agreement for total impairment scores ranged from 72% for age 9 to 87% for age 5.

Comments: The movement ABC has several advantages in that the Checklist helps teachers identify children with movement problems, the Test battery provides for a quantitative measure approach to intervention, and the qualitative components help teachers observe and record errors. The test is easy to administer, score, and the scoring systems have been refined.

11. Peabody Developmental Motor Scales (PDMS): Second Experimental Edition (1983)[7]

Authors: M. Rhonda Folio and Rebecca R. Fewell

Author: DLM Teaching Resources
P.O. Box 4000, Dua 2DLC Park
Allen, Texas 75001

Ages: birth to 7 years

Administration: Individual basis is 3 to 5 years; individual or group basis 5 to 7 years; 45 to 90 minutes to administer; scored by direct observation or by parent or teacher report

Description: The Peabody Developmental Motor Scales were designed for use with children who show delay in the rate of progress in gross motor skills. The items are similar to those on other developmental scales but only motor items are included. Items are scored on a 3-point scale: 0 for cannot do, 1 for partially and 2 for mastered performance. A program evaluation profile presents raw scores and standard scores are provided. The following six categories are tested in the gross motor scale (270 items total). These scales are considered to require precise movements of large muscles of body.

1. Reflexes (72 items)	Includes items such as following visual stimulus with eyes, head righting reaction, and the asymmetrical tonic neck reflex
2. Balance (76 items)	Includes items such as head control, sitting balance, standing balance, and walking a line
3. Nonlocomotor (57 items)	Includes items such as total control, sitting, weight bearing, as well as transitions from one skill to another and flexion
4. Locomotion (58 items)	Includes items such as crawling, running, walking, hopping, skipping, jumping, marching, and jumping hurdle
5. Receipt of objects (26 items)	Catching, throwing, and kicking skills

The fine motor scale includes 112 test items considered to require precise movements of small muscles. The following six categories are included:

1. Grasping (22 items)	Includes items requiring the grasping skill, the hands and with the fingers and other manipulations
2. Eye-hand coordination (31 items)	Includes a variety of items ranging from visual tracking to more complex eye-hand coordination and includes the manipulation of objects and other items
3. Eye-hand coordination (visual integration)	Early items include visual tracking, hand-eye coordination, and copying forms
4. Manual dexterity (18 items)	This category begins with pegboard items and includes sorting, stacking, and folding

Characteristics and reliability: The fine motor scale was standardized on a normative sample of 1,000 children ranging in age from birth to 83 months with samples beginning at 2 month intervals and increasing to 1-year intervals. Data collected on the subgroups

are small. A majority among 10 reference items. Samples were selected to match socioeconomic status and ethnic characteristics. A test-retest stability of .90 for the gross motor scale and .70 for the fine motor scale was reported based on a sample of 40 children. Validity was demonstrated by a primary focus on items of the children with developmental concerns on all for the 3 to 5 month children. A study of 40 children established a low but significant correlation (.65) between the PDMS gross motor scale and the Bayley Motor Scale.

4. Peabody Developmental Motor Scales (PDMS)[314]

Author(s): Lee Folio, M.D., Stahl, M.M. Stallug, and D. V. Spalding
Source: Academic Therapy Publications
20 Commercial Boulevard
Novato, CA 94947
Time: 5 minutes
Administration: Individual; 20 minutes
Appropriate: None
Description: The Quick Neurological Screening Test (QNST) was developed as a screening device to identify children who may have a learning disability. The items are adapted from pediatric neurological examinations as well as from developmental assessments. The test is made up of the following fifteen subtests.

1. Jerk test	Moving head from one side to another
2. Tonic neck reflex test	Moving the drawing box from one side to the other
3. Finger-to-nose test	Subject touches examiner's finger and then nose
4. Associated movements	Subject opens hand and closes it, then opens and closes it
5. Fist-edge-palm test	Subject places hand on table in three positions
6. Finger tones	Subject touches each finger to thumb
7. Tandem walk	Subject walks a straight line
8. Romberg test	Subject stands with feet together, eyes closed
9. Past-pointing	Subject touches finger to nose
10. Alternate movements	Subject alternately touches fingers to thumb
11. Tandem walk	Subject walks backward
12. Standing on one leg	Subject stands on one leg, then on the other, eyes open and closed
13. Skip	Subject skips
14. Left-right discrimination	Subject touches left ear, then right ear
15. Bilateral integration	Subject touches left knee with right hand, then right knee with left hand

The test is given to children in the classroom and requires a subjective evaluation of performance. The manual provides ages at which 75% or more children pass each test as well as some indicators of probable neurological dysfunction.

Construction and Standardization: The QNST has been used in numerous research studies of normal children and of children with special learning problems. Although the manual presents some guidelines, the test is not completely standardized. Reliabilities on the whole test are fairly acceptable, with .93 and .97 as reported, but individual items are incomplete. Ages at which 25%, 50%, and 75% of normal children pass each subtest are given based on a compilation of subjects from many studies. Norms for the total test are not given.

Comments and Critique: The QNST is a screening device that identifies children with possible neurological dysfunction. The test should not be used as a diagnostic test but rather as an adjunct to clinical observation. It is important to realize that the test is primarily of motor function. It does not include language tests and, therefore, will not identify all children with learning disabilities. The test is best used for possible minimal brain dysfunction or motor problems.

5. Miller Assessment for Preschoolers (MAP)[315]

Author(s): Lee Jane Miller
Source: Psychological Corporation

The Academic Group
San Antonio, Texas 78204-0952

Ages: 2 years 9 months to 5 years 8 months

Administration: Individual, 20 to 30 minutes including scoring

Equipment: The MAP test kit

Description: The Miller Assessment for Preschoolers was designed to identify children who exhibit mild to moderate developmental delays. The MAP is a developmental assessment intended for use by educational and clinical personnel to identify those children in need of further evaluation and treatment. It also was designed to provide a comprehensive, clinical framework that would be helpful in defining a child's strengths and weaknesses and that would indicate possible avenues of remediation. The test is made up of 27 items and a series of structured observations. The test items are divided into five performance indices:

1. Foundations	Basic motor tasks as well as classical neurological components and sensory awareness and movement tasks
2. Coordination	Gross, fine, and oral motor abilities and articulation
3. Verbal	Cognitive language abilities, including memory, sequencing, comprehension, association, following directions, and expression
4. Non-verbal	Cognitive abilities such as visual figure-ground, puzzles, memory, and sequencing
5. Complex tasks	Tasks involving an interaction of sensory, motor, and cognitive abilities

Standardization and reliability: The MAP has been standardized on a random sample of 1200 preschool children. The sample was stratified by age, race, sex, size of residence, community, and socioeconomic factors. Data were collected nationwide in each of nine US Census Bureau regions. Reported reliabilities are good. In a test-retest of 90 children, 81% of the children's scores remained stable. The coefficient of internal consistency of the total sample was 0.798. Interrater reliability on 40 children was reported as 0.98.

Comments: The MAP was developed by an occupational therapist and provides information that is of particular relevance to therapists. It is carefully standardized and fills a need for early identification of learning and motor deficits in children. Several articles have now been published reporting on validity of the test as a screening instrument.[[illegible]] Reviews of the MAP in the Ninth Mental Measurements Yearbook have described it as the best available screening test for identifying preschool children with moderate "preacademic problems"[[illegible]] and "as an extremely promising instrument which should find wide use among clinical psychologists, school psychologists, and educational therapists in assessing mild to moderate learning disabilities in preschool children."[[illegible]] A more complete review of this test is provided by King-Thomas and Hacker.[[illegible]]

[illegible] FirstSTEP (Screening Test for Evaluating Preschoolers) (1993)[[illegible]]

Author: Lucy J. Miller, PhD

Source: The Psychological Corporation
San Antonio, Texas

Ages: 2 years 9 months to 6 years 2 months

Administration: Individual, 15 minutes

Equipment: Test kit needed

Description: The FirstSTEP is a quick screening tool for identifying developmental delays in all five areas defined by IDEA (Individuals with Disabilities Education Act) and mandated by PL 99-457: cognitive, communication, physical, social/emotional, and adaptive functioning. Twelve subtests assess cognitive, communication and motor domains (see appendix). Social-Emotional Scale includes [illegible] items from five areas: task performance, cooperative mood, temperament and emotionality, unco-operative antisocial behavior, and social communication difficulties that are scored based on behaviors observed by the examiner during the test session. The Adaptive Behavior Checklist is an optional measure completed by parent interview to assess the child's self-help and adaptive living skills. The Parent/Teacher Scale provides additional information about the child's typical behavior.

Subtest Name	Item Assessed

Cognitive Domain

Money Game — Quantitative Reasoning

Description: The child is asked a series of questions about coins, assessing quantity, amount, comparison, addition, and subtraction. This subtest requires receptive understanding of mathematical concepts.

What's Missing Game — Picture Completion

Description: The child is asked to identify what is missing from line drawings of common objects or people [illegible] line drawings. This subtest measures visual figure-ground abilities and a good of general abilities.

Which Way? Game — Visual Position in Space

Description: The child is asked to view an irregular figure that is oriented in a specific direction. The child then must look for the one among others that matches. This subtest measures visual discrimination and the ability to identify [illegible] components.

Put-Together Game — Problem Solving

Description: The child is asked to select the pieces that combine to form a picture. This subtest measures abstract thinking.

School Years — Area Assessed

Language Domain

Expressive Vocabulary Test — Vocabulary Expressiveness

Description: This test provides a quick estimate of a child's expressive vocabulary skills. Test administration involves asking the child to name pictures presented in a booklet.

Peabody Picture Vocabulary Test-III — Word Knowledge

Description: This test is used to estimate a child's receptive vocabulary skills. The child is asked to point to the picture that best represents the meaning of a word read aloud by the examiner. The test can be used with children and adolescents ranging in age from 2½ to 90 years.

Test of Word Finding — Word Retrieval

Description: This test is used to examine a child's word-finding skills. It measures the child's ability to name pictures of objects, actions, and concepts. Different versions of the test are available for children ages 4 to 10 and 5 to 18.

Motor Domain

Developmental Test of Visual-Motor Integration — Visual-Motor Integration

Description: This test is a pencil-and-paper test that requires the child to copy geometric forms of increasing complexity. The child's performance is compared with that of a normative sample of children of the same age.

Test of Visual-Motor Skills — Visual-Motor Planning

Description: This test is used to assess a child's visual-motor integration skills. The child is asked to copy a series of geometric designs. Test scores can be used to identify children who may have difficulty with tasks that require visual-motor planning skills.

Bruininks-Oseretsky Test of Motor Proficiency — Gross and Fine Motor Skills

Description: This test is used to measure the overall motor proficiency of children ages 4½ to 14½ years. It includes eight subtests that measure running speed and agility, balance, bilateral coordination, strength, upper-limb coordination, response speed, visual-motor control, and fine motor dexterity.

Sensory Domain

Sensory Profile — Sensory Processing

Description: This checklist is used to describe a child's sensory processing, modulation, and behavioral responses in everyday situations. The child's caregiver completes the questionnaire, which includes 125 items that describe a child's responses in different situations.

Test of Sensory Functions in Infants — Sensory Integration

Description: This test is used to identify infants who have sensory integration problems. It includes eight subtests that measure the infant's ability to process and integrate sensory information.

Play Assessment Scale — Play Skills

Description: This checklist is used to assess a child's play skills. It includes 29 items that describe play behaviors in the areas of sensorimotor play, exploratory play, symbolic play, and social play.

Motor Domain

Developmental Test of Visual-Motor Integration — Visual-Motor Integration

Description: This test is a pencil-and-paper test that requires the child to copy geometric forms of increasing complexity. Scores can be used to identify children who may have difficulty with tasks that require visual-motor planning skills.

Test of Visual-Motor Skills — Visual-Motor Planning

Description: This test is used to assess a child's visual-motor integration skills. The child is asked to copy a series of geometric designs. Test scores can be used to identify children who may have difficulty with tasks that require visual-motor planning skills.

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Test of Sensory Functions in Infants — Sensory Integration

Description: This test is used to identify infants who have sensory integration problems. It includes eight subtests that measure the infant's ability to process and integrate sensory information.

Play Assessment Scale — Play Skills

Description: This checklist is used to describe a child's play skills. It includes 29 items that describe play behaviors in the areas of sensorimotor play, exploratory play, symbolic play, and social play.

Examination and suitability. The BASC-2 is a norm-referenced test that was standardized on 1,753 children. Norms are provided in female, male, and combined gender groups. Standardization sample closely matches demographic characteristics provided by the US Census Bureau. Scores are reported in standard scores as well as percentile ranks. Validity studies included risk factors, as indicated by the child's performance on the test, and clinical groups, including children with ADHD, learning disabilities, emotional disturbance, and mental retardation. Correlations between the BASC-2 and other measures of behavior and personality are provided.

Reliability. The BASC-2 has adequate to excellent internal consistency reliability coefficients for most scales and indexes. Test-retest reliability coefficients are adequate for most scales and indexes when assessed over short intervals. Interrater reliability coefficients are adequate for most scales and indexes.

Comments. The BASC-2 is a well-developed test battery that includes multiple measures of behavior and personality. Its strengths include the use of multiple informants (teacher, parent, and self-report forms), the ability to compare responses of informants, and the ability to compare responses of children in different clinical groups. The BASC-2 is a good choice for a comprehensive assessment of behavior and personality.

Behavior Rating Inventory of Executive Function (BRIEF)

Author: Gerard A. Gioia, Peter K. Isquith, Steven C. Guy, and Lauren Kenworthy

Publication Info: Lutz, FL: Psychological Assessment Resources, Inc.

Ages: 5 to 18 years

Administration: Individual or group

Qualifications: Bachelor's degree in psychology or related field

Description: The BRIEF is a norm-referenced rating scale that measures executive functioning in children and adolescents. It includes two forms: a parent form and a teacher form. Each form has 86 items that are rated on a 3-point scale (never, sometimes, often). The items are grouped into eight clinical scales: Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor. The scales can be combined to form two composite scores: the Behavioral Regulation Index (BRI) and the Metacognition Index (MI). The BRI and MI can be combined to form the Global Executive Composite (GEC).

Examination and suitability. The BRIEF is easy to administer and score. It takes about 10 minutes to complete. The test manual provides clear instructions for administration and scoring. The BRIEF is available in English and Spanish versions.

Reliability. The BRIEF has excellent internal consistency reliability. Test-retest reliability is also good. Interrater reliability between parent and teacher forms is moderate.

Validity. The BRIEF has good content validity. It was developed based on a review of the literature on executive functioning and on clinical observations of children with executive dysfunction. The BRIEF has been shown to discriminate between children with and without clinical diagnoses, such as ADHD, learning disabilities, and autism spectrum disorders. It has also been shown to correlate with other measures of executive functioning, such as the Wisconsin Card Sorting Test and the Tower of London.

Comments. The BRIEF is a well-developed and psychometrically sound measure of executive functioning in children and adolescents. It is a useful tool for clinicians who are working with children who have suspected executive dysfunction. The BRIEF can help clinicians to identify specific areas of executive functioning that are impaired, which can then be targeted for intervention.

Gilliam Autism Rating Scale-Second Edition (GARS-2)

Author: James E. Gilliam

Publication Info: Austin, TX: PRO-ED, Inc.

Ages: 3 to 22 years

Administration: Individual

Qualifications: Bachelor's degree in psychology or related field

Description: The GARS-2 is a norm-referenced rating scale that measures the severity of autism symptoms in children and adolescents. It includes 42 items that are rated on a 4-point scale (never, sometimes, often, always). The items are grouped into three subscales: Stereotyped Behaviors, Communication, and Social Interaction. The subscales can be combined to form the Autism Index (AI).

Examination and suitability. The GARS-2 is easy to administer and score. It takes about 10 minutes to complete. The test manual provides clear instructions for administration and scoring. The GARS-2 is available in English and Spanish versions.

Reliability. The GARS-2 has excellent internal consistency reliability. Test-retest reliability is also good. Interrater reliability between parent and teacher forms is moderate.

Validity. The GARS-2 has good content validity. It was developed based on a review of the literature on autism and on clinical observations of children with autism. The GARS-2 has been shown to discriminate between children with and without autism, as well as between children with autism and children with other developmental disabilities. It has also been shown to correlate with other measures of autism, such as the Childhood Autism Rating Scale and the Autism Diagnostic Interview-Revised.

Comments. The GARS-2 is a well-developed and psychometrically sound measure of autism symptoms in children and adolescents. It is a useful tool for clinicians who are working with children who have suspected autism. The GARS-2 can help clinicians to identify specific areas of autism symptoms that are impaired, which can then be targeted for intervention.

Test of Motor Proficiency (Oseretsky)

Author: Robert H. Bruininks

Publication Info: In Oseretsky (Ed.), The Oseretsky Test of Motor Proficiency. Circle Pines, MN: American Guidance Service, Inc.

Ages: 4 to 14 years

Administration: Individual

Qualifications: Bachelor's degree in psychology or related field

Description: The Oseretsky Test of Motor Proficiency is a norm-referenced test that measures gross and fine motor skills in children and adolescents. It includes 36 items that are grouped into eight subtests:

1. Balance
2. Running speed and agility
3. Strength
4. Coordination
5. Response speed
6. Visual-motor control
7. Upper-limb coordination
8. Fine motor dexterity

5. [illegible] with double bow
6. Thread IC beads
7. Stack 20 pennies on an eye pencil
8. Insert a bow in a hair scrunchie in appropriate sizes

The first two items are scored pass or fail. The score for the Coordination is the number of items passed. Performance is considered poor if two or more items are missed.

Preliminary Cutoff's tests were devised as a rapid screening to be used together with further qualitative analysis of clumsy children in a clinical program. They are valuable if used as intended. One or more of the items could be misinterpreted or misperformed, producing a score that would overemphasize developmental coordination disorder. Only standardized test and further normative data as well as validity and reliability studies are needed.

F. The Sensory Integration and Praxis Tests (SIPT) (1989)[37]

Author: A. Jean Ayres
Source: Western Psychological Services
12031 Wilshire Boulevard
Los Angeles, CA 90025
Ages: 4 years 6 months through 8 years 11 months
Administration: Individual. 2 hours. Must be certified to administer test.
Evaluation: SIPT Test Kit.
Description: The Sensory Integration and Praxis Tests are a major revision and standardization of the Southern California Sensory Integration Tests. A total of 17 new tests of praxis were added. The tests measure visual perception, right-left discrimination, motor coordination, and finger function abilities. The tests are also grouped to identify sensory integrative and praxis deficits in children with learning disabilities. There are 17 tests described as follows:

1. Space Visualization	Select from six choices the one that is the same as the standard when it is rotated in space.
2. Figure-Ground Perception	The child views items on a colored background and identifies the items from among the background.
3. Manual Form Perception	Part A: Using the nondominant hand, the child feels a form and identifies it from a group of forms. Part B: Using the dominant hand, the child feels a form and identifies it from a group of forms.
4. Kinesthesia	With eyes closed, the child moves the arm to a position and then to the right and then places pennies in the appropriate slots. Scoring is provided for each side.
5. Right-Left Discrimination	With hands across from each other, the examiner touches the child's hands. The child is instructed and then must name the fingers touched.
6. Graphesthesia	The examiner traces a letter on the back of the child's hand. The child identifies the letter. Each side is done.
7. Localization of Tactile Stimuli	With eyes closed, the child responds to the touch on the back of the hand with the finger touched by the examiner and then touches the finger.
8. Design Copying	The examiner provides the child with a series of designs and the child reproduces them.
9. Design Copying	Part A: The child copies a design by connecting dots on the grid. Part B: The child copies a design without the aid of a grid. Lines and angles are scored.
10. Postural Praxis	Working with a child, the examiner performs two different tasks sequentially. The child observes the examiner, then performs the tasks. The second attempt is recorded.
11. Bilateral Praxis	The child places a small bead on a string and then slides the bead to the other end.
12. Motor Accuracy	The child draws a line between two lines.
13. Design Copying	The child copies a design.
14. Postural Praxis	The child imitates a series of unique postures with hand movements in response to the examiner.
15. Bilateral Coordination	The child imitates a series of bilateral arm and hand movements demonstrated by the examiner.
16. Standing and Walking Balance	The subject performs a series of balance tasks. Errors are recorded.
17. Motor Accuracy	The child draws a pattern ("road") that has both a left and right boundary. Errors are recorded.

17. Sensory-integration inventory — Test aims to predict learning disabilities and poor adaptation in children; an inventory examines a variety of sensory-motor behaviors in children

In addition to these 17 tests, a series of Cattell Developmental Scales is incorporated in the STPT. These clinical observations include the following:

1. Fine coordination
2. Eye-hand coordination
3. Manipulation
4. Concentration
5. Postural background movements
6. Postural security
7. Equilibrium reactions on various surfaces or situations
8. Synchrony of simultaneous gestures
9. Stereognosis
10. Finger extension
11. Asymmetrical tonic neck reflex
12. Hyperkinesis, distractibility
13. Double dissociation test
14. Ability to perform sequential tasks
15. Trunk-limb coordination
16. Body awareness
17. Bilateral synergic movements
18. Hopping, jumping, skipping

Interpretation and Applications: The interpretation of the Sensory Integration and Praxis Tests was based on a theoretical model developed from observations of children with learning disabilities and supported by factor analysis of the clinical analysis scales. Interpretation utilizes a normal model based on patterns of scores rather than a deficit model based on any one test.

The SIPT was nationally standardized in 1977. Children from seven- and three-year-old groups and 7 areas. Socioeconomic status, ethnicity, and type of community were represented in proportion to the 1970 US census.

Reliability: Reliability was evaluated in a sample of 45 children from seven age groups. As a group, the praxis tests had the highest reliability. Intercluster reliability is excellent with most correlation coefficient values at .900 or higher.

Comments: The SIPT is comprehensive and well-developed, and a full interpretive manual is provided that summarizes major SIPT studies and provides helpful guidelines for clinical use. Future reliability studies of the SIPT should be undertaken with a heterogeneous sample of children with learning disabilities and emotional problems.

9. Bender Gestalt Test for Young Children (BGT)[9]

Author: Elizabeth M. Koppitz

Publisher: Grune and Stratton, Inc.
New York, NY

Ages: 5 to 10 years

Administration: Individual; 2 to 15 minutes; paper-and-pencil response required

Overview: The Bender Gestalt Test for Young Children is an extension of the Bender Visual Motor Gestalt Test, which is an individually administered test of perceptual-motor integration. The test consists of nine designs that are presented in sequence one at a time to the child. Psychological interpretations are supported by empirical studies. Designed to yield developmental scoring systems for young children, it was developed by Koppitz.[9] The Bender Gestalt is used by psychologists to assess visual-motor maturation and possible neuropsychological impairment, and it is also used with the Koppitz scoring system to evaluate personality functioning and emotional adjustment. The reproduction designs are scored for developmental maturity, perceptual-motor integration, and signs of emotional disturbance. The Koppitz scoring system yields an estimate of the child's developmental age.

Psychometric Considerations: The Bender Gestalt Test is a widely used and heavily researched test of neuropsychological impairment following brain injury, emotional disorders, and developmental problems. Considerable clinical skill is required for the Koppitz scoring of the Bender Visual Motor Gestalt, and an extensive inquiry from CAD or ChildPsychometrist is suggested.

Comment: The Bender Gestalt test yields considerable information about a child's ability to integrate visual perception and motor coordination, but it requires special skills for interpretation. Inquiry to copy geometric forms may reveal several reasons for any visual-perceptual discrepancies, such as visual acuity, motor ataxia, confusion in the orientation of the concepts of the forms, or fragmentation.

10. Developmental Test of Visual-Motor Integration (VMI, or Beery VMI; JR; 1989)[10]

Author: K. E. Beery

Publisher: Modern Curriculum Press
Cleveland, Ohio

Ages: 2 years 0 months to 17 years 11 months

Administration: Individual or group; 10 to 15 minutes

Type of Test: Paper-and-pencil or form

Description: The Developmental Test of Visual-Motor Integration tests the ability to copy geometric forms. A booklet is provided with the forms in an age-graded

response. The child copies each design immediately below it. Items are added as child progresses in the manual.

Administration and Interpretation. The most recent revision of this test includes abbreviated procedures for the scoring of some items. In addition the range of VMI scores was expanded to include standard values for the 3rd through 12th percentiles, which are clinically difficult to differentiate. Further discriminations among normal children, especially at the older ages, can be made using the Visual-Motor Integration Maturity norms. Information relating to each of which items are passed was provided by Beery and other researchers as well as age-equivalent scores, percentile equivalents, standard scores, and T scores based on a sample of 582 children. This included a 1982 sample combined with two previous normative samples. Various studies of reliability and validity are reported in the manual. Studies of concurrent validity were reported for groups of children of varying ages and ranges (Lim, 1983; Tseng, Hsueh, & Hsu, 2002) to 0.82 (Brown, Knott, & Loader, 2001) with a median of 0.68. There are no reports of reliability or individual item agreement. Interrater agreement was reported to range from 0.66 to 0.91 and test-retest agreement was 0.93.

Comments. The Beery-Buktenica Test of Visual-Motor Integration provides a quick and easy method for assessing the development of a child's ability to copy geometric forms. It is useful for identifying a child's overall level of the form-perception ability. When the child is presented with the booklet page, the examiner should be sure that the booklet is placed in front of the child facing the same direction as the page of the booklet. This prevents some of the problems of letter reversals that the child has when the booklet is presented with the wrong orientation. However, the structured format does not allow the examiner to assess overall organization of complex forms as can be done with the Rey-Osterrieth Complex Figure Test. Therefore overall organization cannot be easily assessed.

The Test of Visual-Motor Skills (TVMS; Gardner, 1996)[1]

Author: Marian F. Gardner.

Source: Children's Hospital of San Francisco
Achievement Improvement Center
PO Box 3607, San Francisco, CA 94119

Ages: 2 to 15 years

Administration: Individual or group. Takes 5 minutes.

Equipment: Pencil or crayon.

Description. The TVMS consists of a series of 30 forms to be copied by the child. Each form is on a separate page in the booklet with the same format. Forms are mostly geometric but many more lines and angles for examinee's but many more forms are difficult in this test. Color was taken out of the test to avoid language problems. The forms are shown from 1 to 4 inches in height. The child is asked to copy the forms with paper and pencil. A basal of 3 consecutive pass determination is used. Criteria for scoring each item are given, with exceptions for each item. Age equivalents and standard scores are provided.

Administration and Interpretation. The Test of Visual-Motor Skills was administered to 1,616 children in the San Francisco Bay area at 11 age levels, from 2 years to 12 years. The number of subjects in each age group ranged from 100 to 150, with a total of 1,616 subjects. Chronological age was used to determine the internal consistency of the test. The reliability coefficients were lowest for the younger children (0.67 at 2 years and 0.74 at 3 years) but all were statistically significant (0.01 or better) for all other age groups, ranging 0.91 for the sample as a whole. Test-retest reliability was not reported in the manual, but the author cited the need for research in this area.

Comments. The TVMS is a comparable alternative to the Test of Visual-Perceptual Skills (TVPS), which is also based on the work of Frostig and colleagues. Which test is more appropriate for a child is a clinical judgment that is affected by the examiner's impression of whether the problem is in visual perception or whether the problem is in visual motor execution. The TVMS yields slightly more precise standard scores than other comparable tests. For example, a raw score of 20 on the TVMS yields a standard score of 100, whereas a raw score of 20 on the Test of Visual-Motor Integration yields a standard score of 90. Therefore, it should be used by those who have had training in psychometrics and test interpretation, which can be used in addition.

The Bender Visual-Motor Gestalt Test: Revised (BVMGT: Revised; Brannigan & Decker, 2003)[2]

Author: Gary G. Brannigan and Sally A. Decker.

Source: Gary G. Brannigan and Sally A. Decker, 300 Century Drive, Suite 308, Bloomingdale, IL 60108.

Ages: 4 to 85+ years

Administration: Individual. 5 to 30 minutes per group. 20 minutes

Equipment: Pencil (not included)

Description: The Bender Visual-Motor Gestalt Test—Revised consists of eleven items:

1. Basic curve	Shows coordination and flexibility
2. Large curves	Arches, connections, in drawing
3. Middle curves	Proper direction and speed of arm movement
4. Basic curve and long curves	Flexibility of wrist and fine arm muscles
5. Basic line and long curve	Straight and curved lines and intersections
6. Basic curve and angles	Speed and ability in changing from curves to angles
7. Basic balance	Can draw accurately with eyes open and eyes closed
8. Movement, curves, and angles	Arm and shoulder gross motor control

3. Tool learning	Coordination of actions (e.g., pulling a string to get a toy)
4. Time concepts	Use of time concepts
5. Agility test	Ability to apply more body and tool skills

Administration and scoring. The test is standardized on children between the ages of 3 and 7 years. The tasks are presented in a fixed order and scored according to specific criteria. Norms are provided for each age group. Separate norms are provided for boys and girls. Norms are also provided for children with visual impairments. Raw scores are converted to standard scores (mean = 10, SD = 3) and percentiles. Separate norms are provided for each age group.

Comments. One of the most attractive features of this test is that it is directly related to curriculum. Data provide an evaluation of students' performance. The test is not a substitute for, but rather a supplement to, other tests.

12. Purdue Perceptual Test (1948, 1963)[11]

Author: Joseph P. Roach
Publication history:
Purdue Perceptual Test (1948)
Purdue Perceptual Motor Survey (1963)
Ages: 5 years through adult
Administration Time: 20 to 45 minutes
Components: Eight subtests that measure visual perception and motor skills
Purpose: To test of perceptual-motor skills and abilities

1. Right-left	Discriminate between right and left sides of body, body parts, right and left in relation to objects
2. Form copy	Copy geometric designs and pictures
3. Body image	Identify parts of body and their relationship to each other
4. Imagery	Draw from memory a picture of a person

Construction and standardization. The test has been revised twice since its original publication. The 1963 revised edition is the most widely used. Raw scores are converted to percentiles by age and grade. Reliability data are adequate. Validity data are limited and inconclusive. Although reliable, the test is difficult to score. Norms extend from 5 to 10 years. A number of other perceptual-motor tests are available. Children perform more poorly on tests of perceptual-motor skills than on tests of visual perception.

Comment. The test was originally designed for adults with brain damage. It has recently been used with children with learning disabilities.[12]