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of School Neuropsychological Assessment

Daniel C. Miller

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To my loving wife, Michie,
who for 20 years has been
my best friend and best
supporter.

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Foreword

The *Essentials of School Neuropsychological Assessment* by Daniel C. Miller is yet one more excellent addition to the Wiley *Essentials* series. Over the years, the *Essentials* series, designed and edited by Alan and Nadeen Kaufman, has provided a very valuable avenue for the dissemination of information across many specialties in psychology. Each book is a concise, well-written, up-to-date, and practical resource. These "little" books may be small in size, yet they consist of a synthesis of huge amounts of information. They are relatively little in cost yet they provide referenced materials that are used in everyday practice over and over again. It is hard not to own an *Essentials* book that does not look dog-eared and well worn!

From experience, I know that it is not easy to write these seemingly easy-to-read books. Parsimony is the rule of thumb during manuscript preparation, and the author(s) struggle with the synthesis of vast quantities of information sifted down into small tables, "Don't Forget" boxes, and streamlined chapters that give all the constituent parts of a subject while not losing the big picture. *Essentials* authors try to be fair and represent the subject matter objectively and with substantial evidence. They take great pains to give practical, evidence-based guidance that translates quickly into everyday practice. In this instance, I am delighted to say that Daniel C. Miller has managed to provide us with a typical *Essentials* book!

There is a movement afoot in school psychology to include neuropsychological assessment principles into everyday practice. This movement has not evolved as a reactionary force loudly proclaiming its right to be heard, but it has come quietly and more like a reflection of practitioners trying to keep up with the advances of modern science. The field of school psychology had to assemble quickly after the passage of the first laws that guaranteed children with special needs rights to a free appropriate public education. In the 1960s and 1970s, very little was known about brain-behavior relationships. Researchers struggled with very vague technology to document what was going on in the brain. In kind, school psychologists struggled with their duty to bring science down to the everyday level of the classroom. The gap between the laboratory and the classroom was wide indeed. As technology improved and researchers were able to observe the brain processing information with increasingly clearer media, so did the opportunities for applications of this information come clearer. Studies investigating dyslexia, Attention-Deficit/Hyperactivity Disorder, and autism (to name a few) gave us direct inroads into understanding the physical processes that underlined the behaviors that we were seeing in the classroom. In turn, remediative efforts are now starting to become based in concrete science. Work by eminent researchers such as Sally Shaywitz, Jack Fletcher, Peg Semrud-Clikeman, Erin Bigler, and many others show serious and powerful attempts to bring laboratory findings directly into clinical practice. Interventions that were previously based on theory and speculation are now becoming interventions based on concrete attempts to encourage neural plasticity and all of the benefits of strength models of remediation. Therefore the gap between science and practice is rapidly decreasing and school psychology practitioners must keep up if they wish to apply best practices.

How does the school psychologist keep up? What kind of information is needed in today's workplace? This quiet movement of applying neuropsychological information into school psychology practice is starting to crystallize. Leaders in the field are recognizing the need for training and school psychology training programs across the country are enhancing their programs to include courses on neuroanatomy, neuropsychological assessment, consultation, and competencies in medical liaison activities.

There is enough established activity and interest in school neuropsychology for some authors to suggest that the time for a specialty within school psychology has come. The issues surrounding credentialing and competencies for such a specialty are quite complex, but regardless of the outcome of such issues, *the fact that the ethical demand for school psychologists to be aware of and incorporate scientific information into everyday practice will remain*. Efforts to codify and express practice guidelines, such as those found in this book, are needed at this time to direct and assist school psychologists in navigating their way in the future. It is not possible to wait for all issues to be resolved before applying new knowledge: that day may never come. After all, as a child stands before us today, we are charged to bring everything that we have and know to help him or her meet the demands of everyday living in the real world. Not a clinical setting, not a hospital or rehabilitation center, but a real classroom where most of the children have few problems and can easily perform learning and social tasks that sometimes seem insurmountable to the children we serve.

Daniel C. Miller's *Essentials of School Neuropsychological Assessment* is an important book. It provides us with clear and concise guidance on how to bring neuropsychological information and research into our nonclinical settings. This guidance is not simple, it is complex and will require much effort on the part of the reader to assimilate and translate into everyday practice. Dr. Miller emphasizes the need for formal training, appropriate supervision, and ongoing education. He also infuses the text with an exceptional level of competency, enthusiasm, and excitement for the subject matter that is contagious and motivating. This will be a welcome addition to the school psychologist's library and is destined to become dog-eared and well worn!

Elaine Fletcher-Janzen, Ed.D., NCSP
San Angelo, Texas
Co-Editor, *The Handbook of School Neuropsychology*

SERIES PREFACE

In the *Essentials of Psychological Assessment* series, we have attempted to provide the reader with books that will deliver key practical information in the most efficient and accessible style. The series features instruments in a variety of domains, such as cognition, personality, education, and neuropsychology. For the experienced clinician, books in the series will offer a concise yet thorough way to master utilization of the continuously evolving supply of new and revised instruments, as well as a convenient method for keeping up to date on the tried-and-true measures. The novice will find here a prioritized assembly of all the information and-techniques that must be at one's fingertips to begin the complicated process of individual psychological diagnosis.

Wherever feasible, visual shortcuts to highlight key points are utilized alongside systematic, step-by-step guidelines. Chapters are focused and succinct. Topics are targeted for an easy understanding of the essentials of administration, scoring, interpretation, and clinical application. Theory and research are continually woven into the fabric of each book but always to enhance clinical inference, never to sidetrack or overwhelm. We have long been advocates of what has been called *intelligent testing*—the notion that a profile of test scores is meaningless unless it is brought to life by the clinical observations and astute detective work of knowledgeable examiners. Test profiles must be used to make a difference in the child's or adult's life, or why bother to test? We want this series to help our readers become the best intelligent testers they can be.

Essentials of School Neuropsychological Assessment provides clinicians with a practical guide on how to integrate neuropsychological assessment into educational practice. The author provides a useful review of the history of adult and pediatric clinical neuropsychology and paints a careful picture of the emerging specialization of school neuropsychology. The book features a list of professional organizations, training requirements, and professional resources such as books, journals, and web sites that are related to school neuropsychology. The author offers a conceptual framework that can be used to guide practitioners who are interested in conducting school neuropsychological assessments and to help them understand the neuropsychological correlates of common neurodevelopmental disorders. The conceptual school neuropsychological assessment model is described thoroughly and systematically with a chapter on each component (e.g., sensory-motor functions, executive functions). The author provides comprehensive case study that illustrates how the school neuropsychological model can be operationalized and the reader is provided with a step-by-step interpretative guide for making sense of divergent data. Finally, as an example, the school neuropsychological conceptual model is applied as a template to review the neuropsychological correlates to autism spectrum disorders. It is our belief that *Essentials of School Neuropsychological Assessment* will become a useful resource for all mental health care providers who work with children and who are interested in integrating neuropsychological principles into educational practice.

Alan S. Kaufman, PhD, and Nadeen L. Kaufman, EdD, Series Editors
Yale University School of Medicine

One

THE MOVEMENT OF APPLYING NEUROPSYCHOLOGICAL PRINCIPLES TO THE PRACTICE OF SCHOOL PSYCHOLOGY

RECOGNITION OF THE NEUROBIOLOGICAL BASES OF CHILDHOOD LEARNING AND BEHAVIORAL DISORDERS

The interest in the biological bases of human behavior is not new to the school psychology profession, but it is becoming more relevant to the current generation of school psychologists. Some of the more seasoned veterans, or psychology historians, would suggest that there has always been an interest in the biological bases of behaviors. In fact, the *nature versus nurture* debate is as old as the psychology profession itself. Some major theorists in our shared past, such as B. F. Skinner and John B. Watson, were strict behaviorists. They believed that observable behavior was the only essential element that needed to be considered in human behavior. The curriculum-based measurement/assessment approach touted by many practitioners today has its theoretical roots in behaviorism.

In the late 1950s, researchers came to realize that the behaviorist approaches could not "explain complex mental functions such as language and other perceptual functions" (Gazzaniga, Ivry, & Mangun, 2002, p. 21), and this still holds true today. On the opposite end of the theoretical spectrum were the cognitive psychologists, such as George Miller, Noam Chomsky, and Michael Posner, who believed that brain function needed to be considered in understanding human behaviors. Since the 1970s, cognitive psychologists have been tremendously aided by the development of neuroimaging techniques. Magnetic resonance imaging (MRI), positron emission tomography (PET), and functional MRI (fMRI) are all useful tools in validating or helping to refine theoretical models of cognition developed by cognitive psychologists.

DON'T FORGET

Many parents and educators are looking to school psychologists for answers as to why a student is not achieving at grade level or is behaving in socially inappropriate ways, rather than merely receiving a special education diagnosis.

CAUTION

A chief concern among school neuropsychologists is the increased emphasis in these federal laws and national reports on behavioral techniques at the apparent expense of the role that individual differences in cognitive processes play in the child's learning.

It is important to acknowledge that the integration of neuropsychological principles into educational practice got off to a rough start. Practitioners who predate the mid-1970s may remember the days of Doman and Delcato's perceptual-motor training for children with "minimal brain dysfunction" or tests such as the Illinois Test of Psycholinguistic Abilities. These approaches may have had good face validity, but they did not accurately show treatment efficacy for either perceptual-motor deficits or language deficits. These early missteps in integrating neuropsychological principles into educational practice only reinforced the rising role of behaviorism in school psychology (Hynd & Reynolds, 2005). Some contemporary and influential scholars still cite inadequate findings on the early process assessment approach in the 1970s as the basis for current legislative changes to the definition of a specific learning disability (Reschly, Hosp, & Schmied, 2003). Unfortunately, these influential scholars seem to have omitted an impressive body of empirical research over the past 30 years that supports a biological bases for the majority of childhood disorders.

After passage of P.L. 94-142 in the 1970s, researchers began to investigate the neurobiological bases of learning disabilities and behavioral disorders (Obrzut & Hynd, 1996). There is strong neurobiological evidence for attention deficit hyperactivity disorders (see Pliszka, 2003 for a review), reading disorders (see Feifer & DeFina, 2000; Hale & Fiorello, 2004 for reviews), written language disorders (see Feifer & DeFina, 2002; Hale & Fiorello, 2004 for reviews), mathematics disorders (see Fiefer & DeFina, 2005; Hale & Fiorello, 2004 for reviews), and pervasive developmental disorders (see Bauman & Kemper, 2005 for a review). School psychologists who want to translate this brain-behavior research into practice are increasingly interested in the applying neuropsychological principles into their professional practice.

Influences of Federal Education Laws and National Task Force Reports

Since 2000, there have been several key pieces of federal legislation and national task force reports that will influence the practice of school psychology and the emerging movement toward school neuropsychology for years to come. Rapid Reference 1.1 outlines those recent federal laws and task force reports.

Rapid Reference 1.1

Recent Federal Legislation and National Task Force Reports Influencing the Practice of School Neuropsychology

- No Child Left Behind (NCLB) Act of 2001.
- Rethinking Special Education for a New Century (Finn, Rotherham, & Hokanson, 2001). Report for the Thomas B. Fordham Foundation and the Progressive Policy Institute.
- Report of the President's Commission on Excellence in Special Education (2002).
- Minority students in special and gifted education (Donovan & Cross, 2002). Report for the National Research Council.
- Learning Disabilities Roundtable Report (2002).
- And miles to go . . . :State SLD requirements and authoritative recommendations. Report to the National Center for Learning Disabilities (Reschly, Hosp, & Schmied, 2003).
- Learning Disabilities Roundtable Report (2004).
- Individuals with Disabilities Education Improvement Act (IDEA) of 2004.

The *No Child Left Behind Act of 2001* (NCLB) and the *Individuals with Disabilities Education Improvement Act of 2004* (IDEA) were not designed to be mutually exclusive. Together, these laws envision a seamless system of supports in both general and special education based on evidence-based instruction (Kovaleski & Prasse, 2005). Both laws emphasize scientifically based instruction, curriculum, and interventions; early identification of learning problems (i.e., reading); ongoing monitoring of annual yearly progress (AYP); designing and implementing remedial and individualized interventions for those who do not respond to the general curriculum; and inclusion of students in a single, statewide accountability system (Kovaleski & Prasse, 2005). A chief concern among school psychologists is the increased emphasis in these federal laws and national reports on behavioral techniques at the apparent expense of the role that individual differences in cognitive processes play in the child's learning.

The No Child Left Behind Act (NCLB) of 2001 placed an emphasis on early intervention, particularly with reading problems, state-wide accountability requirements, and alternatives for parents to move their child from a failing school. The NCLB changes have had a profound impact upon public education. After the passage of NCLB in 2001, the focus shifted to what was, and was not, working in special education. The *Rethinking Special Education for a New Cen-*

tury (2001) report for the Thomas B. Fordham Foundation and the Progressive Policy Institute and the *Report of the President's Commission on Excellence in Special Education* (2002) focused clearly on the problems with the operationalization of the specific learning disabled (SLD) classification. The identified problems with SLD identification included:

- Too many students were being identified as SLD as compared to other disabilities.
- There was an overrepresentation of minorities identified as SLD (reiterated in the Overrepresentation of Minorities in Special Education Report by Donovan & Cross, 2002).
- The widespread use of the discrepancy model required a "wait-to-fail" approach, resulting in identification much too late in the educational process.
- Current identification methods were too costly and often identified the wrong students.

In 2002, the Office of Special Education Programs within the U.S. Department of Education sponsored a Learning Disabilities Roundtable discussion. Ten stakeholder organizations, including the National Association of School Psychologists (NASP), participated in this event and issued a final report entitled *Specific Learning Disabilities: Finding Common Ground* (Learning Disabilities Roundtable, 2002). There were several key portions in the consensus statements that are relevant to school neuropsychologists:

- The concept of Specific Learning Disabilities (SLD) is valid and supported by strong converging evidence.
- Specific learning disabilities are neurologically based and intrinsic to the individual (and the statutory definition of SLD should be maintained in IDEA reauthorization).
- Individuals with SLD show intra-individual differences in skills and abilities.
- The ability-achievement discrepancy formula should not be used for determining eligibility.
- Decisions regarding eligibility for special education services must draw from information collected from a comprehensive evaluation using multiple methods and sources in gathering relevant information.

The 2002 Learning Disabilities Roundtable consensus report was not without critics. In the 2003 report for the National Center for Learning Disabilities, *And miles to go . . . :State SLD requirements and authoritative recommendations,* Reschly and colleagues (2003) expressed a few concerns about the Roundtable report and provided some useful survey data about SLD identification practices across states. Reschly et al. (2003) expressed a concern that:

> The LD Roundtable participants did not recommend changes in the IDEA definition of SLD, although the National Joint Committee on Learning Disabilities (NJCLD) formulated an SLD definition in 1988 that did not mention psychological process disorders (Hammill, 1990). It is likely that this was not a mere oversight, but more likely a conscious effort to focus on the most pressing issues, elimination of the ability-achievement discrepancy and development of a reasonable set of alternative procedures. (p. 7)

Members of the Learning Disabilities Roundtable have reported to this author that when the Roundtable reconvenes, the definition of SLD will be a topic of discussion. Despite years of empirical evidence, which proves that learning disabilities are a result of neuropsychological deficits, some educational policy makers remain unconvinced.

The IDEA (2004) law and rules have provided states the option of not using a discrepancy-based formula for the identification of specific learning disabilities. As an alternative to the discrepancy-based formula identification method a response-to-intervention model is being suggested. The long-standing definition of SLD has remained in the IDEA law and regulations. The IDEA law requires the use of a variety of assessment tools and the use of any single measure or assessment as the sole criterion for determining SLD is *not permitted*. Finally, the IDEA law requires that assessments must not be discriminatory based on race or culture. The nonmandated use of the ability achievement discrepancies in the identification of SLD opens the door for practitioners to implement alternative methods of assessment and identification. In this book, the author will be advocating for a process assessment approach for evaluating children with neurocognitive processing disorders (e.g., ADHD, SLD, TBI).

Increased Number of Children with Medical Conditions that Affect School Performance

An increasing number of children in the schools are affected with known or suspected neurological conditions. Unfortunately, many of these children rarely have their educational needs addressed. Accurate developmental histories may not be available to reflect early developmental concerns, medical conditions, or genetic predispositions.

As an example, if you were to walk into a neonatal intensive care unit, you would find many infants who were born prematurely and with very low birth weight. Many of these infants are so small that you might hold them in the palm of your hand. These infants often spend the first several months of their lives attached to ventilators and a mass of other medical monitors. Researchers have been increasingly interested in the potential negative academic and behavioral consequences of these premature and low birth weight babies as they reach school age and beyond (see Dooley, 2005 for review).

When a school neuropsychologist reviews the cumulative record of a child referred for special education services, it is not uncommon to find a positive history of birth trauma or neonatal risk factors. While there has been no noticeable decrease in the number of low birth weight infants born annually, gradually advancement in quality neonatal intensive care has resulted in an increased survival rate. Whereas in the recent past, low birth weight and premature infants faced a high mortality rate, more of these at-risk infants are surviving. It is estimated that roughly 400,000 infants a year or 11.6 percent of all live births are premature (York & Devoe, 2002). Nathanielsz (1995) reported that although premature births may appear somewhat infrequent when compared to all live births, prematurity is still responsible for 75 percent of perinatal mortality. In addition to prematurity and low birth weight, Rapid Reference 1.2 lists several other major medical influences on school neuropsychology.

Despite this high perinatal mortality rate, there has been an improvement in the overall survival of low birth weight infants, most likely associated with advanced technology (Horbar & Lucey, 1995). Interestingly, the actual cause of preterm

Rapid Reference 1.2

Increased Medical Influences on School Neuropsychology

- More children are surviving birth traumas and other major medical illnesses with known correlates to later academic and behavioral concerns.
- Children and adolescents with traumatic brain injury present unique challenges to educators.
- There has been a tremendous increase in the number of children who are prescribed medications to control mood and behavioral disorders.
- There has been an increased number of research studies illuminating neuropsychological deficits associated with chronic illnesses such as asthma, diabetes, and heart disease.
- There has been an increased discovery of the limitations of clinical treatment for neurological disorders such as autism in school-based settings

birth remains somewhat elusive. While there are definite risk factors (e.g., cigarette smoking, first births, female sex, maternal low birth weight, fetal infections, metabolic and genetic disorders), there is essentially no known identifiable cause (Shiono & Behrman, 1995). A review of the literature reveals that low birth weight infants are at risk for neurosensory, cognitive/neuropsychological, behavioral, and academic difficulties (Dooley, 2005; Hack, Klein, & Taylor, 1995; Litt, Taylor, Klein, & Hack, 2005; Parker, 1998).

Modern medical advances have also had an impact on the lives of children with other medical conditions such as cancer, AIDS, demylenating diseases, traumatic brain injuries, and more rare medical diseases and conditions. Chronic illnesses affect approximately 20 percent of all children in the United States (Newacheck & Stoddard, 1994; Sexton & Madan-Swain, 1995). Kline, Silver, and Russell (2001) reported that within the population of chronically ill children, 30 to 40 percent have school-related problems. The majority of these children would qualify under the IDEA category of other health impaired. These health problems and their treatments can cause secondary academic and behavioral problems that could also lead to classification under other IDEA categories (e.g., specific learning disabilities, serious emotional disturbance).

In the early 1990s, a child with a head injury would move from an acute care hospital setting, where the physical and medical needs were met, to an intermediate rehabilitation setting for an extended period of time, where cognitive rehabilitation took place (Miller, 2004). Today it is typical for a child to forego any formal cognitive rehabilitation and return to school soon after being medically stabilized. During the past 10 to 15 years, managed health care has led to a reduction in cognitive rehabilitation services offered to children and youth with TBIs. In defense of the managed health care industry, the literature on the effectiveness of cognitive rehabilitation with children has been sparse (McCoy, Gelder, Van Horn, & Dean, 1997).

Despite the fact that TBI and OHI have been disability classifications for decades, school personnel are often ill-prepared to educate children with, or recovering from, severe and chronic illnesses, including TBI. Children and adolescents with TBI require specialized treatment and monitoring different from children within other special education classifications. Due to uneven spontaneous recovery of brain function and continued developmental changes, the clinical manifestation of TBI is constantly changing and requires frequent monitoring. Unlike some disabilities that only require 3-year reevaluations, children with TBI need frequent monitoring for changes in academic, behavioral, adaptive, and social-emotional functioning (McCoy et al., 1997). School neuropsychologists can play a major role in being the liaisons between the school and the medical community, developing transitional/reentry plans for school-aged children after injury or insult, assisting with IEP development and monitoring, and general case management.

Increased Use of Medications with School-Aged Children

There has been a dramatic increase in the number of school-aged children taking psychotropic medications. Patel (2005) examined the prevalence rates of antipsychotic use in children and adolescents from 1996 to 2001 across three Medicare states (Ohio, Texas, and California) and one private managed care organization. The prevalence of atypical antipsychotic use increased dramatically (Ohio Medicaid: 1.4 to 13.1 per 1,000; Texas Medicaid: 2.5 to 14.9; California Medi-Cal: 0.3 to 6.2; and, Managed Care Organization: 0.4 to 2.7). Disruptive behavioral disorders were most commonly associated with antipsychotic prescription.

Another disturbing trend with school-age children is the multiple types of medications prescribed without apparent regard for the potential drug interactions and adverse side effects. Zonfrillo, Penn, and Leonard (2005) reviewed the research studies published from 1994 to 2004 regarding the practice of prescribing multiple medications to treat mental conditions in children and adolescents. The results suggested that there was a marked increase in the use of multiple medications (or polypharmacy) with children, despite a lack of research in this area.

School neuropsychologists are not physicians, but they can provide information about how psychotropic medication used to treat common problems like depression, anxiety, attentional processing disorders, and so on can affect learning and behavior. There is a wealth of information available about medication interactions and potential side effects on the Internet. Questions concerning the interactions and long-term consequences of polypharmacy and the neuropsychological effects of medications are currently being researched.

Increase in the Number of Challenging Educational and Behavioral Issues in the Schools

School psychologists note that there appear to be more children today, than 10 to 20 years ago, who are exhibiting severe behavioral, social-emotional, and academic problems. There is evidence to support that consensus. In the Report of the Surgeon General's Conference on Children's Mental Health: A National Action Agenda (2000), it was reported that there are approximately 6 to 9 million U.S. children and adolescents with serious emotional disturbances, which accounts for 9 to 13 percent of all children. Unfortunately, many children with diagnosable mental disorders do not receive services. The Surgeon General's Report on Children's Mental Health: A National Action Agenda (2000) indicated that approximately 70 percent of children and adolescents who are in need of treatment do not receive services. Many of the serious emotional disturbances experienced by children such as depression, anxiety-related disorders, and ADHD have known or suspected neurological etiology. Therefore, many children with known or suspected neurological impairments who exhibit symptoms of mental health problems are not identified, or are identified and not receiving services.

Another major concern in educational practice is the inaccurate diagnoses and placements of children and adolescents with known or suspected neurological impairments. Neurologically impaired children are often mislabeled as Seriously Emotionally Disturbed or Specific Learning Disabled. These diagnoses and subsequent educational and behavioral interventions do not address underlying neuropsychological dysfunction. Misdiagnosis or misclassification can lead to serious consequences in a child's lifetime. Lewis, Pincus, Bard, Richardson, and colleagues (1988) evaluated 14 juveniles incarcerated in four U.S. states using comprehensive psychiatric, neurological, neuropsychological, and educational evaluations. The results were alarming. Nine of the 14 juveniles had symptoms consistent with major neurological impairment, 7 suffered from psychotic disorders that preceded incarceration, 7 showed symptoms of significant organic brain dysfunction on neuropsychological testing, and only 2 had Full Scale IQ scores above 90.

From a prevention and early intervention perspective, it seems to make sense that children with known or suspected neurological disorders must be educated appropriately. Too often, educators treat only the symptoms and not the underlying problems. Even though the classification of TBI has been in the IDEA law since 1990, many educators and school psychologists are ill equipped to deal with the special needs of this population.

In summary, school psychologists have been interested in applying neuropsychological principles since the early 1980s. Since then, there has been an explosion of research that provides support for the biological bases of learning and behavior. In the more recent past, there has been a resurgence of interest in school neuropsychology due to the convergence of several factors. First, federal legislation such as NCLB and the 2004 reauthorization of IDEA has caused school psychologists to critically evaluate their service delivery models. Old models, such as using the ability-achievement discrepancy model for the identification of SLD, have proven to be ineffective. There is a conceptual tug-of-war taking place as the school psychology profession struggles to come to terms with all of the

CAUTION

Access to clinical and pediatric neuropsychologists is often difficult or impossible in some portions of the country. At a minimum, school psychologists need to enhance their knowledge base about the biological bases of behavior.

systemic changes in education: on one side the strict behaviorists (the curriculum-based assessment advocates), who discount the value of individualized assessment of cognitive abilities, and on the other side the school psychologists and school neuropsychologists, who advocate for a more individualized process-based assessment to guide interventions.

School psychologists are also working with more children who have survived major medical insults and children who are taking more medications that affect learning and behavior. The effects of changing educational law, policies, and practices on the emerging specialization of school neuropsychology have been reviewed in this section of the chapter. In the next section, the reasons for neuropsychological assessment to be in included in the schools will be reviewed.

THE NEED FOR NEUROPSYCHOLOGICAL ASSESSMENT IN THE SCHOOLS

Access to Neuropsychological Services in the Schools

Access to neuropsychological services both inside and outside of the schools is often limited. Due to a supply and demand problem, even if a school district locates a neuropsychologist to evaluate a child, the evaluation may be costly and there may be a long wait time to have it completed. Access to neuropsychological services is even more difficult, if not impossible, in rural portions of the country where there are often no neuropsychologists.

In an ideal world, each school district would have access to a pediatric neuropsychologist who would write reports that were both informative and educationally relevant and who would consult regularly with educators and parents. Across the country, clinical neuropsychologists are more plentiful than pediatric neuropsychologists, but most clinical neuropsychologists are trained to work with adult populations, not school-aged children. A pediatric neuropsychologist would typically be found working in a hospital or rehabilitation setting with severely impaired children and generally would not have time for school-based assessments. Therefore, access to neuropsychological services from a clinical neuropsychologist for school-aged children is often difficult.

Limited Usefulness of Some Neuropsychological Reports

> **DON'T FORGET**
>
> The delivery of neuropsychological services in the schools is more than completing comprehensive assessments. Overseeing the implementation of the evidenced-based interventions is crucial.

Educators may have experienced sitting in an IEP meeting where a parent brings in a report from an outside neuropsychologist. Too frequently, neuropsychological reports from outside consultants are filled with diagnostic conclusions and much test data, but lack prescriptive recommendations that would be useful interventions in educational settings. Pelletier, Hiemenz, and Shapiro (2004) refer to this report as a "pin the tail on a lesion" type of report (p. 19). In these cases, the very expensive report that the parent brings to the school is frequently filed in the child's academic folder as educationally irrelevant and the experience becomes frustrating for all parties concerned.

Historically, neuropsychologists come from clinical psychology doctoral programs and have been trained in clinical psychopathology models of assessment and intervention for adults. These practitioners are often unfamiliar with educational laws such as IDEA, NCLB, and Section 504 of the Rehabilitation Act, or the organization and operations of schools in general. Fletcher-Janzen (2005) presented a chart showing a clear comparison of the differences between neuropsychologists that practice in the schools and neuropsychologists that practice in private agencies. School neuropsychologists have the advantage of working with children with whom they have a long educational history and multiple opportunities for assessment and intervention progress monitoring. Comparatively, pediatric neuropsychologists typically only see children outside of the school setting for a brief period of time (e.g., during a hospital stay) and are not able to observe the child in the natural school setting, nor follow-up on the effectiveness of their recommended interventions.

Also, clinical neuropsychologists may not understand that a clinical report with a *DSM* diagnosis does not always equate to a child's need for special education services. There is an obvious need for more cross training between school psychologists and clinical neuropsychologists (pediatric neuropsychologists included). In order to best help the child, clinical neuropsychologists must learn which diagnoses and educational interventions are useful to school districts. School psychologists with training in neuropsychology can play a role in consulting with clinical neuropsychologists to help determine services needed by the school districts.

Keeping in mind the limited access to neuropsychologists and the documented needs of children with known or suspected neurological conditions in the schools, we turn our attention to the approximately 35,000 school psychologists in the United States who have direct access to children. Miller (2004) pointed out that many of the new cognitive abilities tests and tests of memory and learning routinely used by school psychologists have strong theoretical foundations in neuropsychological theory. At a minimum, all school psychologists will have to improve their knowledge base about neuropsychological theories if they are going to appropriately interpret these new tests. The advantage of having a school psychologist trained in integrating neuropsychological principles into practice is that the end product of all services delivered by the school psychologist will be generally more pragmatic for the school and the child. However, as Miller (2004) pointed out, although a school neuropsychologist writes an insightful report and makes practical, evidence-based recommendations, there is no guarantee that the recommendations will be implemented. A major role of a neuropsychologist, whether an external consultant or an internal school psychologist with neuropsychology expertise, is to help teachers implement the educational recommendations using their consultation skills, instructional design knowledge, and program evaluation skills. An excellent neuropsychological evaluation filed away in the child's cumulative folder will benefit neither the school nor the child.

In summary, there is a documented need for neuropsychological services within the schools. However, finding a neuropsychologist with an understanding of developmental issues and the rules and regulations that guide educational practice is very difficult. Traditional reports written by clinical neuropsychologists are often not very useful in the schools. These reports tend to be too long and cumbersome, often describe the tests more than the child, and have recommendations not terribly relevant for most school-based learning environments. In addition, clinical neuropsychologists are not in a position to be held accountable for evidence of the success or failure of interventions. School psychologists, on the other hand, are directly responsible for outcomes and therefore are close at hand on a daily basis to see the interventions through to fruition. School psychologists are ideal candidates to broaden their competencies in neuropsychology to better serve educators, children, and their families.

DON'T FORGET

School psychologists are ideal candidates to broaden their competencies in neuropsychology because they are increasingly being held accountable for evidence of success or failure of interventions.

The integration of neuropsychological principles into the practice of school psychology and into the educational setting has its theoretical roots in clinical and pediatric neuropsychology. These historical influences on school neuropsychology along with the current trends in the field will be discussed in the next section.

HISTORICAL INFLUENCES OF CLINICAL AND PEDIATRIC NEUROPSYCHOLOGY

To understand and appreciate the emerging specialty of school neuropsychology, one must review the influences of adult clinical neuropsychology, pediatric neuropsychology, school psychology, and education in general (see Figure 1.1). Several authors (Hartlage, Asken, & Hornsby, 1987; Rourke, 1982) reviewed the history of adult clinical neuropsychology. Rourke (1982) labeled the first three historical stages of clinical neuropsychology as (1) the *single test approach stage,* (2) the *test battery/lesion specification stage,* and (3) the *functional profile stage.* This author has labeled current trends in neuropsychology as the *integrative and predictive stage.* These stages are reviewed in the next few sections of this chapter.

Single Test Approach Stage

Modern adult clinical neuropsychology has its origins in the mid-nineteenth century researchers (e.g., Broca, 1865, as cited in Von Bronin, 1960; Jackson, 1874, as cited in Taylor, 1932) who studied localization of brain functions. Despite the early emphasis on localization of brain functions, such as Broca's and Wernicke's areas, early adult clinical neuropsychology in the United States focused on global brain function and dysfunction.

The single test approach domi-

CAUTION

The single test approach did not differentiate brain injured from non-brain injured children with sufficient validity.

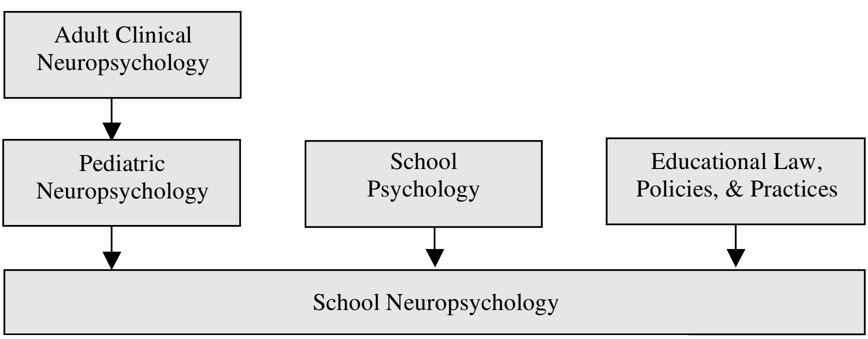


Figure 1.1 Historical influences on school neuropsychology

nated the practice of adult clinical neuropsychology during the 1900 to 1950s. One goal of practitioners during this period was to differentiate patients with brain damage from other groups using a single measure. Practitioners were taught to look for signs of overall "organicity" or brain dysfunction using single tests such as the Bender Visual-Motor Gestalt, Benton Visual Retention, or the Memory for Designs tests.

An analogy to the *single test approach* is the example of baking a cake. If your mother taught you how to bake a cake, she probably told you to stick a toothpick into the center of the cake to see if the cake was done. In other words, you generalized from a single sample to the rest of the cake. If the toothpick came out clean, then the rest of the cake was assumed to be done (see Figure 1.2). The "single sample" toothpick worked well in generalizing to the rest of the cake.

However, if we conceptualize the cake as being the construct of brain organicity (see Figure 1.2), a single test does not generalize well to the rest of the brain functions. For example, a child's poor performance on the Bender Visual-Motor Gestalt Test could be a result of multiple factors rather than an indicator of organicity. Poor performance on the Bender Gestalt could be a result of poor visual-motor coordination, motor awkwardness, poor visual-spatial skills, poor motivation, or poor fine motor coordination, and so on. In current school psychology practice, there are still some practitioners who refer to signs of "organicity" being observed in single samples of assessment; however, this approach has not differentiated brain-injured from nonbrain-injured children with sufficient validity (Rourke, 1982).

Test Battery/Lesion Specification Stage

As neuropsychological measurement increased in sophistication, clinicians and researchers determined that taking multiple samples of the same construct led to a better measurement of the construct of brain organicity or dysfunction. Therefore, in the "cake pan" analogy in which the cake is the construct of organicity,

Figure 1.2 Analogy of baking a cake

that construct would be better determined by taking samples from several locations measuring visual-spatial abilities, executive functions, attentional skills, memory and learning functions, and so on. Test batteries that measure a variety of neuropsychological constructs were developed to alleviate some of the concerns of using a single test to predict neuropsychological dysfunction.

In the 1940s, WWII played a major role in reshaping clinical neuropsychology. The war created a large number of soldiers who became patients with severe concussive and penetrating head injures (Hartlage et al., 1987). During this period, clinical psychology was also emerging as a profession, and a host of practitioners became available to evaluate patients with brain injuries. From the 1940s through the 1970s, several major neuropsychological test batteries were developed and widely used by clinicians. The principle role of the clinical neuropsychologist during this period was to administer neuropsychological batteries of tests to determine the source of possible brain dysfunction(s). The contributions of Ward Halstead, Ralph Reitan, Alexander Luria, Edith Kaplan, and colleagues will be reviewed in the next section.

Halstead-Reitan's Contributions to Clinical Neuropsychology

Ward Halstead was a prominent researcher and practitioner who published a monograph in 1947 that related the observations made on hundreds of patients with frontal lobe damage (see Halstead, 1952). Halstead's approach to assessment was largely atheoretical and designed to maximize the hit-rate in differentiating brain-injured patients from normal controls.

One of Halstead's students, Ralph Reitan, expanded the Halstead neuropsychological test battery and verified its use with lateralizing brain dysfunction (Reitan, 1955), lateralized motor deficits (Reed & Reitan, 1969), temporal lobe damage (Reitan, 1955), abstraction ability (Reitan, 1959), dysphasia (Reitan, 1960), and sensorimotor functions (Reitan, 1971). The *Halstead-Reitan Neuropsychological Test Battery* (HRNTB; Reitan, 1955; Reitan & Davidson, 1974; Reitan & Wolfson, 1993), as it became known, has been widely used in adult clinical neuropsychology practice.

The normative database for the adult version of the HRNTB has been updated in recent years (Heaton, Grant, & Matthews, 1991), which makes it still clinically useful with adults. While the Halstead-Reitan tests were assembled into a battery, the *single test approach stage* that dominated the early field is still somewhat evident. For example, on the Aphasia Screening Test, a Halstead-Reitan test, a child is labeled "dyslexic" if only one item is failed. As in the *single test approach stage,* this is a questionable practice because there are multiple explanations for poor performance on a particular item rather than ascribing a neuropsychological condition.

Alexander Luria's Contributions to Clinical Neuropsychology

Alexander Luria was a Russian neuropsychologist who spent over 40 years evaluating the psychological and behavioral effects of brain-injured adults. Although Luria and Halstead were contemporaries, they took a very different approach to understanding brain-behavior relationships. Whereas, Halstead (and subsequently Reitan) used a *quantitative* approach to differentiating brain-injured from controls, Luria heavily emphasized the *qualitative* observations of the error patterns of patients. He summarized his theoretical and clinical observations in two influential books, *Higher Cortical Functions in Man* (Luria, 1966) and *The Working Brain* (Luria, 1973).

Luria's original method relied on detailed clinical insight and informal hypothesis testing. American clinicians were suspect of Luria's approach because it did not have the standardization of procedures and established psychometric properties that they were growing accustomed to with other instruments. Anne-Lise Christensen, an apprentice of Luria, originally standardized some of Luria's stimulus materials in the 1960s. In the 1970s, an English version of the test was standardized by Charles Golden, a Nebraska neuropsychologist, along with Thomas Hammeke and Arnold Purish. Golden and his colleagues administered the original Luria items to hundreds of neurologically impaired and control adults. They then used discriminant function analyses to determine which test items differentiated the normal controls from the brain-injured patients. Their research produced the first version of the *Luria-Nebraska Neuropsychological Battery* (LNNB; Golden, Hammeke, & Purish, 1978), which was later revised in 1986 (Golden, 1986).

Kaplan and Colleague's Contributions to Clinical Neuropsychology

In the 1960s and 1970s, a group of clinicians and researchers (e.g., Norman Geschwind, Harold Goodglass, Nelson Butters, Heinz Warner; see Hebben & Milberg, 2002) in the Boston area investigated variations in cognitive processes across clinical populations, but did not use either the HRNTB or the LNNB. Instead, this group used a flexible test battery designed to answer the referral question. This approach was named the Boston Process Approach in 1986 (Milberg, Hebben, & Kaplan, 1996) and has been called the Boston Hypothesis Testing Approach (Teeter & Semrud-Clikeman, 1997). The basic tenet of this approach to neuropsychological assessment was the idea that how a person arrives at an answer on a test is as important as the test score itself. This emphasis on qualitative behaviors and hypothesis testing has some similarities to the original Lurian clinical method, but the Boston Process Approach uses standardized tests. The principle of "testing the limits" by asking individuals questions beyond the ceiling levels or modifying the questions is a hallmark of this approach. Edith Kaplan was one of the principle advocates for this approach to assessment. Many of the "process oriented" approaches originally advocated by these clinicians and researchers have become part of current assessment techniques.

DON'T FORGET

Luria's conceptualization of "functional systems" within the brain has served as the theoretical foundation for several current tests (e.g., *Cognitive Assessment System:* Naglieri & Das, 1997; *Kaufman Assessment Battery for Children–Second Edition:* Kaufman & Kaufman, 2004; *NEPSY:* Korkman, Kirk, & Kemp, 1998).

Adult Clinical Neuropsychology Practitioner's Philosophical Orientations

By the 1980s, surveys of clinical neuropsychologists reported that 28 percent of respondents preferred the Halstead-Reitan tests, 13 percent preferred the Luria-Nebraska tests, 15 percent preferred neither of the fixed batteries, and 44 percent of the respondents were not trained to use either of the fixed batteries (Guilmette, Faust, Hart, & Arkes, 1990). Guilmette et al. (1990) also reported that, while the Halstead-Reitan tests battery was the most popular, only 27 percent of the survey respondents used the complete battery in their assessments. Most clinical neuropsychologists in the 1980s used portions of fixed batteries in their practices but not the entire battery.

In the late 1980s and early 1990s, the adult clinical neuropsychology profession began endorsing the use of a flexible battery in assessment rather than a fixed battery. By the early 1990s, 60 percent of practitioners preferred the flexible battery approach to the fixed battery approach (Sweet, Moberg, & Westergaard, 1996). By the end of the 1990s, approximately 70 percent of practitioners preferred the flexible battery approach to the fixed battery approach (Sweet, Moberg, & Suchy, 2000).

Early Neuropsychological Test Batteries for Children

While adult clinical neuropsychologists were moving away from fixed batteries of assessment to more flexible batteries of assessment by the end of the 1990s, pediatric neuropsychologists had few assessment tools from which to choose.

CAUTION

If the Halstead-Reitan tests are going to be used in clinical practice today, make sure to use the consolidated norms at a minimum (see Baron, 2004). Even these norms remain problematic because they do not represent a true national standardization sample. A better practice for practitioners would be to use the Dean-Woodcock Sensory-Motor Battery (Dean & Woodcock, 2003b), which includes many of the original Halstead-Reitan tests but are based on a recently broad-based, restandardized population.

This section will review the history of pediatric neuropsychology and its influence on school neuropsychology.

First Neuropsychological Test Battery for Children

In the 1960s, pediatric neuropsychology emerged as a subspecialization within the broader field of clinical neuropsychology. Initially, many of the early neuropsychological test batteries developed for children were downward extensions of adult test batteries. Ernhart, Graham, and Eichman (1963) were credited as being the first researchers to apply a battery of tests to assess developmental outcomes in children with brain injuries. They found that brain-damaged children manifested deficits on multiple verbal and conceptual measures, as well as on multiple perceptual measures. They reported that no single measure yielded a satisfactory discrimination of brain-damaged children; whereas, the use of the whole battery did. This was consistent with the idea that multiple measures are better discriminators of brain function/dysfunction than a single sample of behavior.

Halstead-Reitan Tests for Children

In the 1970s, a downward extension of the adult HRNTB was developed for children in the 9- to 14-year-old range called the Halstead-Reitan Neuropsychological Test Battery for Older Children (HRNTB-OC; Reitan & Davidson, 1974; Reitan & Wolfson, 1992). A version of the test was also developed for children ages 5 to 8 called the Reitan-Indiana Neuropsychological Test Battery (RINTB; Reitan & Wolfson, 1985). Rapid Reference 1.3 presents the tests that are included in the HRNTB-OC and the RINTB. See Reitan and Wolfson (1992) for an expanded description of the HRNTB and RINTB tests and see Teeter and Semrud-Clikeman (1997) for an extensive review of the HRNTB and RINTB clinical research studies. Teeter and Semrud-Clikeman (1997) pointed out that the Halstead-Reitan tests for children must be used with caution. Concerns about the HRNTB and RINTB tests include: insufficient norms (Leckliter & Forster, 1994), covariance with intelligence, inability to distinguish psychiatric from neurological conditions in children, and the inability of the tests to localize dysfunction or predict recovery after a brain insult or injury.

Rapid Reference 1.3

Subtests from the Halstead-Reitan Neuropsychological Test Battery for Older Children (HRNTB-OC) and the Reitan-Indiana Neuropsychological Test Battery (RINTB)

HRNTB-OC Children Ages 9–14	RINTB Children Ages 5–8
Category Test	Category Test
Tactual performance test	Tactual performance test
Fingertip tapping test	Fingertip tapping test
Speech sounds perception test	
Seashore rhythm test	
Trail-making test, Parts A & B	Marching test
Strength of grip test	Strength of grip test
Sensory perceptual exam	Sensory perceptual exam
Tactile finger localization test	Tactile finger localization test
Fingertip number writing test	Fingertip symbol writing test
Tactile form localization test	Tactile form recognition test
Aphasia screening test	Aphasia screening test
	Color form test (opt.)
	Progressive figures test (opt.)
	Matching pictures test (opt.)
	Target Test (opt.)
	Matching figures and matching V's test (opt.)
	Drawing of start and concentric squares (opt.)

Several researchers have compiled HRNTB and RINTB normative data sets for children since their initial publications (see Baron, 2004 for consolidated norms for most of the Halstead-Reitan tests for children). Rather than using the original Halstead-Reitan tests for children based on a synthesized collection of normative data that may be up to 35 years old, it is recommended that practitioners evaluate the Dean-Woodcock Sensory-Motor Battery (DWSMB; Dean & Woodcock, 2003b). The DWSMB incorporated many of the Halstead-Reitan tests when it restandardized the tests using a broad-based national sample. The DWSMB is also conormed with the Woodcock-Johnson III Tests of Cognitive

Ability (Woodcock, McGrew, & Mather, 2001a). The Dean-Woodcock will be discussed in a later section of this book.

Luria-Nebraska Neuropsychological Battery: Children's Revision

After the Luria-Nebraska Neuropsychological Battery for adults was introduced in 1978, Golden and his colleagues started working on a revision. In 1986, the revised Luria-Nebraska Neuropsychological Battery for adults was published along with a separate Luria-Nebraska Neuropsychological Battery: Children's Revision (LNNB-CR; Golden, 1986).

The LNNB-CR was designed to evaluate a wide range of skills aimed at assessing the neuropsychological processes of children ages 8 through 12. Rapid Reference 1.4 presents the LNNB-CR scales and the cognitive processes each scale measures. Golden (1997) reported that he and his colleagues spent nearly a decade, from the mid-1980s to the mid-1990s, working on the LNNB-III that would integrate the children and adult versions, but the test has never been published. Therefore, practitioners who use the LNNB-CR must rely on standardization sample norms that come from samples collected in the 1980s. Please refer to Golden (1997) for an expanded description of the LNNB-CR tests, and see Teeter and Semrud-Clikeman (1997) for an extensive review of the LNNB-CR clinical research studies. Some studies found the LNNB-CR was useful in discriminating LD from non-LD children, but little research has been done on the effectiveness of the test in discriminating neurologically impaired children from nonclinical groups.

Rapid Reference 1.5 presents the advantages and disadvantages of using the Halstead-Reitan or the Luria-Nebraska tests for children. A major concern about both the Halstead-Reitan and the Luria-Nebraska tests for children was that conceptually both instruments were downward extensions of adult models. These early fixed batteries treated children as miniature adults and did not take into consideration the developmental variations of childhood.

In summary, the focus of the *test battery/lesion specification stage* was to develop multiple neuropsychological measures within a test battery that when viewed together were useful predictors of brain dysfunction. The fixed-battery approach by its definition was restrictive. The tests served as gross indicators of brain function or dysfunction but were not very useful in localization or in developing prescriptive interventions. The need to move beyond assessment only for the sake of diagnosis, to a model of assessment that linked to prescriptive interventions laid the foundation for the next stage in clinical neuropsychology, called the *functional profile stage*.

Rapid Reference 1.4

The Luria-Nebraska Neuropsychological Battery–Children's Revision Scales

Scale	Cognitive Functions Assessed
Clinical Scales	
• Motor	• Bilateral motor speed, coordination, imitation, construction
• Rhythm	• Auditory discrimination, sequencing, memory, attention
• Tactile	• Finger and arm localization, two-point discrimination, shape discrimination, movement detection, attention
• Visual	• Visual recognition, visual memory, visual-spatial abilities
• Receptive Speech	• Receptive language, problem solving, flexibility, sequencing
• Expressive Speech	• Reading, expressive speech, sentence repetition, memory, object naming, grammar
• Writing	• Spelling, copying, sequencing, memory, spontaneous writing
• Reading	• Sound synthesis, letter recognition, reading, writing
• Arithmetic	• Number recognition, number writing, simple and complex arithmetic operations
• Memory	• Short-term verbal and nonverbal memory, and paired-associate learning
• Intelligence	• General intelligence (comprehension, language, problem solving)
Clinical Summary Scales	
• Pathognomonic	• Consists of items drawn from 10 of the ability scales. "Best indicator of brain integrity." Highly sensitive to presence of brain dysfunction or overall impairment.
• Left Hemisphere	• Measures integrity of left-hemisphere sensorimotor strip (sensory and motor functions).
• Right Hemisphere	• Measures integrity of right-hemisphere sensorimotor strip (sensory and motor functions).

Rapid Reference 1.5

Advantages and Disadvantages of the HRNTB-OC/RINTB and the LNNB-CR

Halstead-Reitan Tests	Luria-Nebraska Tests
Advantages	
• Empirically designed battery	• Empirically designed battery
• Well researched	• Strong theoretical basis
• Reliability and comparability across different clinical groups	• Relatively brief administration time and inexpensive
• Ability to be administered by a technician	• Rich qualitative component of the test
Disadvantages	
• Largely a downward extension of an adult model to children	• Largely a downward extension of an adult model to children
• Theoretically weak	• Not as well researched as the Halstead-Reitan tests
• Long administration times which requires a moderate amount of training	• Too much overlap with measures of achievement
• Costly set of materials	• Not a true reflection of the Lurian method
• Only one sample of behavior	• Not as popular as the Halstead-Reitan tests
• Samples of behavior not consistent with current theories	• Samples of behavior not consistent with current theories
• No contemporarily collected, broad-based normative data[a]	• No contemporarily collected, broad-based normative data

[a] Many of the Halstead-Reitan tests have been restandardized and included in the *Dean-Woodcock Sensory-Motor Battery* (Dean & Woodcock, 2003b).

Functional Profile Stage

Rourke (1982) referred to the first two stages in the history of clinical neuropsychology (*single test approach* and the *test battery/lesion specification*) as *static* stages. Starting in the late 1970s, three major factors influenced the evolution of neuropsychology: (1) pediatric neuropsychologists started to question the downward extension of adult models applied to children, (2) neuropsychologists in general started to question the validity of neuropsychological test batteries to localize brain lesions, and (3) noninvasive neurodiagnostic methods (e.g., CAT, MRI, PET scans) began to replace neuropsychological tests for making inferences regarding brain lesions. With the evolution of neuroimaging techniques, neuropsychologists no longer used test batteries to determine localization of the sites of possible brain dysfunction. CAT and MRI scans provide detailed views of the structure of the brain, while early PET scans provided both structural and functional information about the brain. During this period, neuropsychologists shifted the focus of their reports away from brain localization issues to identifying a functional profile of an individual's strengths and weaknesses. The neuropsychologist's goal became to differentiate between spared and impaired abilities.

> **DON'T FORGET**
>
> With recent changes to federal education laws, school psychologists are uniquely poised to put the practice of "psychology" back into the practice of school psychology, more specifically integrating the principles of cognitive psychology and neuropsychology.

Rourke (1982) referred to this *functional profile stage* as the *cognitive stage*. Rourke's implication was that the *functional profile stage* put the principles of cognitive psychology back into the practice of neuropsychology. Rather than administer a fixed battery of tests and indicate the presence or absence of a suspected lesion, the neuropsychologists of the 1980s and beyond were asked to comprehensively assess the cognitive processes of the individual.

One cannot help but draw a parallel between the shift from the *fixed battery / brain localization stage* to the *functional profile stage* in clinical neuropsychology and the current state of school-psychology specific learning disabilities identification practices. Rapid Reference 1.6 highlights these similarities. During the

Rapid Reference 1.6

Parallels Between the Shift in Neuropsychology from a Fixed-Battery Stage to a Functional Profile Stage and Present Day School Psychology Practice

Neuropsychology	School psychology
• "Repsychologizing" of the field through emphasis on cognitive strengths and weaknesses.	• De-emphasis on SLD discrepancy formulas and reemphasis on processing deficits.
• Few new tests in the 1980s that addressed the reconceptualization.	• Many new assessment measures and intervention techniques designed to address processing deficits.

fixed battery stage, the assessment tools themselves made clinical neuropsychologists become more like technicians rather than clinicians. The test results were clear-cut, indicating either the presence or the absence of brain dysfunction. Many aspects of school psychology practice between the 1980s and today have relied too heavily on using fixed methods (e.g., discrepancy formulas) to indicate the presence or absence of specific learning disabilities. When the field of neuropsychology made the shift to valuing a more functional assessment of the individual's strengths and weaknesses and linking that information to prescriptive interventions, neuropsychologists were at a disadvantage because there were no new testing instruments that addressed this reconceptualization.

School psychology is in a much more favorable position since the 1990s, as there has been a steady increase in assessment tools designed to address functional strengths and weaknesses and make prescriptive linkages. School psychologists are on the cusp of putting the practice of "psychology" back into the practice of school psychology, or more specifically of integrating the principles of cognitive psychology and neuropsychology.

So the *functional profile stage* of neuropsychology reemphasized the "repsychologizing" of neuropsychology by emphasizing the psychological aspects of neurological insults and anomalies and identifying the functional strengths and weaknesses of individuals. Although this stage of development represented a shift in the goals of neuropsychological assessment, there were no dramatic changes or innovations in the types of tests and measures being used. The "state of the art" of clinical neuropsychological assessments during this period was still the three major approaches: the Halstead-Reitan, the Lurian perspective, and the Boston Process Approach.

For the sake of continuity, let's return to the analogy of the cake pan. If we continue to use the analogy that the cake represents the construct of organicity or overall brain function, neuropsychologists in the *functional profile stage* would continue to advocate for taking multiple samples (or tests) of behavior. However, the emphasis would shift from prediction of "organicity" to an analysis of the relationships between the performances on the behavioral samples (i.e., did the "cake" samples show differences among the sampled sites?).

Integrative and Predictive Stage

The *integrative and predictive stage* is a term used by this author to describe the period of the early 1990s to present time. During this period, many multidisciplinary changes have influenced school neuropsychology. Many of these changes are related to advances in how the brain influences learning and behavior. The rapid explosion of research related to brain-behavior relationships resulted in the U.S. Congress declaring the 1990s as the "Decade of the Brain."

School neuropsychologists are ultimately interested in how to assess neurocognitive functions reliably and validly. Accurate assessment is essential for accurate diagnoses and strengthening prescriptive interventions. The multidisciplinary advances since the 1990s that have influenced the practice of school psychology and the specialty of school neuropsychology include: development of tests specifically designed for children, advancement of neuroimaging techniques, theoretical advancement, influences of a cross-battery approach, influences of a process-assessment approach, and the professional focus on ecological validity and linking assessment data with evidence-based interventions.

Development of Tests Specifically Designed for School-Aged Children

Prior to the *integrative stage,* if a researcher wanted to develop a new test that measured visual short-term memory as an example, the courses of action were clear. The researcher would develop a set of items, administer them to a broad-based sample, validate the psychometric properties of the test, and then publish the test. A common method for establishing the validity of that new test would have been to correlate it with an existing test that reported to measure the same construct. If the two tests correlated, the researcher indicated that the new test was a valid measure of the construct being tested. Today, the test developer is faced with a new set of challenges. A new test must still adhere to psychometric rigor, but it is also important for the test to fit within a theoretical frame of reference, report both quantitative and qualitative samples of behavior, be ecologically valid, and have some linkages to evidence-based interventions. This push for integration of all of these attributes is also an important feature of the *integrative and predictive stage.*

One of the hallmark features of the *integrative and predictive stage* is that neuropsychological tests developed for children in this period are not downward extensions of adult models. The newer neuropsychological batteries for children and stand-alone tests of neuropsychological processes (reviewed in Chapters 4–12) are specifically designed for and standardized on children. The *Test of Memory and Learning* (TOMAL; Reynolds & Bigler, 1994) was one of the first examples of a neuropsychological test designed specifically for school-aged children. Test authors in the 1990s provided school neuropsychologists with a rich array of assessment tools that were developed for school-aged children. Some of these newer tests will be discussed in the next major section of the book.

Influences of Brain Imaging Studies on Learning and Behavior

The TOMAL was also one of the first measures that used CT scans to validate some of its construct validity. Increasingly, neuroimaging techniques such as functional MRI scans (fMRI) are being used to validate neuropsychological instruments that report to measure certain cognitive processes. In addition, functional imaging techniques are opening the "windows of the mind" to allow us to peek into the brains of children while they are performing basic cognitive functions. In a more recent and exciting application, researchers such as Shaywitz (2003) have started to use functional imaging techniques to evaluate the effects of specific reading interventions. Neuropsychological test development and validation of the future will include neuroimaging studies.

Expansion of Theoretical Frames of Reference

From the early 1900s through the mid-1980s, the theoretical frames of reference for classifying human cognitive abilities were limited to one (verbal) or two factor (verbal and visual-spatial) solutions. The theoretical models of intelligence increased dramatically just prior to the start of the *integrative stage* of neuropsychology in the 1990s. See Flanagan and Harrison (2005) for a comprehensive review of the contemporary theories of intelligence, including: Carroll's Three-Stratum Theory of Cognitive Abilities, Gardner's Theory of Multiple Intelligences, the Cattell-Horn Fluid-Crystallized (*Gf-Gc*) theory, and the Luria-Das Model of Information Processing.

The current state-of-the-art practice of school psychology and school neuropsychology demands that assessment of cognitive abilities have a strong theoretical foundation. The strong theoretical foundation also facilitates the interpretation of the test data within a theoretical frame of reference. For example, the advanced and integrated Cattell-Horn-Carroll theory served as the theoretical foundation for the Woodcock-Johnson Third Edition Tests of Cognitive Abilities (Woodcock, McGrew, & Mather, 2001a), while the Luria-Das Model of Information Processing served as the theoretical model of the Cognitive Assessment System (Naglieri & Das, 1997) and the Kaufman Assessment Battery for Children–Second Edition (Kaufman, & Kaufman, 2004).

DON'T FORGET

Current state-of-the-art practice demands that assessments have a theoretical foundation to aid in test interpretation.

Influences of the Cross-Battery Approach

An outgrowth of the advances in our theoretical conceptualization of cognitive abilities is the cross-battery approach. In constructing a school-based neuropsychological assessment to answer a particular referral question, a school neuropsychologist may need to draw subtests from multiple test batteries. This is essentially a cross-battery approach. At the foundation of the cross-battery approach, (Carroll, 1983, 1993) and Horn (1988, 1994) conducted several factor-analytical studies across multiple measures of intelligence, which yielded a taxonomy of broad cognitive abilities. Woodcock (1990) was one of the first to suggest that pulling measures from one or more intellectual test batteries during a single assessment would provide a broader measure of cognitive abilities. The cross-battery approach was expanded as a means of bridging a gap between modern theories of the structure of intelligence and current practice of assessing those cognitive abilities (see Flanagan & McGrew, 1997; Flanagan & Ortiz, 2001).

Influences of the Process Assessment Approach

One of the legacies of the Boston Process Approach has been the inclusion of qualitative aspects of a child's performance within new tests. Practitioners and researchers have recognized the importance of both the quantitative and qualitative aspects of a child's performance. The emphasis on the qualitative behaviors is part of a broader *process assessment approach.* The process assessment approach assists school neuropsychologists in determining the strategies a child uses to solve a particular task. Test authors and their publishers have excelled in recent years in establishing base rates for common qualitative behaviors. For example, a test with such data included in the standardization will allow a practitioner to make statements such as "Asking for repetitions 10 times on the verbally presented material occurred with such frequency in only 3 to 10 percent of other 5 year olds in the standardization sample." The qualitative information can provide useful clues to interventions. See Rapid Reference 1.7 for a list of assessment instruments that have included qualitative components.

Emphasis on Ecologically Valid Assessment

As practitioners, we have attempted to administer standardized assessments to children in school closets or on gymnasium stages only to later question if those test results will mirror the child's actual level of abilities or achievement. This is an issue of ecological and predictive validity, which has been discussed in the literature

Rapid Reference 1.7

Tests with an Increased Emphasis on the Qualitative Aspects of Performance

- Luria-Nebraska Neuropsychological Battery–Children's Revision (Golden, 1986)
- Cognitive Assessment System (Naglieri & Das, 1997)
- NEPSY (Korkman, Kirk, & Kemp, 1998)
- Wechsler Intelligence Scale for Children–Third Edition as a Process Instrument (Kaplan, Fein, Kramer, Delis, & Morris, 1999)
- Wechsler Intelligence Scale for Children Fourth Edition Integrated (Wechsler, 2004a)

in recent years (Chaytor & Schmitter-Edgecombe, 2003; Sbordone, 1996). Improving the ecological validity of our assessment approaches was one of the goals of the Futures in School Psychology Conference in 2002 (Harrison et al., 2004).

In the *integrative and predictive stage* of neuropsychology, there has been, and is, an increased emphasis on relating assessment findings to an individual's everyday functioning. Sbordone (1996) defines ecological validity as "the functional and predictive relationship between the patient's performance on a set of neuropsychological tests and the patient's behavior in a variety of real-world settings" (p. 310). As in the functional stage of neuropsychology, the emphasis on assessment today is more on the prescriptive recommendations rather than the diagnostic conclusions within a report. In recent years, greater emphasis has been placed on the fields of clinical neuropsychology, school psychology, and the emerging specialty area of school neuropsychology to demonstrate predictive validity of assessment techniques. Parents and educators want to know how well the child will perform in the future based on current assessment data. This is especially true of using current assessment data to predict performance on high-stakes competency-based accountability testing for NCLB compliance. If we must continue to use high-stakes assessment, there will always be a percentage of the students who fail to reach the cut-off scores. School neuropsychologists can provide valuable assessment services to children who are failing competency-based tests by linking the assessment results to individualized remedial interventions.

Mandate to Link Assessment Results with Evidence-Based Interventions

In the grand scheme of things, the field of school psychology is relatively young. Within the past 100 years, the field has become better at developing and validating theoretical constructs and approaches to assessment. However, the field is lagging in the area of empirically validated interventions. School psychologists have many "cookbook" resources that provide recommendations based on common academic or behavioral problems. Review of the literature shows there is little solid evidence for many of the recommendations that are consistently made by practitioners. As a result of the recent legislative changes, there is an added emphasis in education on identifying methods that work.

Having stated the need for evidence-based interventions, where does the field proceed? Questions need to be answered, such as "What constitutes an evidenced-based intervention?" Kratochwill and Shernoff (2004) suggested that an intervention could be considered *evidence-based* if its application to practice was clearly specified and if it demonstrated efficacy when implemented into practice. Several joint task forces across professional organizations have been working on establishing guidelines for evidence-based practice research. This line of research is crucial to the credibility of school psychology and the school neuropsychology specialty. Gone are the days of assessing a child only for an educational classification. Clearly lawmakers, educators, teachers, and parents are demanding assessment that guides intervention.

There are challenges to conducting evidence-based research in the schools. Obtaining permission to conduct applied research in the schools has become increasingly difficult because administrators, teachers, and parents are concerned with "time on task" and maximizing the classroom time spent on preparing for high-stakes, competency-based exams. Evidence-based research may have the best chance of getting into the schools if the results can be shown to help improve test performance on statewide competency exams.

Let's return to the cake pan analogy one last time. If we consider the cake pan analogous to the concept of "organicity" or brain function/dysfunction, neuropsychologists in the current *integrative and predictive stage* would continue to advocate for taking multiple samples of behavior (i.e., multiple toothpick probes into the cake). However, in the past stages, all of the samples of behavior were based on behavioral test samples; that is what we would actually see on the toothpick after it is stuck in the cake. Today in clinical practice and research there is a cross-disciplinary approach to understanding brain functioning with integrated functional imaging techniques, advancements in test development, and inclusion of qualitative analyses of test performance. These multiple samples of any construct such as "organicity" must also strive to be ecologically valid and have good predictive validity; that is, we have to take the temperature of the cake probe (i.e., the toothpick) and analyze the contents adhering to the toothpick using technology and other tests that provide qualitative, chemical, physiological, and functional information. Future researchers will continue to advance

Rapid Reference 1.8

Historical Stages of Neuropsychological Assessment

Stage	Focus of Stage
• Single test approach (1900–1950)	• Emphasized using a single test (e.g., Bender Visual-Motor Gestalt) to predict brain dysfunction.
• Test battery/ lesion specification (1940–1980s)	• Emphasized using a battery of tests to predict brain dysfunction.
• Functional profile (1970–2000)	• Deemphasized localization of brain "lesions" and emphasized the identification of impaired and spared abilities.
• Integrative and predictive (1990–present)	• Current view of neuropsychology with an emphasis on cross-battery, multidimensional, and ecologically valid assessments.

the knowledge base in all disciplines such as education, psychology (including neuropsychology), school psychology, functional neuroanatomy, biochemistry, electrophysiology, genetics, and so on. The knowledge gleaned from these fields will reshape the ways in which we practice.

Summary of the Historical Influences of Clinical and Pediatric Neuropsychology on the School Neuropsychology Specialty

Rapid Reference 1.8 presents a review of the historical stages in clinical and pediatric neuropsychology and the major focus of each stage. The influences of clinical neuropsychology and pediatric neuropsychology on the emerging specialty of school neuropsychology have been reviewed. The next section will shift the focus to the history of school neuropsychology.

HOW DOES THE INTEGRATION OF NEUROPSYCHOLOGICAL PRINCIPLES FIT WITHIN THE BROADER FIELD OF SCHOOL PSYCHOLOGY?

The following questions are posed to the reader:

- *Is the integration of neuropsychological principles into the practice of school psychology an expansion of basic neuropsychological training received at the specialist level?*

- *Is school neuropsychology a specialty within the broader field of school psychology?*
- *Is school neuropsychology an emerging and unique specialization, separate from but related to school psychology and pediatric neuropsychology?*

These three questions represent different levels of classification of school neuropsychology based on current practice. The *first question* suggests that school neuropsychology may be a focused area of interest for some school psychology practitioners. Many practitioners attend, as often as they can, continuing education workshops that relate to neuropsychological topics. There is a tremendous interest in any topic related to school neuropsychology at each annual National Association of School Psychologists (NASP) and American Psychological Association (APA) conventions and annual state affiliate association conferences. This level of practice would be considered a baseline entry into school neuropsychology and only implies *interest* in the school neuropsychology field, not *competency* in school neuropsychology.

The *second question* suggests that school neuropsychology is a specialty area within the broader field of school psychology. Currently, NASP does not recognize specialties within the field of school psychology. Hynd and Reynolds (2005) emphatically stated in the recently published *Handbook of School Neuropsychology* that: "the time for development of specializations in school psychology has come" (p. 12). This author endorses that sentiment as well, recognizing that there is still controversy in the school psychology profession over this subject (see Pelletier et al., 2004).

The body of specialized school psychology knowledge has grown exponentially in recent years. We truly live in the information age. The training requirements for entry-level school psychology practitioners have increased dramatically since the early 1990s. Trainers of school psychologists do their best to train entry-level and advanced practitioners in a variety of roles and functions including: data-based problem solving, assessment, consultation, counseling, crisis intervention, and research. Most school psychology curriculums at the specialist level have a class that covers the biological bases of behavior; but there is no in-depth exposure to neuropsychology. School psychology trainers often feel that they only have enough time to introduce specialist-level students to the broad array of roles and functions available to them as practitioners. Increased specializations in areas such as school neuropsychology must occur either through organized, competency-

DON'T FORGET

School neuropsychology is quickly becoming a specialty within school psychology even though it has not been formally recognized by the school psychology professional organizations.

based post-graduate certification programs or through doctoral school psychology programs that offer specialization in school neuropsychology.

Many graduates of school psychology graduate programs (specialist or doctoral levels) report that they quickly choose an area of specialization once they graduate. Some graduates become "specialists" in autism assessment and interventions, others are "specialists" in early childhood assessment, adolescent psychopathology, curriculum-based measurement consultants, and so on. The point is that the field of school psychology has become so rich in knowledge that practitioners often seek a specialization. These specializations already taking place within our field are a result of both individual interest and the need for more in-depth knowledge and training in narrower areas of knowledge and practice.

Currently, the movement of integrating neuropsychological principles into school psychology practice is naturally evolving into a specialty within the broader field of school psychology. The question that arises with the specialization topic is: What constitutes specialization? Taking one course on how to administer a popular neuropsychological battery certainly does not constitute specialization; however, specializing in school neuropsychology does require minimal levels of training in identified competencies.

The *third statement* suggests that school neuropsychology is an emerging and unique specialization, separate from but related to school psychology and pediatric neuropsychology. This may be the long-range status of school neuropsychology, but school neuropsychology is probably best viewed as an area of interest for practicing school psychologists or, at best, as an emerging subspecialty area within the broader field of school psychology.

DEFINITION OF SCHOOL NEUROPSYCHOLOGY

In 2004, Miller [this author] along with two colleagues, DeFina (school/pediatric neuropsychologist) and Lang (pediatric neuropsychologist), wrote the following definition of school neuropsychology for a series of training workshops:

> School neuropsychology requires the integration of neuropsychological and educational principles to the assessment and intervention processes with infants, children, and adolescents to facilitate learning and behavior within the school and family systems. School neuropsychologists also play an important role in curriculum development, classroom design, and the integration of differentiated instruction that is based on brain-behavior principles in order to provide an optimal learning environment for every child.

In order to discuss some of the associated implications, this definition will be broken down into smaller components.

"*School neuropsychology requires the integration of neuropsychological and educational principles . . .*" The blend between educational and neuropsychological foundations is an essential knowledge base for school neuropsychologists.

"*. . . to the assessment and intervention processes with infants, children, and adolescents . . .*" School neuropsychology is not limited to assessment and diagnosis. Linking assessment with evidenced-based interventions is an important focus for school psychologists and school neuropsychologists. Also, school neuropsychologists are trained to work with infants and school-aged children.

"*. . . to facilitate learning and behavior within the school and family systems.*" School neuropsychologists are trained to work with children and adolescents within the context of their school and home environments. Learning and behavioral problems do not stop at the end of the school day. Family involvement is crucial in affecting positive behavioral and academic change in a child.

"*. . . School neuropsychologists also play an important role in curriculum development, classroom design, and the integration of differentiated instruction that is based on brain-behavior principles in order to provide an optimal learning environment for every child.*" School psychologists and school neuropsychologists are trained as consultants to the learning environment, linking instructional design, curriculum development, and differential assessment to research-based interventions. School neuropsychologists are uniquely trained to apply brain-based research principles to enhance the educational environment.

ROLES AND FUNCTIONS OF A SCHOOL NEUROPSYCHOLOGIST

George Hynd (1981) is credited as being the first school psychologist to advocate for doctoral school psychologists to be trained in clinical neuropsychology. Hynd suggested that a doctoral-level school psychologist with training in neuropsychology:

- interprets the results of neuropsychological assessment and develops strategies of intervention
- presents recommendations for remediation based on knowledge of scientifically validated interventions

- consults with curriculum specialists in designing approaches to instruction that more adequately reflect what is known about neuropsychological development
- acts as an organizational liaison with the medical community, coordinating and evaluating medically based interventions
- conducts in-service workshops for educational personnel, parents, and others on the neuropsychological basis of development and learning
- conducts both the basic and applied educational research investigating the efficacy of neuropsychologically based interventions and consultation in the schools

More recently, Crespi and Cooke (2003) posed that training in neuropsychology can:

- Facilitate teacher and parent education/consultation;
- Assist in developing neuropsychologically-informed special education decisions;
- Enhance referral use for neuropsychological services;
- Increase the ability to comprehend articles that have relied on neuropsychological concepts and methods in attempts to understand the etiology and behavioral or educational consequences of childhood developmental disorders;
- Protect against more simplistic and inaccurate habits (i.e., specific localization of brain functions or dysfunctions based on performance on a single psychological measure);
- Serve as a bridge between clinically-based neuropsychologists and school-based psychologists in providing an interpretative explanation of specific results and recommendations, and;
- Provide a theoretical framework that appreciates the value of multidimensional batteries and the inherent complexities and difficulties of making inferences about brain integrity (pp. 98–99).

Rapid Reference 1.9 summarizes the various roles and functions of a school neuropsychologist.

DON'T FORGET

The roles and functions for school neuropsychologists suggested by Hynd in 1981 are still relevant today.

HISTORY OF THE SPECIALTY OF SCHOOL NEUROPSYCHOLOGY

The history of school neuropsychology is still emerging as a specialty

Rapid Reference 1.9

Roles and Functions of a School Neuropsychologist

- Provide neuropsychological assessment and interpretation services to schools for children with known or suspected neurological conditions.
- Assist in the interpretation of neuropsychological findings from outside consultants or medical records.
- Seek to integrate current brain research into educational practice.
- Provide educational interventions that have a basis in the neuropsychological or educational literature.
- Act as a liaison between the school and the medical community for transitional planning for TBI and other health-impaired children and adolescents.
- Consult with curriculum specialists in designing approaches to instruction that more adequately reflect what is known about brain-behavior relationships.
- Conduct in-service training for educators and parents about the neuropsychological factors that relate to common childhood disorders.
- Engage in evidenced-based research to test for the efficacy of neuropsychologically based interventions.

area. Rapid Reference 1.10 presents some of the highlights of the history of school neuropsychology.

The 1960s

As previously mentioned in the history of clinical neuropsychology, Ernhart, Graham, and Eichman published the first neuropsychological test battery for children in 1963.

The 1970s

The Halstead-Reitan Neuropsychological Test Battery for Older Children was published in 1974.

The 1980s

George Hynd (1981) was first to refer to neuropsychology as a specialty area in doctoral school psychology. A clinical and pediatric neuropsychology literature review places Hynd's first mention of this potential specialty within the *test*

Rapid Reference 1.10

Historical Events in School Neuropsychology

1963	Ernhart and Graham published the first neuropsychological test battery for children.
1974	Halstead-Reitan Neuropsychological Test Battery for Older Children test published.
1981	Neuropsychology as a specialty area in school psychology first appeared in publication in the *Journal of School Psychology*.
1981	*Neuropsychological Assessment of the School-Aged Child: Issues and Procedures* (Hynd & Obrzut, 1981) book published.
1983	*Child Neuropsychology: An Introduction to Theory, Research, and Clinical Practice* (Rourke, Bakker, Fisk, & Strang, 1983) book published.
1986	Luria-Nebraska Neuropsychological Battery: Children's Revision test published.
1986	*Child Neuropsychology: Volume 1–Theory and Research* (Obrzut & Hynd, 1986a) book published.
1986	*Child Neuropsychology: Volume 2–Clinical Practice* (Obrzut & Hynd, 1986b) book published.
1986	*Neuropsychological Assessment and Intervention with Children and Adolescents* (Hartlage & Telzrow, 1986) book published.
1988	*Pediatric Neuropsychology* (Hynd & Willis, 1988) book published.
1988	*Fundamentals of Clinical Child Neuropsychology* (Novick & Arnold, 1988) book published.
1988	*Assessment Issues in Clinical Neuropsychology* (Tramontana & Hooper, 1988) book published.
Late 1980s	Neuropsychology Special Interest Group formed in the National Association of School Psychologists.
1989	First edition of the *Handbook of Clinical Child Neuropsychology* (Reynolds & Fletcher-Janzen, 1989) book published.
1990	IDEA reauthorized and traumatic brain injury was included as a disability.
1990's	Several tests of memory and learning specifically designed for school-aged children were published (e.g., Wide Range Assessment of Memory and Learning: WRAML [Sheslow & Adams, 1990; 2003]; Test of Memory and Learning: TOMAL [Reynolds & Bigler, 1994]; and Children's Memory Scale: CMS [Cohen, 1997a]).
1992	*Advances in Child Neuropsychology–Volume 1* (Tramontana & Hooper, 1992) book published.
1995	*Child Neuropsychology* journal published first issue.
1996	*Pediatric Neuropsychology: Interfacing Assessment and Treatment for Rehabilitation* (Batchelor & Dean, 1996) book published.

1996	*Neuropsychological Foundations of Learning Disabilities: A Handbook of Issues, Methods, and Practice* (Obrzut & Hynd, 1996) book published.
1997	*Child Neuropsychology: Assessment and Interventions for Neurodevelopmental disorders* (Teeter & Semrud-Clikeman, 1997) book published.
1997	Second Edition of the *Handbook of Clinical Child Neuropsychology* (Reynolds & Fletcher-Janzen, 1997) book published.
1997	NEPSY test published (Korkman, Kirk, & Kemp, 1998).
1999	American Board of School Psychologists established.
2000	*Pediatric Neuropsychology: Research, Theory, and Practice* (Yeates, Ris, & Taylor, 2000) book published.
2000	*The Neuropsychology of Reading Disorders: Diagnosis and Intervention* (Feifer & DeFina, 2000) book published.
2002	*The Neuropsychology of Written Language Disorders: Diagnosis and Intervention* (Feifer & DeFina, 2002) book published.
2002	*Brain Literacy for Educators and Psychologists* (Berninger & Richards, 2002) published.
2003	*Overcoming Dyslexia: A New and Complete Science-Based Program for Reading Problems at Any Level* (Shaywitz, 2003) book published.
2004	*Neuropsychological Evaluation of the Child* (Baron, 2004) book published.
2004	*School Neuropsychology: A Practitioner's Handbook* (Hale & Fiorello, 2004) book published.
2004	The annual theme for the year and the NASP convention was "Mind Matters: All Children Can Learn."
2004	*Brainstorming: Using Neuropsychology in the Schools* (Jiron, 2004) resource book published
2005	*The Neuropsychology of Mathematics: Diagnosis and Intervention* (Feifer & DeFina, 2005) book published.
2005	*School Neuropsychology Handbook* (D'Amato, Fletcher-Janzen, & Reynolds, 2005) book published.
2005	IDEA reauthorized—discrepancy formula-based methods of identifying specific learning disabilities deemphasized—opens door to a more process assessment approach in identifying all children with special needs.
2006	First national conference for school neuropsychologists held in Dallas, Texas.

battery/lesion specification stage shortly after the publication of the Halstead-Reitan Neuropsychological Test Battery for Older Children.

The first textbook for practitioners was called the *Neuropsychological Assessment of the School-Aged Child: Issues and Procedures* (Hynd & Obrzut, 1981). In the 1981 book, Marion Selz, an early researcher of the Halstead-Reitan tests for children, wrote a chapter on the test battery. Charles Golden also wrote a chapter on the early development of the Luria-Nebraska Neuropsychological Battery–Children's Revision that was later published in 1986.

Several school neuropsychology textbooks published in the mid-to-late 1980s were used for a number of years in many graduate neuropsychology classes (Hartlage & Telzrow, 1986; Novick & Arnold, 1988; Obrzut & Hynd, 1986a, 1986b; Reynolds & Fletcher-Janzen, 1989; Rourke et al., 1983; Tramontana & Hooper, 1988). In the late 1980s, neuropsychology had gained such a following within the school psychology community that a special interest group was formed within NASP.

The 1990s

The federal *IDEA* legislation was reauthorized in 1990 and included traumatic brain injury as a handicapping condition for the first time. The 1990s were the decade that test authors and test publishers provided school neuropsychology practitioners with a set of new assessment tools specifically designed for the assessment of memory and learning in school-aged children (e.g., WRAML, TOMAL, CMS), or for complete cognitive or neuropsychological test batteries (e.g., CAS, NEPSY, WISC-III PI).

In the 1990s and through the year 2000, several books were published by school psychologists related to school neuropsychology (see Obrzut & Hynd, 1996; Reynolds & Fletcher-Janzen, 1997; Teeter & Semrud-Clikeman, 1997), and several books were published related to pediatric neuropsychology (see Batchelor & Dean, 1996; Tramontana & Hooper, 1992; Yeates, Ris, & Taylor, 2000).

In 1995, the *Child Neuropsychology* journal published its first issue. This journal, still published, has become an important outlet for research related to school neuropsychology and pediatric neuropsychology.

In 1999, the American Board of School Neuropsychology (ABSNP) was established. The ABSNP started issuing Diplomate certificates in school neuropsychology based on peer-review case studies and objective written examinations.

The 2000s

In 2000, 2002, and 2005, Steven Feifer and Philip DeFina, two school neuropsychologists, published three informative books: *The Neuropsychology of Reading Disorders: Diagnosis and Intervention, The Neuropsychology of Written Language Disor-*

ders: Diagnosis and Intervention, and *The Neuropsychology of Mathematics: Diagnosis and Intervention,* respectively.

In 2002, Virginia Berninger, a trainer of school psychologists, and Todd Richards, a neuroscientist, wrote a book designed to bridge the gap between brain-behavior research and education called *Brain Literacy for Educators and Psychologists.*

In 2003, Sally Shaywitz, a physician, published an influential book called *Overcoming Dyslexia.* She was the keynote speaker at the 2004 NASP Convention in Dallas, Texas.

In 2004, three school-neuropsychology books were published: Ida Sue Baron, a clinical neuropsychologist, wrote *Neuropsychological Evaluation of the Child;* two school psychologists, James B. Hale and Catherine A. Fiorello, wrote *School Neuropsychology: A Practitioner's Handbook;* and Colleen Jiron, a school psychologist and pediatric neuropsychologist, wrote *Brainstorming: Using Neuropsychology in the Schools.*

In 2005, Rick D'Amato, Elaine Fletcher-Janzen, and Cecil Reynolds served as editors for the first publication of the *School Neuropsychology Handbook.*

In 2006, the first national school neuropsychology conference was held in Dallas, Texas.

In summary, the understanding and respect for the biological bases of behavior has been a part of psychology since it's inception. The increased interest in applying neuropsychological principles into the practice of school psychology and educational settings has been a direct result of many factors including:

- the growth in pediatric/child neuropsychological research,
- advances in neuropsychological theories applied to assessment,
- advances in functional and structural brain imaging techniques,
- limitations of clinical applications in school settings,
- increased use of medications by children and youth and their potential side effects on cognitive processing, and
- advances in understanding the neurocognitive effects of traumatic brain injury, common neurodevelopmental disorders, and chronic illness.

There will be continued interest in school neuropsychology because school psychologists work with children who have known or suspected neurodevelopmental disorders every day. With the increased emphasis on implementing and monitoring the effectiveness of evidence-based interventions, school psychologists are under pressure to provide the best assessment-intervention linkage as quickly as possible. School psychologists and educators need to know the documented neuropsychological correlates to common neurodevelopmental disorders in order to prescribe and monitor the most effective interventions. The past two decades, in particular, have been an exciting time for school psychologists interested in learning more about neuropsychology and how to apply that knowledge base to helping children, educators, and their families. School psychologists have more assessment tools today that are psychometrically sound and theoretically based than ever before. The challenge for all of education, school psychology as a discipline, and school neuropsychology as an emerging specialization, is to increase our research that validates the linkage with assessment data to prescriptive interventions that have been shown to be the most effective.

The interest in school neuropsychology is strong but the emerging specialty area still needs to crystallize entry-level training standards. In Chapter 2, training and credentialing issues for school neuropsychology will be discussed, along with a proposed set of training standards, a model program of study, and resources for school neuropsychologists (e.g., books, journals, web sites).

TEST YOURSELF

1. Using the Bender Visual-Motor Gestalt test to predict overall brain dysfunction would be an example of what stage in the history of clinical neuropsychology?

(a) the integrative and predictive stage
(b) the functional profile stage
(c) the single test approach stage
(d) the test battery/lesion specification stage

2. According to the author, what is the principal reason why the Halstead-Reitan tests for children and the Luria-Nebraska Neuropsychological Battery–Children's Revision are not suitable for current clinical use?

(a) Neither test has been shown to differentiate brain-injured from normal controls.
(b) Neither test has contemporarily collected broad-based normative data.
(c) Neither test has a strong theoretical basis.
(d) Neither test is empirically designed.

3. George Hynd was the first person to refer to neuropsychology as a specialty area in doctoral school psychology. True or False?

4. **Luria's conceptualization of "functional systems" within the brain has served as the theoretical foundation for several current tests including all of the following except one, which one?**
   (a) Cognitive Assessment System (Naglieri & Das, 1997)
   (b) Kaufman Assessment Battery the Children–Second Edition (Kaufman & Kaufman, 2004)
   (c) NEPSY (Korkman, Kirk, & Kemp, 1998).
   (d) Test of Memory and Learning (Reynolds & Bigler, 1994)
5. **Current state-of-the-art practice demands that assessments have a theoretical foundation to aid in test interpretation.** True or False?
6. **What stage in the history of clinical neuropsychology deemphasized localization of brain "lesions" and emphasized the identification of impaired and spared abilities?**
   (a) the integrative and predictive stage
   (b) the functional profile stage
   (c) the single test approach stage
   (d) the test battery/lesion specification stage
7. **All of the following could be a typical role of a school neuropsychologist except one; which one?**
   (a) Seek to integrate current brain research into educational practice.
   (b) Administer CBM measures exclusively without regard to individual differences.
   (c) Provide educational interventions that have a basis in the neuropsychological or educational literature.
   (d) Act as a liaison between the school and the medical community for transitional planning for TBI and other health-impaired children and adolescents.

Answers: 1. c; 2. b; 3. true; 4. d; 5. true; 6. b; 7. b

Two

TRAINING AND CREDENTIALING TO APPLY NEUROPSYCHOLOGICAL PRINCIPLES INTO PRACTICE

In Chapter 1, the multiple reasons for the past and current interest in school neuropsychology were presented. This chapter will focus on the following topics: training and credentialing models, a proposed model curriculum to train school neuropsychologists, and a list of resources (e.g., books, journals, web sites) for the practitioner interested in school neuropsychology.

TRAINING AND CREDENTIALING STANDARDS

What Constitutes Competency?

In larger school districts with multiple school psychologists, the practitioners often, by choice or demand, "specialize" into niches of interest and expertise. For example, one or more school psychologists are identified as experts in diverse areas such as autism spectrum disorders, early childhood assessment/interventions, or neuropsychological assessment/interventions. The question that arises is: What constitutes competency within a specialty area? Competency is often defined by training standards that are set by professional organizations.

When school psychologists are trained to understand, appreciate, and utilize neuropsychological principles in their practice, there is a misconception that they are only trained to administer and interpret neuropsychological test batteries. In fact, not all referrals for special education would benefit from a complete neuropsychological assessment. Neuropsychological assessments are time consuming and not viable for many practitioners with heavy caseloads (Pelletier, Hiemenz, & Shapiro, 2004).

> **DON'T FORGET**
>
> Not all referrals for comprehensive assessments need a full neuropsychological evaluation.

After school psychologists receive advanced training in neuropsychology, they often report that their perceptions of children are unequivocally changed. The practice of school neuropsychology is largely a qualitative understanding of brain-behavior relationships and how those relationships are manifested in behavior and learning. A competent school neuropsychologist with a solid understanding of brain-behavior relationships can recognize neuropsychological conditions based on observing the child in the normal course of daily activities. A competent school neuropsychologist could conduct a neuropsychological examination of a child using a set of Legos™. Neuropsychological tests are tools, but knowing how to use those tests does not make a practitioner a school neuropsychologist. A school neuropsychologist is not someone who went to a workshop and knows how to administer the latest and greatest neuropsychological test battery. A school neuropsychologist knows how to interpret any data from a neuropsychological perspective, whether from an educational, psychological, or neuropsychological report, and correlate it with behavior in order to recommend educationally relevant interventions.

Competency is often loosely defined in many professions, particularly as it relates to post-graduate CEU training. For example, in school psychology when a new version of a cognitive abilities test becomes available, a practitioner goes to a 3-hour workshop on how to administer and interpret that new instrument. Does that make the practitioner competent to use that new test? The answer should be no. Competency must involve supervised practice and feedback on performance during the acquisition of a new skill. A better approach would be to have the basic 3-hour training; send the practitioner off to a daily job to practice the new test; and then return at a later date for small group supervision to review competencies gained in administering and interpreting the new test. If the practitioner demonstrated evidence of mastery of the new test, then that new test could be confidently integrated into practice. If the practitioner could not demonstrate mastery of the new test, additional time for supervised practice should be mandated. This model of competency-based workshop combined with supervised training should be used more often in the ever-changing and often technically and theoretically complex field of school psychology.

Crespi and Cooke (2003) posed several questions related to a specialization in neuropsychology that have sparked a debate in the profession (see Lange, 2005; Pelletier et al., 2004). One of the questions posed by Crespi and Cooke (2003) was "What constitutes appropriate education

DON'T FORGET

Learning to administer a new neuropsychological test battery does not mean that one can practice as a school neuropsychologist. The school neuropsychology specialty area must involve post-graduate supervised, competency-based training.

and training for the school psychologist interested in practicing as a neuropsychologist?" (p. 97). The terms *psychologist* and *neuropsychologist* are protected terms in many states by Psychology Licensing Acts. In most states, if a practitioner wants to be called a psychologist, he or she most probably will be required to have a doctorate in psychology and be licensed as a psychology. Licensure as a psychologist in most states is generic. In other words, a doctoral psychologist trained in the specialties of clinical, school, neuropsychology, or industrial/organization psychology is uniformly licensed as a psychologist. The title *neuropsychologist* is usually not regulated by state licensing acts; but rather is regulated by the level of attained professional experience and training. Unfortunately, there are too many practitioners who claim expertise in neuropsychology when they have had only minimal training in the area (Shordone & Saul, 2000).

The American Psychological Association (APA) has consistently taken the position that a doctorate is the entry level of training for clinical neuropsychology, including the subspecialization of pediatric neuropsychology. In 1987, a joint task force representing the International Neuropsychological Society (INS) and APA's Division 40 (Clinical Neuropsychology) published the first formal guidelines for the education, training, and credentialing of clinical neuropsychologists (Report of the INS-Division 40 Task Force on Education, Accreditation, and Credentialing, 1987). These standards were most recently updated in 1997 by an interorganizational group of neuropsychologists at a conference held in Houston, Texas. The consensus report of the "Houston Conference" reiterated the doctorate as the entry level of training for clinical neuropsychology.

The APA's Division 40 and the National Academy of Neuropsychologists (NAN) have adopted similar guidelines for the definition of a clinical neuropsychologist (see Division 40, 1989; Weinstein, 2001). Both organizations state that a clinical neuropsychologist is a doctoral-level service provider of diagnostic and intervention services who has demonstrated competencies in the following:

- successful completion of systematic didactic and experiential training in neuropsychology and neuroscience at a regionally accredited university
- 2 or more years of appropriate supervised training applying neuropsychological services in a clinical setting
- licensing and certification to provide psychological services to the public by the laws of the state or province in which he or she practices
- review by one's peers as a test of these competencies

In order to be prepared as a clinical neuropsychologist, most training takes place within Ph.D. or Psy.D. clinical psychology programs. Most clinical neuropsychology training programs have an adult focus, with few programs offering a pediatric track. There are several Doctoral School Psychology programs that offer a specialization in school neuropsychology (e.g., Texas Woman's University, Texas A&M, University of Texas, Ball State University, University of Northern Colorado).

Specialty Certification in Adult and Pediatric Clinical Neuropsychology

At the doctoral level of clinical neuropsychology, there are three specialty boards that certify clinical or pediatric neuropsychologists: the American Board of Clinical Neuropsychology (ABCN), the American Board of Professional Neuropsychology (ABPN), and the American Board of Pediatric Neuropsychology (ABPdN). Each of these boards requires a doctoral degree from a regionally accredited university, current licensure as a psychologist, at least 3 years of supervised experience in neuropsychology, and rigorous review of work samples. Of the three boards, only the ABPN does not require an objective written exam, but all three boards require an oral exam.

Hebben & Milberg (2002) stated that "technically, one could argue that the only professionals who can call themselves clinical neuropsychologists are those with one or more of the these qualifications: a doctoral degree in clinical neuropsychology, licensure as a clinical neuropsychologist, or board certified in clinical neuropsychology" (p. 35). It is clear from the definitions as set forth by APA, INS, NAN, and the doctoral specialty boards that a clinical neuropsychologist is defined as a doctoral-level psychologist with specific training, supervised experience, and demonstrated competency in neuropsychology.

Specialty Certification in School Neuropsychology

So where does the practice of school neuropsychology fit, or does it fit at all? The American Board of School Neuropsychology (ABSNP) was incorporated in 1999 in response to the need for setting some standards of practice for those school psychologists who claim competency in school neuropsychology. The purpose of the ABSNP is to promote the active involvement of school psychologists in training and application of neuropsychological principles to the individuals they serve. The ABSNP does require that applicants for the Diplomate in School Neuropsychology be certified or licensed school psychologists, or licensed psychologists with specialization in school neuropsychology, or ABPP Diplomates in School Psychology with additional specialized training in school neuropsychology. See Rapid Reference 2.1 for a comparison of the requirements of the specialty boards in adult and pediatric neuropsychology and school neuropsychology.

Rapid Reference 2.1

Requirements for Specialty Certification Boards in Neuropsychology and School Neuropsychology

Requirement	ABCN	ABPN	ABPdN	ABSNP
Completed Doctorate in Psychology	Yes	Yes	Yes	Yes[g]
Completed Specialist-Level Training (60+ hrs.) in School Psychology	n/a	n/a	n/a	Yes
Completion of an APA, CPA[a], or APPIC[b] listed internship	Yes	Yes	Yes	n/a
Completion of a 1,200-hour internship with at least 600 hours in the schools	n/a	n/a	n/a	Yes
Licensed as a psychologist	Yes	Yes	Yes	n/a
State Certified or Licensed as a School Psychologist or an NCSP[c]	n/a	n/a	n/a	Yes
3 years of experience[d]	Yes	Yes	Yes	Yes
2 years postdoctoral residency[e]	Yes	No	No	n/a
Minimum 500 hrs. each of the past 5 yrs. providing neuropsychological services	No	Yes	No	No
Documentation in APA approved ongoing CEU workshops	No	Yes	No	Yes
Objective written exam	Yes	No	Yes	Yes
Work samples peer reviewed	Yes	Yes	Yes	Yes
Oral exam	Yes	Yes	Yes	Yes
Number of board certified individuals[f]	562	197	40	197

[a] CPA stands for the Canadian Psychological Association.

[b] APPIC stands for the Association of Psychology Postdoctoral and Internship Centers.

[c] NCSP stands for Nationally Certified School Psychologist.

[d] The ABCN board will accept 3 years of experience, including 1 year predoctoral, for candidates who received their doctorate between 1/1/90 and 1/1/05.

[e] The ABCN board requires that candidates who received their doctorate after 1/1/05 must document a 2-year postdoctoral residency (a requirement consistent with the Houston Conference Training Standards).

[f] As of 10/25/06.

[g] A doctorate in psychology (school or clinical) with a specialization in neuropsychology is recognized but not required. An ABPP Diplomate in School Psychology is also recognized.

When a potential candidate for specialty certification is considering with which board to apply, the following factors should be considered:

- *Does the Diplomate credential applied for reflect the practitioner's past and current training and professional experiences?* For example, a clinical psychologist trained in neuropsychology would most probably apply for the ABCN or ABPN Diplomate; whereas, a school psychologist with expertise in applying neuropsychological principles to the school setting would probably consider the ABSNP Diplomate, or recertify in clinical psychology and pursue the ABCN or ABPN.
- *Does the Diplomate credential applied for reflect the clinical populations with which the practitioner typically works?* An adult clinical neuropsychologist may have a difficult time getting board certified as a pediatric neuropsychologist or a school neuropsychologist. The potential applicant to a Diplomate board should read the entrance requirements carefully and talk to other practitioners who have recently completed the credentialing process and ask for advice.
- *What are the implications, if any, for practice within a particular state after the receipt of a Diplomate credential?* Generally, the Diplomate credential is an endorsement of a professional's expertise in the area of neuropsychology and not necessarily a license to practice in that area of expertise. An applicant for a Diplomate in neuropsychology must be aware of current licensing laws within the state(s) of practice.

PROPOSED PROFESSIONAL GUIDELINES TO TRAIN SCHOOL NEUROPSYCHOLOGISTS

Currently, there are no professional standards or guidelines for the practice of school neuropsychology. NASP has a set of practice standards (Standards for Training and Field Placement Standards in Psychology, 2002); but as previously mentioned, NASP does not endorse specialties within the field of school psychology. A proposed set of professional guidelines to train school neuropsychologists is presented in the next section (see Rapid Reference 2.2). If the training guidelines presented by Shapiro and Ziegler (1997) for pediatric neuropsychologists are compared to the training guidelines presented by this author, there are some noticeable differences. The author would argue that training guidelines for pediatric neuropsychologists and school neuropsychologists may have some conceptual overlap, but the guidelines should be inherently different. The training guidelines for the pediatric neuropsychologists emphasize more

Rapid Reference 2.2

Proposed Training Guidelines for School Neuropsychologists

A school neuropsychologist must first have a clear professional identity as a school psychologist. The school neuropsychologist:

- must be trained at the specialist or doctoral-level (preferred) in school psychology from a regionally accredited university.
- must have completed a minimum 1,200-hour internship of which 600 hours must be in the school setting.
- must be state credentialed (certified or licensed) as a school psychologist or equivalent title, or be certified as a Nationally Certified School Psychologist (NCSP), or hold a Diplomate in School Psychology from the American Board of Professional Psychology (ABPP).
- should have a minimum of 3 years of experience working as a school psychologist before seeking to add the school neuropsychology specialization.

In addition, to the entry-level credentials as previously outlined, the school neuropsychologist must have a documented knowledge base and competencies in the following areas:

- functional neuroanatomy
- history of clinical neuropsychology, pediatric neuropsychology, and school neuropsychology
- major theoretical approaches to understanding cognitive processing and brain behavior relationships related to learning and behavior

In addition to the entry-level credentials as previously outlined, the school neuropsychologist must have a documented knowledge base and competencies in the following areas:

- professional issues in school neuropsychology
- neuropsychological disorder nomenclature
- conceptual model for school neuropsychology assessment
- specific theories of, assessment of, and interventions with:
  —sensory-motor functions
  —attention functions
  —visual-spatial functions
  —language functions
  —memory and learning functions
  —executive functions
  —cognitive efficient, cognitive fluency, and processing speed functions
  —general cognitive abilities

- genetic and neurodevelopmental disorders
- childhood and adolescent clinical syndromes and related neuropsychological deficits
- neuropsychopharmacology
- neuropsychological intervention techniques
- professional ethics and professional competencies (i.e., report writing skills, history taking, record review)
- competency-based supervised experiences (minimum of 500 hours)
- continuing education requirements (minimum of 6 CEU hours per year)

medical aspects of neuropsychology such as neurophysiology, neurochemistry, basic knowledge of imaging techniques, and cognitive and medical rehabilitation in hospital settings. The school neuropsychology training guidelines, as presented in the next section, emphasize the theories, assessment, and interventions with the various neurodevelopmental processing systems (e.g., attention, memory, executive functions) within the context of an educational environment.

The entry-level skills and competencies of a school neuropsychologist should first meet the specialist-level training standards as set forth by NASP (Standards for Training and Field Placement Standards in Psychology, 2000). Therefore, it is assumed that a school psychologist trained to become a school neuropsychologist would already have a base knowledge of psychological and educational principles gained as part of his or her specialist or doctoral level of training (e.g., child psychopathology, diagnosis/intervention, special education law, professional ethics). Specialization in school neuropsychology at the doctoral level is the preferred model of training; however some specialist-level school psychologists will seek out formal training in this area as well.

These proposed guidelines for the training of school neuropsychologists are expanded in more detail in Rapid Reference 2.2.

Functional Neuroanatomy

School neuropsychologists must have a knowledge base of functional neuroanatomy. In the school setting it is more important for the school neuropsychologist to know functional neuroanatomy than structural neuroanatomy.

DON'T FORGET

Specialization in school neuropsychology at the doctoral level is preferred. The school psychologist at the specialist level must investigate the *limitations* of practice with national, state, and local credentialing agencies before deciding upon the type of training program and board certification.

History of Clinical Neuropsychology, Pediatric Neuropsychology, and School Neuropsychology

In order to appreciate the current state of professional practice in the field, it is important for school neuropsychologists to review and appreciate the contributions of other related fields to the emerging school neuropsychology specialty.

Major Theoretical Approaches to Understanding Cognitive Processing and Brain Behavior Relationships Related to Learning and Behavior

Many of the theoretical foundations of the newest cognitive abilities tests are based on neuropsychological theories (e.g., Lurian theory, process assessment approach). School neuropsychologists need to understand the major theoretical approaches related to the field.

Professional Issues in School Neuropsychology

School neuropsychologists need to be aware of professional issues within the field (e.g., the debate over the use of the title school neuropsychologist, current practice trends).

Neuropsychological Disorder Nomenclature

School neuropsychologists are frequently called upon to *translate* medical records or previous outside neuropsychological reports to educators and parents. It is crucial that school neuropsychologists know and can appropriately use the neuropsychological nomenclature (e.g., knowing the meaning of unilateral neglect).

Conceptual Model for School Neuropsychological Assessment

School neuropsychologists must be taught a conceptual model to use in their neuropsychological assessments and interventions. A proposed model will be presented and illustrated in later chapters of this book.

Specific Theories of, Assessment of, and Interventions with:

- sensory-motor functions
- attention functions
- visual-spatial functions

- language functions
- memory and learning functions
- executive functions
- cognitive efficiency, cognitive fluency, and processing speed
- general cognitive abilities
- academic achievement
- social-emotional functions

School neuropsychologists need to know the specific theoretical models that apply to the processes and functions listed previously and their relationship to manifestations in learning problems and in making differential diagnosis with the data. They also need to be proficient in the best assessment instruments designed to measure these individual constructs. The school neuropsychologist needs to know which empirically validated interventions can be linked with the assessment data to maximize the educational opportunities for students and demonstrate the efficacy of the interventions used to address the learning problems.

Genetic and Neurodevelopmental Disorders

School neuropsychologists need to understand the low-incidence genetic and neurodevelopmental disorders found in some children. They need to be able to recognize characteristics associated with genetic and neurodevelopmental disorders in children and the related neuropsychological correlates. Often, children identified with a low-incidence disorder will require supplemental medical services, and the school neuropsychologist along with the school nurse may be the first to recognize the characteristic symptoms.

Childhood and Adolescent Clinical Syndromes and Related Neuropsychological Deficits

School neuropsychologists must be familiar with the research related to the known or suspected neuropsychological correlates of common childhood disorders (e.g., ADHD, Tourette, pervasive developmental disorders) and empirically validated interventions in a school setting.

Neuropsychopharmacology

As reported in Chapter 1, children and adolescents are increasingly being administered medications. School neuropsychologists need to understand the mechanism of drug actions on brain neurochemistry. They also need to know the medications used to treat common childhood disorders and the potential side effects in order to consult effectively with medical personnel, health personnel, parents, and educators.

Neuropsychological Intervention Techniques

School neuropsychologists must be proficient in linking evidenced-based interventions to their assessment data. They also must monitor the implementation of their recommendations and evaluate the interventions for effectiveness.

Professional Ethics and Professional Competencies

School neuropsychologists must understand, appreciate, and integrate professional ethics into their daily practices. School neuropsychologists must gain proficiencies in skills such as integrative report writing, history taking, record review, and clinical interviewing.

Competency-Based Supervised Experiences

A school psychologist cannot become a school neuropsychologist without competency-based supervised experiences. Individual supervision or a "grand rounds" group type of supervision must be incorporated into a training program to ensure that the trainee is getting practice and quality feedback on emerging skills before putting those skills into actual practice. It is recommended that the school neuropsychologist have a minimum of 500 hours of supervised, field-based experiences.

Continuing Education Requirements

A school neuropsychologist must be committed to lifelong learning. School neuropsychology is an emerging field. New resources (e.g., books, tests, interventions) are becoming available on a regular basis and school neuropsychologists must maintain their professional skills. The ABNSP requires that Diplomates in School Neuropsychology obtain a minimum of 6 hours of continuing-education credit annually in order to maintain their Diplomate status. Other organizations also require CEUs to renew certification or licensure. For example, NASP requires 75 continuing professional development units every 3 years for renewal of the NCSP credential. Rapid Reference 2.3 presents a doctoral school

Rapid Reference 2.3

Model Doctoral School Neuropsychology Curriculum

Area of Focus	Possible Class Title
• functional neuroanatomy	Functional Neuroanatomy, Advanced Behavioral Neuroscience, Advanced Neurophysiology (3 semester hour class)
• history of clinical neuropsychology, pediatric neuropsychology, and school neuropsychology • professional ethics • major theoretical approaches and professional issues • conceptual model for school neuropsychology • neuropsychological disorder nomenclature • theories of, assessment of, and interventions with: —sensory-motor functions —attention functions —executive functions —cognitive efficiency, cognitive fluency, and processing speed functions • report writing • supervised practice (minimum 50 hours)	School Neuropsychology I (3 semester hour class)
• theories of, assessment of, and interventions with: —memory and learning functions —language functions —visual-spatial functions —social-emotional functions • childhood/adolescent clinical syndromes and related neuropsychological deficits • report writing (reinforced) • professional ethics (reinforced) • supervised practice (minimum 50 hours)	School Neuropsychology II (3 semester hour class)
• genetic and neurodevelopmental disorders	Genetic and Neurodevelopmental Disorders (3 semester hour class)

(*continued*)

• neuropsychopharmacology	Neuropsychopharmacology (3 semester hour class)
• neuropsychological intervention techniques	Neuropsychological Intervention Techniques or Neurocognitive Intervention Techniques (3 semester hour class)
• competency-based supervised experiences (minimum of 225 hours, preferred 500 hours)	Supervised Practicum (3 semester hour class)
• internship hours (minimum of 600 hours in school neuropsychology experiences)	Internship (6–8 semester hour classes)
• totals	27–29 hours of concentrated study in school neuropsychology

Source: Adapted from the School Psychology Doctoral Training Program at Texas Woman's University, Denton, Texas.

neuropsychology curriculum that was modeled after the School Psychology Doctoral Program at Texas Woman's University, Denton, Texas.

This chapter has discussed the need for training and credentialing models for practitioners with advanced graduate degrees, and presented a proposed model curriculum to train school neuropsychologists. The increased interest in school neuropsychology and the demand for more training will undoubtedly help shape credentialing issues in the future. School psychologists and educators are fundamentally interested in helping children learn in the schools and providing targeted interventions as needed. As basic research in cognitive neuroscience and neuropsychology becomes more readily translated into educational practice, there will be a need to define what constitutes competency for practitioners who want to apply this knowledge base with school-aged children and youth.

The final sections of this chapter will list a set of professional resources for school neuropsychologists, or for those interested in school neuropsychology.

LIST OF RECENT NEUROPSYCHOLOGICAL BOOKS

Rapid Reference 2.4 lists some of the major school neuropsychology books that have been published in recent years. A review of the content of some of these

Rapid Reference 2.4

Major School Neuropsychology Publications (most recent to oldest)

D'Amato, R. C., Fletcher-Janzen, E., & Reynolds, C. R. (Eds.). (2005). *Handbook of school neuropsychology*. Hoboken, NJ: Wiley.

Feifer, S. G., & DeFina, P. A. (2005). *The neuropsychology of mathematics: Diagnosis and intervention*. Middletown, MD: School Neuropsych Press.

Hale, J. B., & Fiorello, C. A. (2004). *School neuropsychology: A practitioner's handbook*. New York: Guilford.

Jiron, C. (2004). *Brainstorming: Using neuropsychology in the schools*. Los Angeles: Western Psychological Services.

Baron, I. S. (2004). *Neuropsychological evaluation of the child.* New York: Oxford University Press.

Shaywitz, S. (2003). *Overcoming dyslexia: A new and complete science-based program for reading problems at any level*. New York: Alfred A. Knopf.

Eslinger, P. J. (Ed.). (2002). *Neuropsychological interventions*. New York: Guilford.

Berninger, V. W., & Richards, T. L. (2002). *Brain literacy for educators and psychologists*. New York: Academic Press.

Feifer, S. G., & DeFina, P. A. (2002). *The neuropsychology of written language disorders: Diagnosis and intervention*. Middletown, MD: School Neuropsych Press.

Semrud-Clikeman, M. (2001). *Traumatic brain injury in children and adolescents*. New York: Guilford.

Feifer, S. G., & DeFina, P. A. (2000). *The neuropsychology of reading disorders: Diagnosis and intervention*. Middletown, MD: School Neuropsych Press.

Goldstein, S., & Reynolds, C. R. (Eds.). (1999). *Neurodevelopmental and genetic disorders in children*. New York: Guilford.

Siantz-Tyler, J., & Mira, M. P. (1999). *Traumatic brain injury in children and adolescents: A sourcebook for teachers and other school personnel*. Austin, TX: Pro-Ed, Inc.

Reynolds, C. R., & Fletcher-Janzen, E. (Eds.). (1997). *Handbook of clinical child neuropsychology* (2nd ed.). New York: Plenum Press.

books is featured in the Annotated Bibliography. The vast majority of the authors of the school neuropsychology resource books cited in Rapid Reference 2.4 are school psychologists. One of the most widely recognized publications in the field of school psychology is the *Best Practices* series (Thomas & Grimes, 1985, 1990, 1995, 2002). The first edition of *Best Practices* contained a chapter entitled: "Best practices in neuropsychological assessment" (Hynd & Snow, 1985). *Best Practices in School Psychology–II* contained a chapter entitled "Best practice in neuropsychology" (Kelly & Dean, 1990). The third and fourth editions of the *Best Practice in School Psychology* series did not contain general chapters on neuropsychology, but instead contained chapters with an applied practice-oriented focus on working with students with traumatic brain injury (Harvey, 1995, 2002).

LIST OF NEUROPSYCHOLOGICAL JOURNALS

Rapid Reference 2.5 presents a list of the journals most relevant to the practice of school neuropsychology. Rapid Reference 2.5 also presents a tabulation of published articles related to pediatric neuropsychology in each of these journals from 1991 to 2005. These figures were derived by initially going to the online PsycInfo database and searching each journal for articles that contained the words *neuropsychology* and *child*. When a list of articles was found, the articles

Rapid Reference 2.5

Journals Relevant to School Neuropsychology

Journal	**Number of Articles (1991–2005) Related to Pediatric Neuropsychology Issues**
The Clinical Neuropsychologist	314
Archives of Clinical Neuropsychology	312
Child Neuropsychology[a]	271
Journal of the International Neuropsychological Society	17
Psychological Assessment	16
Psychology in the Schools	12
Developmental Psychology	10
Journal of Clinical and Experimental Neuropsychology	8
Neuropsychology	7
Applied Neuropsychology	4
Neuropsychology Review	3
School Psychology Review	3
Journal of Cognitive Neuroscience	1
Journal of Psychoeducational Assessment	1
School Psychology Quarterly	0

[a] The *Child Neuropsychology* journal was introduced in 1995.

were reviewed to make sure the content was related to school neuropsychology. The numbers of articles that match these criteria are presented in Rapid Reference 2.5. School neuropsychology professional practice issues and research are currently published across a broad spectrum of journals with the majority in neuropsychology journals.

LIST OF NEUROPSYCHOLOGICAL WEB SITES

Rapid Reference 2.6 presents a list of web sites relevant to the practice of school neuropsychology. Please be advised that web site addresses change frequently.

Rapid Reference 2.6

Major School Neuropsychology Web Sites

Childhood Disorders (selected)

- Anxiety Disorders Association of America (http://www.adaa.org/)
  —Mission is to promote the prevention, treatment, and cure of anxiety disorders and to improve the lives of all people who suffer from them.
- Asperger Syndrome Information and Support (O.A.S.I.S.) (http://www.udel.edu/bkirby/asperger/)
  —A resource guide for parents and professionals working with children with Asperger Syndrome.
- Autism Society of America (http://www.autism-society.org)
  —Mission to promote lifelong access and opportunity for all individuals within the autism spectrum to be fully participating members of their communities.
- Children and Adults with Attention-Deficit/Hyperactivity Disorder (CHADD; http://www.chadd.org)
  —Through collaborative leadership, advocacy, research, education, and support, CHADD provides evidenced-based information about AD/HD to parents, educators, professionals, the media, and the general public.
- Epilepsy Foundation of America (http://www.epilepsyfoundation.org/)
  —An index site designed to ensure that people with seizures are able to participate in all life experiences; and will prevent, control, and cure epilepsy through research, education, advocacy, and services.
- Fetal Alcohol Spectrum Disorders Information, Support, Communications Link (FASlink; http://www.acbr.com/fas/)
  —The FASlink is an ideal resource for families and professionals who deal with FASD issues. It deals with medical, educational, behavioral, social, and justice issues that affect individuals prenatally exposed to alcohol.

(*continued*)

- LD Online (http://www.ldonline.org/)
  —LD OnLine is the leading information service in the field of learning disabilities, serving more than 200,000 parents, teachers, and other professionals each month.
- National Center for Learning Disabilities (NCLD; http://www.ncld.org)
  —NCLD provides essential information to parents, professionals, and individuals with learning disabilities; promotes research and programs to foster effective learning; and advocates for policies to protect and strengthen educational rights and opportunities.
  —A set of resources for parents and educators of children with nonverbal LD.
- Obsessive-Compulsive Foundation (http://www.ocfoundation.org/)
  —An international not-for-profit organization composed of people with Obsessive Compulsive Disorder (OCD) and related disorders, their families, friends, professionals, and other concerned individuals.
- Selective Mutism Foundation (http://www.selectivemutismfoundation.org/)
  —To promote further research, advocacy, social acceptance, and the understanding of Selective Mutism as a debilitating disorder.
- Tourette Syndrome Association (http://www.tsa-usa.org/)
  —The site offers resources and referrals to help people and their families cope with the problems that occur with Tourette syndrome.
- United Cerebral Palsy (http://www.ucp.org/)
  —The national organization and its nationwide network of affiliates strive to ensure the inclusion of persons with disabilities in every facet of society.

Credentialing Boards

- American Board of School Neuropsychology (http://www.absnp.org)
- American Board of Pediatric Neuropsychology (http://www.abpdn.org/)
- American Board of Professional Neuropsychology (http://abpn.net/)
- American Board of Clinical Neuropsychology (http://www.theabcn.org/)

Governmental Agencies

- National Institutes of Health (NIH; http://www.nih.gov/)
  —NIH is the nation's medical research agency—making important medical discoveries that improve health and save lives.
- National Institute of Mental Health (http://www.nimh.nih.gov/nimhhome/index.cfm)
  —A governmental agency site that is committed to "working to improve mental health through biomedical research on mind, brain, and behavior."
- National Institute of Neurological Disorders and Stroke (NINDS; http://www.ninds.nih.gov/)
  —The nation's leading supporter of biomedical research on disorders of the brain and nervous system.

Index Sites with Multiple URL Listings

- Child Neurology Home Page (http://www-personal.umich.edu/~leber/c-n/)
  —The main purpose of this index is to coordinate the available internet resources in Child Neurology, both for professionals and patients.
- Family Village (http://www.familyvillage.wisc.edu/index.htmlx)
  —A global community of disability resources that integrates information, resources, and communication opportunities on the Internet for persons with cognitive and other disabilities, for their families, and for those who provide them services and support.
- Neuropsychology Central (http://www.neuropsychologycentral.com/index.html)
  —This is an index of useful resources for professionals interested in neuropsychology.
- School Psychology Resources Online (http://www.schoolpsychology.net/)
  —This is an excellent index of web-based and nonweb-based resources related to the practice of school psychology.

National Organizations

- Division 40 of the American Psychological Association (http://www.div40.org/)
  — A scientific and professional organization of psychologists interested in the study of brain-behavior relationships and the clinical application of that knowledge to human problems.
- International Brain Research Foundation (http://IBRFinc.org/)
  — A Medical Research Organization (MRO) dedicated to excellence in the neurosciences, with the ultimate goal serving to promote brain health. This network of worldwide resources will enable and strengthen multidisciplinary and interdisciplinary collaborative efforts within a unique infrastructure that will accelerate and enhance clinical and translational research.
- International Neuropsychology Society (http://www.the-ins.org/)
  —An organization dedicated to enhancing communication among the scientific disciplines that contribute to the understanding of brain-behavior relationships.
- National Academy of Neuropsychologists (http://www.nanonline.org/)
  —A professional society that includes clinicians, scientist-practitioners, and researchers interested in neuropsychology.
- National Organization for Rare Disorders (http://www.rarediseases.org/)
  —A unique federation of voluntary health organizations dedicated to helping people with rare *orphan* diseases and assisting the organizations that serve them.
- Society for Neuroscience (http://web.sfn.org/)
  —An organization committed to advancing the understanding of brain-behavior relationships.

(*continued*)

Training Resources

- Association of Postdoctoral Programs in Clinical Neuropsychology (APPCN; http://www.appcn.org/)
  —The mission of the APPCN is to foster the development of advanced postdoctoral education and training programs in clinical neuropsychology and to establish standards for residency programs in clinical neuropsychology that lead to the development of competency in this area of specialty practice.
- Association of Neuropsychology Students in Training (http://www.phhp.ufl.edu/anst/)
  —A forum to discuss important graduate student issues in clinical neuropsychology such as training, practice, research, and career opportunities.
- Fielding Institute's Postdoctoral Neuropsychology Certificate Program (http://www.fielding.edu/nro/index.htm)
  —A 2-year postdoctoral program designed for doctoral-level psychologists practicing with populations of neuropsychological relevance who wish to gain special proficiency in neuropsychological assessment and intervention.
- Schoolneuropsych.com (http://www.schoolneuropsych.com)
  —A competency-based continuing education program designed to train school psychologists and psychologists to integrate neuropsychological principles into their professional practices.

SUMMARY

Chapter 1 presented the rationale for and history of the interest in school neuropsychology. This chapter has presented a discussion of what constitutes competency in school neuropsychology, reviewed the neuropsychology credentialing board options, and presented a proposed set of training guidelines along with a model curriculum for those practitioners interested in applying neuropsychological principles into educational practice. The chapter concluded with a list of current resources (e.g., books, journals, web sites) for the practice of school neuropsychology.

TEST YOURSELF

1. Which area of training is more likely to be present in a pediatric neuropsychology program as opposed to a school neuropsychology training program?

(a) functional neuroanatomy
(b) professional ethics
(c) genetic and neurodevelopmental disorders
(d) medical aspects of neuropsychology

2. According to the author, all of the following constitute competency to provide school-based neuropsychological services except one; which one?

(a) Take a couple of CEU workshops on the latest neuropsychology instruments.
(b) Complete a doctoral program with an emphasis in school neuropsychology.
(c) Become a Diplomate in School Neuropsychology from the ABSNP.
(d) Complete a postgraduate, competency-based certification program with a strong supervised component.

3. Which of the Diplomate credentialing boards does not currently require an objective written exam?

(a) The American Board of School Psychology
(b) The American Board of Clinical Neuropsychology
(c) The American Board of Professional Neuropsychology
(d) The American Board of Pediatric Neuropsychologists

4. Which of the Diplomate credentialing boards does not currently require a doctorate in psychology?

(a) The American Board of School Psychology
(b) The American Board of Clinical Neuropsychology
(c) The American Board of Professional Neuropsychology
(d) The American Board of Pediatric Neuropsychologists

5. A school psychologist interested in applying neuropsychological principles into practice can find the most research findings in the school psychology journals. True or False?

6. Which of the following journals has published the most articles in the past 15 years related to child neuropsychology?

(a) *School Psychology Review*
(b) *The Clinical Neuropsychologist*
(c) *Psychology in the Schools*
(d) *Archives of Clinical Neuropsychology*

Answers: 1. d; 2. a; 3. c; 4. a; 5. False; 6. b

Three

WHEN TO INCORPORATE NEUROPSYCHOLOGICAL PRINCIPLES INTO A COMPREHENSIVE INDIVIDUAL ASSESSMENT

This chapter will begin with a review of the common referral reasons for a school neuropsychological evaluation. The reasons for referral reviewed in this chapter include: a child with a known or suspected neurological disorder (e.g., traumatic brain injury, acquired brain injury); children with neuromuscular diseases (e.g., cerebral palsy, muscular dystrophy), brain tumors, or central nervous system infection or compromise; children with neurodevelopmental risk factors (e.g., prenatal exposure to drugs and/or alcohol, low birth weight and/or prematurity); children returning to school after a head injury; and children with a documented rapid drop in academic achievement that cannot be explained by social-emotional or environmental causes, a child who is not responding to interventions, a child with suspected processing weaknesses, or a child with significant scatter in psychoeducational test performance. This chapter will conclude with a discussion on the consideration of children with special needs.

COMMON REFERRAL REASONS FOR A SCHOOL NEUROPSYCHOLOGICAL EVALUATION

When a child is experiencing learning or behavioral difficulties, it is uncommon to start with a neuropsychological evaluation. The next section of this chapter will discuss where neuropsychological assessment fits within a hierarchical model of assessment. A school neuropsychological assessment should be requested when one of the referral questions listed in Rapid Reference 3.1 is under consideration.

> **DON'T FORGET**
>
> It is not uncommon for children who suffer a brain injury or insult to appear to recover and function normally, only to have learning and/or behavioral problems surface later on as their brains mature.

Rapid Reference 3.1

Common Referral Reasons for a School Neuropsychological Evaluation

- a child who is not responding to multiple intervention strategies
- a child with evidence of processing deficiencies on a psychoeducational evaluation
- a child with a valid large scatter in psychoeducational test performance
- a child with a known or suspected neurological disorder
- a child with a history of a neurodevelopmental risk factor
- a child returning to school after a head injury or neurological insult
- a child who has a dramatic drop in achievement that cannot be explained

Children with a Known or Suspected Neurological Disorder

Children and adolescents with known or suspected neurological disorders may not always have clear or readily accessible developmental and medical histories. Conducting a thorough record review and gathering a developmental history from the caregiver are important steps in uncovering any past neurological traumas. However, uncovering evidence of neurological trauma or risk factors may be difficult in families that are reluctant to share information about past childhood abuse or neglect, or from families where the child is adopted or being raised by a relative.

If a child has a positive history for neurological trauma or insult (see following examples) or the school neuropsychologist, parents, or educators suspect a positive—but undocumented—history of neuropsychological trauma or insult, the child is probably a viable candidate for a school neuropsychological evaluation. The only caveat to consider before referring a child for a school neuropsychological evaluation is that the child must be experiencing some form of academic or behavioral difficulties. Some children have a positive history of a head injury but are not experiencing any academic or behavioral difficulties. Children that fall into this category should be marked for monitoring. Monitoring children and youth who have a positive history of neurological insults (e.g., traumatic brain injury) is important because these children may be showing adequate annual yearly progress currently, but they are at risk for future learning and behavioral problems. It is not uncommon for children who experience a head injury at a young age to "look alright" and function normally for a period of time, but later experience learning or behavioral deficits as their brains mature and the academic demands of school become increasingly more difficult.

Children with Past or Recent Head Injuries Who Are Having Academic or Behavioral Difficulties

"Traumatic brain injury (TBI), also called acquired brain injury or simply head injury, occurs when a sudden trauma causes damage to the brain" (National Institute of Neurological Disorders and Stroke web site—http://www.ninds.nih.gov/disorders/tbi/tbi.htm). TBI usually results when the skull suddenly hits an object or is hit by an object with blunt force. A closed-head injury happens when the skull is not penetrated but the force of the blow causes damage. An open-head injury happens when an object pierces the skull and enters brain tissue. TBI is classified as mild, moderate, or severe, depending upon the extent of the brain damage. Mild TBI symptoms include: no loss of consciousness or loss of consciousness for only a few seconds or minutes, headache, confusion, lightheadedness, dizziness, blurred vision or tired eyes, ringing in the ears, bad taste in the mouth, fatigue or lethargy, a change in sleep patterns, behavioral or mood changes, and trouble with memory, concentration, attention, or thinking (Semrud-Clikeman, 2001).

A child with moderate to severe TBI will likely show all of the same symptoms of mild TBI, but will also include: a headache that only gets worse or does not go away, repeated vomiting or nausea, convulsions or seizures, an inability to awaken from sleep, dilation of one or both pupils of the eyes, slurred speech, weakness or numbness in the extremities, loss of coordination, and increased confusion, restlessness, or agitation (National Institute of Neurological Disorders and Stroke web site—http://www.ninds.nih.gov/disorders/tbi/tbi.htm).

The neuropsychological consequences of TBI have been extensively investigated by researchers (see Semrud-Clikeman, 2001; or Yeates, 2000 for reviews). Like many of the disorders or traumas to the brain, developmental factors play a major role in the loss of function, course of recovery, and manifestation of the TBI symptoms acutely and later on in the life of a child. According to Semrud-

DON'T FORGET

TBI has been associated with deficits in various domains including:

- alertness and orientation
- attention and concentration
- intellectual functioning
- language skills
- academic achievement
- adaptive behavior and behavioral adjustment

Clikeman (2001) and Yeates (2000), TBI has been associated with deficits in various domains including: alertness and orientation, attention and concentration, intellectual functioning, language skills, academic achievement, adaptive behavior, and behavioral adjustment.

When TBI children are experiencing academic and behavioral difficulties, they are often misclassified or misdiagnosed as having a different disability other than TBI such as specific learning disability, mental retardation, or severe emotional disturbance (Begali, 1992). As Begali (1992) pointed out, practitioners who work with TBI children and adolescents must remember that the first few years after a TBI hold the most potential for functional change and remediation. A child with a history of a TBI should be monitored for behavioral or academic difficulties. Furthermore, children with TBI may need to be reevaluated more frequently than every 3 years, as is standard with most special education children. Keep in mind that damage to the same part of the brain can lead to an overall pattern of deficits that look different from one child to another. This is because of the differences in the secondary deficits related to axonal shearing, swelling of the brain, infections, and so on.

Children with a History of Acquired or Congenital Brain Damage

Anoxia

Anoxia is an absence of oxygen supply to organ tissues, including the brain. *Hypoxia* is a decreased supply of oxygen to organ tissues. Anoxia and hypoxia can be caused by a variety of factors including: near drowning, strangulation, smoke or carbon dioxide inhalation, or poisoning. Anoxia/hypoxia can cause loss of consciousness, coma, seizures, or even death. The prognosis for anoxia/hypoxia is dependent upon how quickly the child's respiratory and cardiovascular systems can be supported and upon the extent of the injuries. If the child does recover from anoxia/hypoxia, a variety of psychological and neurological symptoms may appear, last for a while, and may then disappear. These symptoms may include mental confusion, personality regression, parietal lobe syndromes, amnesia, hallucinations, and memory loss (National Institute of Neurological Disorders and Stroke web site—http://www.ninds.nih.gov/disorders/anoxia/anoxia.htm).

Meningitis

Meningitis is the inflammation of the lining around the brain and spinal cord that is relatively common in children and can be life threatening (Anderson & Taylor, 2000). Early symptoms of meningitis include: severe headache, stiff neck, dislike of bright lights, fever/vomiting, drowsiness and less responsive/vacant, rash anywhere on the body, and possible seizures (Meningitis Research Foundation web site—http://www.meningitis.org). Baraff, Lee, and Schriger (1993) conducted a meta-analysis of 19 studies that examined the neuropsychological deficits associated with meningitis. They found that 16 percent of the children who had meningitis also had major long-term deficits including total deafness (11 percent), bilateral severe or profound hearing loss (5 percent), Mental Retardation (6 percent), spasticity or paresis (4 percent), and seizure disorders (4 percent). Methodological problems across studies have made it difficult to document the neuropsychological problems or deficits associated with meningitis (see Anderson & Taylor, 2000 for a review). The neuropsychological deficits related to meningitis seem to be a function of developmental variables. As an example, gross motor skills appear to be impaired after acute hospital care discharge, whereas fine motor incoordination, visual-perceptual deficits, and language deficits may become manifested when the child starts preschool.

Children with Neuromuscular Diseases

Cerebral Palsy

Cerebral Palsy (CP) is a term used to describe a heterogeneous group of chronic movement disorders. CP is not a disease. CP is not caused by disturbances in the muscles or nerves, but rather caused by faulty development in the brain structures that help control movement and posture (pyramidal or extrapyramidal tracts). CP is characterized by:

> an inability to fully control motor function, particularly muscle control and coordination. Depending on which areas of the brain have been damaged, one or more of the following may occur: muscle tightness or spasticity; involuntary movement; disturbance in gait or mobility, difficulty in swallowing and problems with speech. In addition, the following may occur: abnormal sensation and perception; impairment of sight, hearing or speech; seizures; and/or mental retardation. Other problems that may arise are difficulties in feeding, bladder and bowel control, problems with breathing because of postural difficulties, skin disorders because of pressure sores, and learning disabilities (United Cerebral Palsy Press Room web site— http://www.ucp.org/index.cfm).

CP is generally classified into four subtypes: spastic, athetoid or dyskinetic, ataxic, or mixed. The characteristics of these CP subtypes and any evidence of neuropsychological deficits are presented in Rapid Reference 3.2. The neuropsycho-

Rapid Reference 3.2

Subtypes of Cerebral Palsy and Associated Characteristics

Subtype	Characteristics
Spastic cerebral palsy	• Affects 70 to 80 percent of patients. • Muscles are stiffly and permanently contracted.
Athetoid, or dyskinetic, cerebral palsy	• Affects about 10 to 20 percent of patients. • Uncontrolled, slow, writhing movements, which usually affect the hands, feet, arms, or legs and, in some cases, the muscles of the face and tongue, causing grimacing or drooling. • Patients may also have problems coordinating the muscle movements needed for speech, a condition known as *dysarthria*.
Ataxic cerebral palsy	• Affects an estimated 5 to 10 percent of patients. • Poor coordination; walk unsteadily with a wide-based gait, placing their feet unusually far apart; and experience difficulty when attempting quick or precise movements, such as writing or buttoning a shirt.
Mixed forms	• The most common mixed form includes spasticity and athetoid movements but other combinations are also possible.

Source: United Cerebral Palsy web site—http://www.ucp.org/index.cfm

logical correlates to CP have not been fully investigated. Blondis (2004) reviewed the literature on the neuropsychological functioning associated with CP. He found several studies that suggested that children with spastic CP appear to be characterized by specific impairments in visual-perceptual-motor functioning with children achieving lower performance, or nonverbal IQs, than verbal IQs. Children diagnosed with some form of CP should be administered a school neuropsychological assessment battery to determine baseline levels of functioning, particularly in the areas of sensory-motor, visual-spatial, and academic achievement.

Muscular Dystrophy Disorders

Congenital muscular dystrophy (CMD) refers to a group of disorders in which infants evidence muscle weakness at birth or shortly thereafter. The condition tends to remain static but some children do show slow progress and others may eventually learn to walk (Blondis, 2004). Rapid Reference 3.3 presents the types of muscular dystrophies and peripheral neuropathy diseases affecting children.

Children with Brain Tumors

Brain tumors can be small and focal, or spread across large areas (invasive). Brain tumors can be noncancerous (benign) or cancerous (malignant) in nature. Brain tumors can destroy brain cells as they grow, as well as cause damage to the brain in secondary ways. Brain tumors can cause inflammation or swelling of the surrounding tissue and overall brain. Brain tumors are classified according to a variety of factors including: their size, location, common characteristics, and treatment outcomes. The effects of brain tumors and their treatments can significantly cause a wide range of neurocognitive deficits. Once the child is medically stabilized and has returned to school, it is important for the school neuropsychologist to establish a baseline profile of the child's neurocognitive strengths and weaknesses. It is equally important to regularly monitor the changes in the child's profile of strengths and weaknesses as the child's brain heals. The functional profile across all dimensions of neuropsychological functioning is important to document and monitor for appropriate intervention planning and implementation. If a school neuropsychologist suspects that a child may have the symptoms of a brain tumor, a referral to a neurologist should be strongly encouraged. Symptoms such as unusual increased irritability, lethargy, diplopia (double vision), vomiting, headaches, or unexplained changes in personality and behavior may all be associated with a possible brain tumor (Mulhern, 1996). (See Rapid Reference 3.4.)

Children with Central Nervous System Infection or Compromise

Asthma

The Centers for Disease Control and Prevention (CDC) estimated that 11 percent of children less than 18 years of age have been diagnosed with asthma at some point in their lives (as cited in Donnelly, 2005), making asthma the most prevalent health condition in children. One direct negative consequence of asthma is the increased number of school absences that often result in academic deficiencies. Medications such as Albuterol™ can have side effects that alter the child's arousal and attention levels, memory, motor steadiness, and visual-spatial planning (see Donnelly, 2005 for a review). Recent research has suggested that these neuropsychological deficits may be overstated and only affect children

Rapid Reference 3.3

Types of Muscular Dystrophies and Peripheral Neuropathy Diseases Affecting Children

Type	Affected Muscle Groups	Onset	Progression	Neuropsychological Correlates
Congenital Muscular Dystrophy (CMD)	All	At or near birth	Varies with type; many are slowly progressive; some shorten life span.	Severe Mental Retardation associated with CMD that has structural brain changes. The effects of Pure CMD on cognitive abilities are variable.
Myotonic Muscular Dystrophy (MMD; a.k.a. Steinert's Disease)	Wide variance	Birth to adulthood	Progression is slow, sometimes spanning 50 to 60 years.	Infant form is associated with Mental Retardation. Juvenile form is associated with learning disabilities before onset of motor problems. ADHD and anxiety disorders may be present in MMD.
Duchenne Muscular Dystrophy (DMD; a.k.a. Pseudo-hypertrophic)	Proximal	Early childhood to about 2–6 years	DMD eventually affects all voluntary muscles, and the heart and breathing muscles. Survival is rare beyond the early 30s.	Mean IQ of children with DMD appears to be 85 with a skewed distribution to the left (lower than normal). Neuropsychological deficits in verbal fluency, reading, phonological processing, receptive and expressive language, verbal learning and attention, and working memory.
Becker Muscular Dystrophy (BMD)	Mainly limb girdle and proximal	Adolescence or adulthood	Most with BMD survive well into mid to late adulthood.	Limited studies suggest that BMD children have low-average verbal and nonverbal IQs.

(*continued*)

Type	Affected Muscle Groups	Onset	Progression	Neuropsychological Correlates
Limb-Girdle Muscular Dystrophy (LGMD)	Mainly limb girdle and proximal	Childhood to adulthood	Usually progresses slowly, with cardiopulmonary complications sometimes occurring in later stages of the disease.	The few studies conducted report a wide range of IQ scores.
Facioscapulohumeral Muscular Dystrophy (FSH or FSHD; a.k.a. Landouzy-Dejerine)	Initially proximal and later distal	Usually by age 20	Progresses slowly with some periods of rapid deterioration. Disease may span many decades.	No known deficits.
Spinal Muscular Atrophy (SMA)	Proximal	Childhood	Usually progresses slowly, and survival into adulthood is common.	No known deficits.

Note: See Blondis (2004) for a more detailed review.

Rapid Reference 3.4

Common Childhood Brain Tumors

Tumor Type	Characteristics	Incident Rate
Cerebellar astrocytoma	• Usually benign, cystic, and slow growing. • Signs usually include clumsiness of one hand, stumbling to one side, headache, and vomiting. • Typical treatment is surgical removal of the tumor. • The cure rate varies, depending on the ability of the tumor to be completely removed by surgery, the tumor type, and the response to other therapies.	• Accounts for about 20% of pediatric brain tumors (peak age is 5 to 8 years old).
Medulloblastoma	• Signs include headache, vomiting, uncoordinated movements, and lethargy. • Can spread (metastasize) along the spinal cord. • Surgical removal alone does not cure medullablastoma. Radiation therapy or chemotherapy are often used with surgery. • If the cancer returns, it is usually within the first 5 years of therapy.	• The most common pediatric malignant brain tumor (10–20% of all pediatric brain tumors). • Occurs more frequently in boys than in girls. Peak age is about 5 years old. Most occur before 10 years of age.
Ependymoma	• Tumor growth rates vary. • Tumors are located in the ventricles of the brain and obstruct the flow of cerebrospinal fluid (CSF). • Signs include headache, vomiting, and uncoordinated movements. • Single or combination therapy includes surgery, radiation therapy, and chemotherapy. • The cure rate varies, depending on the ability of the tumor to be completely removed by surgery, the tumor type, and the response to other therapies, if needed.	• Accounts for 8–10% of pediatric brain tumors.

(continued)

Tumor Type	Characteristics	Incident Rate
Brainstem glioma	• Tumor of the pons and medulla occurs almost exclusively in children. • May grow to very large size before symptoms are present. • Signs include double vision, facial weakness, difficulty walking, and vomiting. • Surgical removal is usually not possible due to the location of the tumor. • Radiation therapy and chemotherapy are used to shrink the tumor size and prolong life. • Overall, 5-year survival rate is low.	• Accounts for 10–15% of primary brain tumors in children; average age is about 6 years old.
Craniopharyngioma	• Tumor located near the pituitary stalk. • Often close to vital structure, making surgical removal difficult. • Signs include vision changes, headache, weight gain, and endocrine changes. • Treated with surgery, radiation therapy, or a combination. There is some controversy over the optimal approach to therapy for craniopharyngioma. • Survival and cure rates are favorable, though endocrine dysfunction may persist as well as the effects of radiation on cognition (thinking ability).	• Rare, less than 10% of childhood brain tumors; average age is about 7 to 12 years old.

Source: National Institutes of Health web site— http://www.nlm.nih.gov/medlineplus/ency/article/000768.htm with the most severe forms of asthma. A school neuropsychologist should be aware of children with a positive history for asthma and help educators and parents be aware of any potential negative side effects the medication may have on the child's behavior and learning.

HIV/AIDS

Human immunodeficiency virus (HIV) infection and the acquired immune deficiency syndrome (AIDS) in children are still relatively new and the research regarding their effects on neurocognitive processes is underway (Pulsifer & Aylward, 2000). In a review of the literature, Pulsifer and Aylward (2000) found that children with AIDS frequently had abnormal motor functions at a young age (less than 12 months), but these abnormalities decreased with age. In preschool-aged children with AIDS, research has found high correlations with progressive encephalopathy, increased developmental delays or loss of developmental milestones, and signs of pyramidal motor dysfunctions. Cognitive decline is seen in children with AIDS as in all other immunological abnormalities (Pulsifer & Aylward, 2000). Specific cognitive deficits associated with AIDS in children can include expressive and receptive language difficulties. Compounding the potential deficits associated with HIV, the medical treatment for AIDS can also cause significant cognitive deficits. A child with AIDS could qualify for special education services, as needed, under the Other Health Impaired category. School neuropsychologists may be asked to consult or assess a child with AIDS to help address some of the potentially related cognitive and behavioral deficits.

Hydrocephalus

Hydrocephalus is a medical condition that is characterized by the ventricles of the brain overfilling with cerebralspinal fluid (Fletcher, Dennis, & Northrup, 2000). Hydrocephalus is not a disease by itself, but rather a symptom of some other physiological disorder (e.g., tumors, infections, trauma to the brain). Early onset hydrocephalus occurs in children within the first year of life as a result of congenital or perinatal disorders (Fletcher et al., 2000). The increased cranial pressure in the brain can cause increased head size and lasting damage to the brain tissue as it gets compressed and squeezed against the skull. A common treatment for children with hydrocephalus is to surgically implant a shunt to drain the extra cerebralspinal fluid into the abdominal cavity. Children with early onset hydrocephalus have been found to have deficits in both fine and gross motor coordination, visual-motor and visual-spatial processes, some language delays, problem-solving skills, and focused attention (Fletcher et al., 2000). If a preschool- or elementary-aged child had a history of early onset hydroencephalitis, a school neuropsychologist would be encouraged to monitor the potential deficit areas previously listed.

Juvenile Diabetes

Insulin-dependent diabetes mellitus (IDDM) is a common childhood autoimmune disease. The disease destroys the cells within the pancreas that are essential to produce insulin. Children with this disease must take daily injections of insulin. Rovet (2000) reported that there are both transient and permanent effects of diabetes on the brain associated with too much or too little glucose or insulin. Rovet (2000) reported that children with diabetes might have associated neurocognitive deficits in the areas of visual-motor, memory, and attention. Rovet (2000) found that the age of onset of IDDM will vary the associated neurocognitive deficits. According to Rovet's (2000) research, visual-spatial abilities appear to be more adversely affected by early onset diabetes, and language, memory, and attention seem to be more adversely affected by late-onset diabetes. School neuropsychologists should be aware of children in their schools who have been diagnosed with IDDM and monitor their educational progress carefully.

Leukemia

Acute lymphoblastic leukemia (ALL) is the most common malignancy in children (see Waber & Mullenix, 2000 for a review). Current treatment of ALL has lead to a success rate of over 70 percent. The most common treatments used to treat ALL are chemotherapy and radiation. These treatments carry with them associated toxicity to the entire central nervous system, especially in younger children. The role of the pediatric neuropsychologist is to help oncologists determine the extent of the neurobehavioral outcomes related to the medical treatment. Espy and colleagues (2001) investigated the long-term outcomes of ALL children at 2, 3, and 4 years post chemotherapy. Modest deficits were noted in arithmetic, visual-motor integration, and verbal fluency. Donnelly (2005) noted that some important roles of a school neuropsychologist in working with ALL children would be monitoring educational performance, providing feedback, and helping the child with ALL to maintain a sense of self-efficacy and a continued connection to the school environment.

End-Stage Renal Disease

Renal failure in children can be caused by a variety of disorders or abnormalities, including: trauma to the kidneys, hypoxia, infections, drug toxicity, and immunological disorders (Fennell, 2000). Fennell (2000) reviewed the literature and found that renal failure is associated with the following neuropsychological problems: intellectual impairments (lower performance and full scale IQs), developmental delays in infants (motor and mental), memory disorders (impaired short-term memory and verbal learning problems), attentional dysfunction (impaired immediate span, slower reaction times, errors of impulsivity and inattention on tests of vigilance), and visuospatial and visuoconstructional problems (impaired two-dimensional construction, and impaired two-dimensional copying). School neuropsychologists can be helpful in monitoring educational progress and providing the child emotional support in dealing with the consequences of the disease.

Children with Neurodevelopmental Risk Factors

See Arnstein and Brown (2005) for a detailed review of the literature related to the effects of prenatal exposure to neurotoxins. Neurodevelopmental risk factors include prenatal exposure to drugs and alcohol, and low birth weight and prematurity. The neuropsychological deficits associated with these risk factors are discussed in this section.

Prenatal Exposure to Drugs or Alcohol or Both

Fetal Alcohol Exposure

Exposure to prenatal alcohol can cause effects that fall along a continuum ranging from relative normalcy on one end, to perinatal death on the other (Mattson & Riley, 1998). Along this continuum of potential symptoms are constellations of behavioral and physical features that have been called fetal alcohol syndrome (FAS), fetal alcohol effects (FAE), prenatal exposure to alcohol (PEA) (Mattson, Riley, & Gramling, 1998), and alcohol-related neurodevelopmental disorder.

FAS is the most severe form of the disorder and develops most commonly in infants of women who chronically use alcohol (Don & Rourke, 1995). The diagnosis of FAS is based on three key features: (1) growth deficiency both prenatally and postnatally; (2) a characteristic pattern of craniofacial malformations; and (3) central nervous system dysfunction (Matttson, & Riley, 1998). The characteristic facial features include a small head (microcephaly), small eyes with skin folds at the corners (microphthalmia), poorly developed vertical ridge between the mouth and nose (philtrum), thin upper lip, and flattening of the midfacial jawbone (Phelps, 2005).

The neuropsychological correlates to fetal alcohol exposure ranging from deficits in fine motor coordination (e.g., deficits in motor speed/precision, finger tapping speed; Janzen, Nanson, & Block, 1995; Kelly, Day, & Streissguth, 2000); poor gross motor skills (e.g., grip strength; Conry, 1990; Janzen et al., 1995; Mattson, Riley, & Gramling, 1998); poor selective/focused and shifting attention (Mattson & Riley, 1998); poor auditory and visual selective attention

(Korkman, Kirk, & Kemp, 1998); poor sustained attention problems (Carmichael, Olsen, Feldman, Streissguth, & Gonzales,1992; Streissguth et al., 1994); poor visual-spatial skills (e.g., performed poorly on simple drawing tasks; Conry, 1990; Janzen et al., 1995; Uecker & Nadel, 1996); receptive language deficits (Mattson & Riley, 1998); expressive language deficits (Abel, 1990); multiple memory deficits (Mattson & Riley, 1998); poor executive functions (Carmichael et al., 1992; Mattson, Riley, & Gramling, 1998); lower full-scale IQs (in the 70s; Mattson & Riley, 1998); low reading accuracy scores (Mattson, Riley, & Gramling, 1998; Streissguth et al., 1994); low math calculation scores (Don & Rourke, 1995; Mattson, Riley, & Gramling, 1998; Streissguth et al., 1994); low spelling scores (Mattson, Riley, & Gramling, 1998); increased symptoms of hyperactivity (Carmichael et al., 1992); and impaired social skills (Kelly, Day, & Streissguth, 2000). Due to the wide-ranging deficits associated with FAS/FAE, it is recommended that a full school neuropsychological evaluation be conducted when prenatal alcohol exposure is known or suspected.

Nicotine Exposure

According to Martin et al. (2003), 11.4 percent of pregnant women continue to smoke during their pregnancies. Smoking during pregnancy causes the fetus to be exposed to *carbon dioxide and nicotine*, along with multiple other chemicals. Causal links have been made between smoking and infertility, miscarriages, still births, and low birth weight babies (Olds, 1997). Olds (1997) conducted a meta-analysis of the research related to the long-term neurobehavioral effects of nicotine on children. He found that when studies controlled for the effects of prenatal alcohol exposure and the quality of parental caregiving, maternal nicotine use was related to conduct and attention problems in children.

Cocaine Exposure

Frank, Augustyn, Knight, Pell, and Zuckerman (2001) reviewed the literature on the effects of prenatal exposure to *cocaine*. Contrary to popular belief that prenatal exposure to cocaine must lead to severe neurodevelopmental and neurobehavioral disturbances, the research does not support this myth. Any behavioral or neurodevelopmental effects observed in children exposed to cocaine is probably due to the child's exposure to other concurrent substances during pregnancy (e.g., nicotine, marijuana, alcohol), or to maternal neglect or abuse.

Marijuana Exposure

Fried and Simon (2001) reviewed the literature on the neurodevelopmental and neurobehavioral effects of *marijuana use* during pregnancy. Similar to smoking, the fetus is exposed to carbon dioxide when the mother smokes, as well as the chemical THC that is specific to marijuana. Fred and Simon's examination of the literature concluded there was no evidence that prenatal marijuana use adversely affects the course of the pregnancy or early development; however, prenatal marijuana use may be associated with later neurocognitive difficulties. Specifically, Fred and Simon (2001) found support for a linkage between maternal marijuana use and later deficits in executive functions within the offspring.

Environmental Toxin Exposure

A *teratogen* is a substance that adversely affects normal development. The effects of exposure to a teratogen vary depending upon the time of exposure to the fetus, the amount of exposure, the duration of the exposure, and the genetic vulnerability of the mother and fetus to the teratogen. There has been a dramatic increase in the prenatal and childhood exposure of *environmental toxins* during the past few decades (Arnstein & Brown, 2005). Toxin exposure to polychlorinated biphenyls (PCBs), methylmercury, and lead can lead to known neurodevelopmental problems. For further review of various teratogens and their relative impact on neurodevelopment, please refer to J. P. Byrnes (2001).

Low Birth Weight and Prematurity

Low birth weight in infants has been associated with developmental delays, attention problems, behavioral difficulties, academic failure, and cognitive impairment. Delays in cognitive and motor functioning can be found in children with a history of low birth weight as early as 18 to 24 months (Dooley, 2005). A review of the literature revealed that low birth weight is associated with later deficits in visual-motor integration problems that can lead to academic difficulties (Gabbard, Goncalves, & Santos, 2001; Parker, 1988).

A Child Returning to School After a Head Injury

School neuropsychologists are in a unique position to facilitate a smooth transition from the hospital setting back to the school setting for a child or adolescent recovering from a TBI. It is important for the school district to have a plan in place for TBI students. For example, typically the school discovers that a student has sustained a TBI when the teacher or principal is notified by the parent, or in high-profile car accidents, school personnel see all of the details on the evening news. When the school finds out about a student who has been hospitalized for a TBI, the special education director should be notified. Ideally, there should be a TBI team in place within the district or region that can be contacted as well. The TBI team should be composed of a school neuropsychologist (or school psychologist), a speech and language pathologist, an occupational therapist, a school nurse, and a curriculum specialist (e.g., teacher, homebound instructor). Other specialized personnel, such as adaptive physical therapists or mobility specialists, can be called upon as needed and if they are available to the school district. The function of the TBI team is to interface with the hospital or medical setting and plan for the acute and long-term educational needs of the student.

Initially, the medical needs of the student take precedence. As the student's medical condition becomes stabilized and the student regains mental capacities, the school will need to provide some educational services. As the student recovers from the TBI, the educational services may range from homebound instruction to full reintegration into the regular classroom. The school-based TBI team needs to be a part of the decision-making process related to the child's educational needs as soon as possible. If the school-based TBI team can get involved early, the student should benefit from coordinated medical-home-school interventions. Rapid Reference 3.5 highlights some of the roles that a school-based TBI team can play in the student's course of recovery. See Begali (1992) or Semrud-Clikeman (2001) for more detailed reviews of how school neuropsychologists can help with a TBI student coming back to school.

A Child Who Has a Documented Rapid Drop in Academic Achievement that Cannot Be Explained by Social-Emotional or Environmental Causes

If a school neuropsychologist receives a referral for a student who has a sudden drop in academic achievement and symptoms of lethargy, headaches, increased irritability, diplopia (double vision), vomiting, or unexplained changes in personality and behavior, that child must be carefully evaluated. It must be determined if the student is experimenting with drugs or is overly medicated. Other possible explanations for this unusual behavior must be explored such as acute social-emotional changes or environmental causes. If all of these factors are ruled out, a school neuropsychological evaluation seems warranted. It is important to note that some aggressive brain tumors can cause a sudden change in academic performance. If a school neuropsychologist suspects that the child has a neurological condition, it may be warranted to first refer the child to a neurologist for a medical evaluation before proceeding with the assessment.

Children Not Responding to Evidence-Based Interventions

The recent federal educational laws such as NCLB (2001) and IDEA (2004) have placed an emphasis on early interventions using evidence-based instruc-

Rapid Reference 3.5

Possible Roles of School-based TBI Teams

Stage	Possible Functions
Initial identification of the TBI child.	• Provide counseling support to the school friends of the TBI student. • Provide the hospital with educational records upon parental/guardian release of information.
Medical treatment planning at the hospital.	• Attend the case staffing at the hospital to monitor the therapies received by the student (e.g., speech therapy, physical therapy) with the awareness that those therapies may need to be picked up by the school at a later stage of recovery. • Plan for the educational needs of the student as the student becomes medically stabilized. • Provide regular updates to the school personnel (e.g., special education director, principal, teachers).
Prior to hospital discharge.	• Arrange a home visit with the hospital rehabilitation personnel and the school-based TBI team to assess the physical layout of the home, any architectural barriers, and any potential hazards that would interfere with the student's discharge to the home. • Assess the school's physical layout, any architectural barriers, and any potential hazards that would interfere with the student's reintegration into the school. • Determine the need for in-service training, consultation, and/or peer preparation for the school staff and students and deliver appropriate education and counseling. • In conjunction with the hospital social worker and rehabilitation personnel, prepare the family for the reentry process. • Obtain medical records for educational programming upon appropriate release of the medical records by the parent/guardian. • Establish a follow-up schedule and post-discharge set of contacts.

(*continued*)

Stage	Possible Functions
	• Conduct a school-neuropsychological evaluation to determine the educational needs of the student.
School Reentry	• Put any special education or educational modifications in place and monitor regularly. • Coordinate the home/school/agency service delivery. • Monitor the educational progress of the student regularly and adjust the IEP goals as needed.

tional methods. If a child does not respond to multiple interventions, a child may be referred for a comprehensive evaluation by a multidisciplinary team to determine eligibility for special education and related services. What constitutes a comprehensive, multifactored evaluation will vary based on the referral question(s). In Chapter 13, the differences between psychoeducational and neuropsychological evaluations will be presented.

The purpose of a school neuropsychological evaluation will be to determine if there are neurocognitive explanations for a child's poor response to prior intervention(s) and to align new interventions with the neurocognitive assessment data. A school neuropsychological assessment, if conducted properly, can provide educators with a rationale for a targeted, prescriptive intervention that will likely succeed. For example, if the child has difficulty with reading due to a poor grasp of phonological skills, early intervention and remedial strategies to teach phonological processing should be tried. However, after a period of time during which the child has not shown adequate academic progress in reading, further assessment is needed to help guide alternative interventions.

Children with Suspected Processing Weaknesses

Typically, children with learning problems are administered a psychoeducational evaluation prior to a school neuropsychological evaluation. As an example, if children achieve low scores on the long-term memory cluster on the WJIII-COG (Woodcock, McGrew, & Mather, 2001a) or low Working Memory Index scores on the WISC-IV (Wechsler, 2003), then additional neuropsychological testing may be warranted. It is important to evaluate the relative strengths and weaknesses of children compared to their own scores (i.e., ipsative comparisons) and evaluate the children's scores relative to a norming group. Generally, a processing weakness is defined as an ipsative score of at least 1.5 standard deviations below the average of their other test scores and at least 1 standard deviation below the mean for a standardization group (i.e., standard score of 85 or lower). Some general interpretative guidelines will be presented in Chapter 15. The purpose of a school neuropsychological assessment with children who have suspected processing weaknesses is to establish, confirm, or deny the existence of any processing deficits, discuss the potential impact those deficits may have on the learning potential of the child, and link appropriate educational interventions to the assessment data (see Dehn, 2006, for a thorough review of processing assessment).

Children with Significant Scatter in Psychoeducational Test Performance

Children sometimes have an unusually large and significant range of performance on traditional psychoeducational measures. An example would be a child who obtains standard scores on the WJIII-COG ranging from 65 to 115, which is an occurrence obtained by 1 percent or less of children his or her age. If an examiner has confidence that the child put forth good effort and motivation while obtaining these scores, then the child is probably a good candidate for a school neuropsychological evaluation. The purpose of the school neuropsychological evaluation will be to tease out specific neurocognitive strengths and weaknesses, and to develop an intervention plan consistent with the unique learning profile of the child.

CONSIDERATION OF SPECIAL NEEDS CHILDREN

Modification of the Testing Materials and Standard Administration Instructions

Every effort should be made to administer tests following standardized instructions. However, a major part of the process-assessment approach is testing the limits. After the test has been administered in a standardized manner, the examiner may "test the limits" by asking individuals questions beyond the ceiling levels or modifying the questions to see if the child's performance will improve. The WISC-IV Integrated (Wechsler et al., 2004) is an example of a test that has standardized the testing of the limits concept. The WISC-IV Integrated will be discussed in Chapter 4. The scores from the standardized administration should always be reported. Scores generated from a modified administration may be reported if the examiner clearly reports how the test instructions or materials were modified. Scores from a modified administration should not replace scores from a standardized administration.

Many of the neuropsychological tests designed for school-aged children assume that the child's motor and sensory functions are intact (Hebben & Milberg, 2002). When a child's motor functions (e.g., poor fine motor coordination, poor gross motor coordination) or sensory functions (e.g., vision, hearing) are impaired, it becomes a challenge for the school neuropsychologist to assess the child. Ideally, if test modifications are needed for a particular child, the school neuropsychologist should first determine if there is a standardized test available to meet the child's needs. If customized modifications to the testing materials are made by the examiner to elicit a behavioral sample, the characteristic of these modifications must be reported. For example, to assess the receptive language skills in a visually impaired child, visual stimuli may need to be enlarged, or visual stimuli may need to be avoided altogether. Rapid Reference 3.6 presents some possible test modifications for children with special needs.

Recognizing the Influences of Cultural, Social-Economic, and Environmental Factors

It is assumed that the neuropsychological constructs, such as sensory-motor functions, attention, memory, executive functions, and so on, are universal across cultures, class, and race. It is the measurement of these neuropsychological constructs across cultures that represents the real challenge. The majority of neuropsychological tests are "conceived and standardized within the matrix of Western culture" (Nell, 2000, p. 3). There are two major barriers in the assessment of children from nonwesternized cultures: language differences and acculturation. When a 7-year-old child, who has recently come to the United States from Mexico, performs poorly on a test of intelligence, both the poor understanding of the English language and the poor knowledge of the U.S. culture may be contributing factors to the child's poor performance. Additionally, most nationally norm-referenced tests were not standardized on students outside of the United States.

There are many languages spoken in the United States. For example, when most people think about Texas they would say that English and Spanish were the primary languages spoken. They would be correct, but, as an example, there are 70 different languages spoken in the homes of Dallas Independent School District students (Dallas Independent School District web site). Ardila, Roselli, and

Rapid Reference 3.6

Possible Test Battery Modification for Children with Special Needs

Testing Children with Visual Impairments

- Administer verbal portions of standardized tests.
- Administer nonverbal tests that require spatial manipulation and problem solving but not sight.
- Administer a standardized or criterion-referenced test specifically designed to evaluate visually impaired children.

Testing Children with Hearing Impairments

- Have an interpreter use American Sign Language if possible for verbal tasks.
- Substitute written language for oral language.
- Give directions through pantomine, signing, or gesture.
- Use standardized nonverbal tests (e.g., Universal Nonverbal Intelligence Test [UNIT]; Bracken & McCallum, 1998).

Testing Children with Expressive Language Impairments

- Establish that an adequate output channel exists (e.g., pointing).
- Document expressive language deficits on standardized tests (e.g., NEPSY).
- Use nonverbal tests.
- Give directions through pantomime and gesture.

Testing Children with Motor Impairments

- Assess overall cognitive ability with verbal and motor-free tasks.
- Avoid speeded motor tasks.
- Test motor abilities without time constraints.

Source: Adapted from Hebben & Milberg, 2002, page 89.

Puente (1994) noted that a common solution to assessing a child whose primary language is not English is to use translations of the tests. There are very few foreign language neuropsychological tests designed for children. Rapid Reference 3.7 lists a sample of the tests that are available in a foreign language, which can be used in neuropsychological assessment.

Another approach to the lack of foreign language translations of neuropsychological tests is to use a translator to assist with the administration. There are several problems with using translators: (a) some of the concepts in the English version of the test are not directly translatable into a foreign language; (b) there is no guarantee that the translator will not embellish or alter the meaning of the questions via translation; and (c) even if a translator is used, most of the

Rapid Reference 3.7

Selected Foreign Language Translated Neuropsychological Tests

Test	What it Measures
• Batería III Woodcock-Muñoz (Woodcock, Muñoz-Sandoval, McGrew, & Mather, 2005)	The WJIII-Cognitive and Achievement Batteries translated into Spanish.
• Battelle Developmental Inventory–Second Edition (Newborg, 2005)	Personal-social, adaptive, motor, communication, and cognitive development in children, birth to 7–11 years. Spanish version available.
• Bilingual Verbal Ability Tests (BVAT; Muñoz-Sandoval, Cummins, Alvarado, & Ruef, 1998) • Bilingual Verbal Ability Tests (BVAT) Normative Update (Muñoz-Sandoval, Cummins, Alvarado, & Ruef, 2005)	Assesses the total knowledge of a bilingual individual using a combination of two languages. Norms available in 17 languages plus English.
• CELF-4 Spanish (Wiig, Secord, & Semel, 2006)	A comprehensive language assessment for Spanish speakers.
• Dean-Woodcock Neuropsychological Battery (Dean & Woodcock, 2003b)	Directions for the test are available in Spanish.
• Expressive One-Word Picture Vocabulary Test: Spanish-Bilingual Edition (EOWPVT-SBE; Brownell, 2000b)	Verbal Expression of Language for children who are bilingual in English and Spanish for ages 4–0 to 12–11 years.
• Preschool Language Scale, Fourth Edition (PLS-4) Spanish Edition (Zimmerman, Steiner, & Pond, 2002)	Receptive and expressive language skills in young children ages birth through 6–11 years.
• Receptive One-Word Picture Vocabulary Test: Spanish-Bilingual Edition (ROWPVT-SBE; Brownell, 2000d)	Receptive Vocabulary for children bilingual in English and Spanish, ages 4–0 to 12–11 years
• Test de Vocabulario en Imágenes Peabody (TVIP; Dunn, Lugo, Padilla, & Dunn, 1986)	Receptive Vocabulary for Spanish speaking and bilingual students ages 2–6 to 17–11 years

Test	What it Measures
• Test of Phonological Awareness in Spanish (TPAS; Riccio, Imhoff, Hasbrouck, & Davis, 2004)	Phonological Awareness in Spanish-speaking children ages 4–0 to 10–11 years.
• WISC-IV Spanish (Wechsler, 2004c)	The Spanish version of the WISC-IV.
• Woodcock-Muñoz Language Survey–Revised (Woodcock, Muñoz-Sandoval, Ruef, & Alvarado, 2005)	Establishes language proficiency level in English or Spanish in measures of reading, writing, listening, and comprehension.

neuropsychological tests lack appropriate normative samples for different cultures (Ardila et al., 1994). Rhodes (2000) developed a practical guide for using interpreters in a school setting that is relevant to school neuropsychologists.

The other major barrier in the assessment of children from nonwesternized cultures is acculturation. Acculturation is defined as "the change in cultural patterns that result from the direct and continuous firsthand contact of different cultural groups" (Pontón & Leon-Carrión, 2001, p. 40). Acculturation may be best conceptualized as a cluster of interrelated variables including "language, values, beliefs, attitudes, gender roles, psychological frames of references, skills, media preferences, leisure activities, observance of holidays, and cultural identity" (Felix-Ortiz, Newcomb, & Myers, 1994, as cited in Pontón & Leon-Carrión, 2001, p. 40).

Given the ever-growing culturally diverse populations with which school neuropsychologists are being asked to work, there are some possible approaches to assessment. Nell (2000) recommended that neuropsychologists should use a core test battery for cross-cultural assessment. The specific cognitive constructs that he recommended to be assessed in children are: visuomotor abilities, visuopraxis, stimulus resistance, working memory, auditory memory (immediate, delayed, and recognition), visual memory (immediate and delayed), and language. Nell (2000) provided descriptions of the various tests that could be used to measure each one of these cognitive domains.

Remember that the practice of school neuropsychology is largely a qualitative understanding of brain-behavior relationships and how those relationships are manifested in behavior and learning. Neuropsychological tests are tools to aid in assessing brain-behavior functions but they are not our only tools. Hess and Rhodes (2005) suggest that, given the scarcity of neuropsychological measures for culturally and linguistically diverse children, the clinical interview may be the best source of information. The neuropsychological assessment of culturally and linguistically diverse populations will continue to be a challenge for practitioners. Researchers, test authors, and publishers are encouraged to develop new measures that are ecologically valid and reliable for use with multiple populations.

This chapter has reviewed the common referral reasons for a school neuropsychological evaluation. The chapter concluded with a discussion on potential modifications for special needs children and recognizing the influences of cultural, social-economic, and environmental factors on school neuropsychological assessment. In the next chapter, Chapter 4, a conceptual model for school neuropsychological assessment will be presented.

TEST YOURSELF

1. All of the following are valid reasons for a neuropsychological evaluation except which one?

(a) A child returning to school after a head injury.

(b) A child with a valid large scatter in psychoeducational test performance.

(c) A mentally retarded child.

(d) A child who is not responding to multiple intervention strategies.

2. Which of the following refers to a decreased oxygen supply to the brain?

(a) anoxia

(b) repoxia

(c) dyspoxia

(d) hypoxia

3. It is not uncommon for children who suffer a brain injury to appear to recover and function normally, only to have learning and/or behavioral problems surface later on as their brains mature. True or False?

4. Which subtype of cerebral palsy (CP) affects 70–80 percent of CP patients with the symptoms of muscles stiffly and permanently contracted?

(a) spastic cerebral palsy

(b) ataxic cerebral palsy

(c) mixed cerebral palsy

(d) dyskinetic cerebral palsy

5. What is the most common type of malignant brain tumor in children?
(a) cerebellar astrocytoma
(b) medulloblastoma
(c) ependymoma
(d) brainstem glioma

6. Cocaine exposure prenatally leads to serious neurodevelopmental and neurobehavioral disturbances. True or False?

7. According to the research, the long-term neuropsychological deficits associated with acute lymphoblastic leukemia are:
(a) Modest deficits in reading, written language, and verbal immediate memory.
(b) Severe deficits in social skills, expressive language, and fine motor coordination.
(c) Modest deficits in arithmetic, visual-motor integration, and verbal fluency.
(d) Severe deficits in spelling, reading, and written language.

8. The juvenile form of this muscular dystrophy is associated with learning disabilities before onset of motor problems. ADHD and anxiety disorders may also be present.
(a) Congenital Muscular Dystrophy
(b) Myotonic Muscular Dystrophy
(c) Duchenne Muscular Dystrophy
(d) Becker Muscular Dystrophy

Answers: 1. c; 2. d; 3. true; 4. a; 5. b; 6. false; 7. c; 8. b

Four

A MODEL FOR SCHOOL NEUROPSYCHOLOGICAL ASSESSMENT

This chapter will begin with a review of school neuropsychology conceptual models previously reported in the literature. A proposed *Levels of Assessment Model* will illustrate where neuropsychological assessment fits within a broader range of assessment. Next, a comprehensive model for school neuropsychological assessment will be presented with a rationale for each component of the model. Finally, the major test batteries used for school neuropsychological assessment will be reviewed in this chapter, while the individual subcomponent-specific tests (e.g., memory and learning) will be presented in Chapters 5 through 11.

PRIOR MODELS FOR SCHOOL NEUROPSYCHOLOGY

Several models have been proposed in the literature for conceptualizing school neuropsychology. Three of these models: the functional organization approach, the transactional model, and the cognitive hypothesis-testing models will be highlighted in this section.

Fletcher and Taylor (1984) pointed out that children should not be viewed as miniature adults. They noted that the signs of brain-related dysfunction in adults could not be assumed to be the same in children, and that tests designed and validated on an adult population could not be assumed to measure the same constructs and functions in a child and adolescent population. Fletcher and Taylor (1984) proposed a model for developmental neuropsychology, called the *functional organization approach*. The central focus of the model was to understand the traits of common developmental disorders well enough to identify those neurocognitive subcomponents that define the disorders. The goal of this approach was not to localize brain regions that may or may not be affected by a particular disorder but rather focus on how normal development may be adversely affected. The rationale for this functional organization approach is consistent with the Functional Profile Stage of neuropsychology that was reviewed in Chapter 1.

In the 1980s, professionals in the field recognized that the adult neuropsychological model used to localize functions was not applicable to children.

Teeter and Semrud-Clikeman (1997) proposed a *transactional model of child clinical neuropsychology*. In the model, the authors recognize the importance of both genetic and environmental factors in the development and maturation of the central nervous system. The model also illustrates the bidirectional influence of the subcortical and cortical regions of the brain on various neurocognitive functions. The neurocognitive functions were said to form the foundations for intelligence or cognitive abilities, which in turn influence academic, behavior, and social functions. The basic tenets of the transactional neuropsychological paradigm were: the appreciation of the neuropsychological correlates of psychiatric, neurodevelopmental, and acquired disorders of childhood; the understanding of the neurodevelopmental course of those disorders; and a recognition of the importance of the moderating variables (e.g., cognitive, social, behavioral) on the overall adjustment of children who have neurodevelopmental disorders. The rationale for this transactional model of child clinical neuropsychology is consistent with the Integrative Stage of neuropsychology that was reviewed in Chapter 1. In the 1990s, professionals in the field started to use multiple methods to study neurodevelopmental disorders (e.g., neuroimaging, genetics, comparative neuropsychology).

Hale and Fiorello (2004) proposed a *cognitive hypothesis-testing (CHT) model*. The authors combine two approaches into their model: (a) individual psychoeducational assessment, and (b) intervention development and monitoring, using both behavioral interventions and problem-solving consultation. Inherent in their model is a respect for assessing the child's behavior within the confines of his or her environment and for assessing the influences of the neuropsychological constraints on the child's behavior. The authors advocate using behavioral analyses to track intervention progress and they stress the importance of single-subject designs. However, unlike the strict behaviorists that advocate for behavioral assessment and monitoring exclusively, Hale and Fiorello (2004) also recognized the importance of using information about the child's cognitive functioning in forming appropriate and effective interventions.

The baseline component of the CHT Model is the stated need for school psychologists to engage in more indirect service delivery, such as consultation and serving on prereferral intervention teams. Hale and Fiorello's advocacy for an indirect service delivery model that relies on problem-solving techniques is consistent with the positions taken by the national school psychology organizations for almost 20 years. An indirect service-delivery model has become paramount in recent years because of the increasing shortage of school psychologists

(Miller & Palomares, 2000). With the recent reauthorization of IDEA 2004 and the potential adoption of a response-to-intervention model for special education, the school psychology field may finally have a stronger push for utilizing prereferral intervention teams and an evidenced-based problem-solving approach.

The CHT Model has four component parts: theory, hypothesis, data collection, and interpretation. Hale and Fiorello (2004) propose that once a child is referred for a psychoeducational or school neuropsychological evaluation there are up to 13 steps in a CHT evaluation. Rapid Reference 4.1 illustrates the CHT Model. Hale and Fiorello (2004) pointed out that the majority of psychoeducational evaluations stop at step 5 in the model. Recent federal mandates, such as NCLB of 2001 and IDEA of 2004, will require educators to implement steps 9 through 13, which is consistent with the Tier I and II levels of a response-to-intervention model.

A key component of the CHT Model, particularly the assessment component, is the analysis of the neurocognitive demands/solution strategies required to perform a given task. To generate hypotheses about why a particular child performed poorly or well on any given task, the examiner must understand the neurocognitive demands/solution strategies for successful performance on the task. An examiner can obtain this information in several ways. First, the examiner can access the promotional literature about the test from the test publishers and read what the test is reported to measure. Second, the examiner can read the test manual to evaluate the test's construct validity: Does the test measure what it reports to measure? Third, the examiner can read the research literature about the test to see how it can be used with clinical populations and how it relates to similar measures. Fourth, further training in school neuropyschology provides the examiner a greater understanding of the neuropsychology constructs vital for the development of reading, math, writing, and spelling. The second and third methods, stated previously, are the most reliable methods for obtaining the demand characteristics of a particular test.

The CHT Model relies heavily on Lurian and process-oriented approaches to neuropsychological assessment. In the CHT Model, if a global deficit is observed in a child's assessment data, a reason for the global deficit is hypothesized and then further tested for specific deficits. This approach is consistent with the Lurian and process-oriented approaches. In this section of the chapter, three previously formulated theories on how to approach school neuropsychology have been reviewed. Rapid Reference 4.2 presents a comparison of the basic tenets of the three prior theories of school/pediatric neuropsychology. In the next sections of this chapter a levels of assessment model and a conceptual model for

Rapid Reference 4.1

The Cognitive Hypothesis-Testing (CHT) Model

The CHT Assessment Process

1. Develop a theory of the presenting problem.	Theory
2. Generate a hypothesis of whether cognitive functioning is related to the specific academic or behavioral deficit area in question.	Hypothesis
3. Administer and score cognitive abilities measures.	Data Collection
4. Interpret the neurocognitive demands of the cognitive abilities measures.	Interpretation
5. Determine neurocognitive strengths and weaknesses from a theoretical perspective.	Theory
6. Based on the overall profile of neurocognitive strengths and weaknesses, generate additional hypotheses to confirm or reject the global findings.	Hypothesis
7. Choose tests that further explore and refine the neurocognitive strengths and weaknesses observed globally.	Data Collection
8. Data from multiple sources are interpreted and integrated to gain understanding of the presenting problems.	Interpretation

The CHT Intervention Process

9. Possible interventions are explored in consultation with the teacher(s) and parent(s).	Theory
10. An empirically based intervention plan that is related to the assessment results is developed.	Hypothesis
11. The systematic intervention plan is then implemented with efficacy data collected along the way.	Data Collection
12. The effectiveness of the intervention is determined.	Interpretation
13. If the intervention is not effective, return to steps 9–12, then develop and test the effectiveness of another intervention strategy.	Theory

Source: Adapted from Hale and Fiorello (2004, p. 129).

Rapid Reference 4.2

Comparison of Three School/Pediatric Models

Model	Principle Tenets
Functional organization approach (Fletcher & Taylor, 1984)	• Children cannot be viewed as miniature adults. • Adult models and downward extensions of adult tests may not be appropriate for children. • Neurocognitive subcomponents of developmental disorders must be understood. • Moderating influences of developmental factors on neuropsychological performance recognized and accounted for.
Transactional model of child clinical neuropsychology (Teeter & Semrud-Clikeman, 1997)	• Neuropsychological correlates of psychiatric, neurodevelopmental, and acquired disorders of childhood appreciated. • Neurodevelopmental course of those disorders understood. • Importance of the moderating variables on the overall adjustment of children who have neurodevelopmental disorders recognized.
Cognitive hypothesis-testing (CHT) model (Hale & Fiorello, 2004)	• Assess the child's behavior within the confines of his or her environment. • Assess the influences of the neuropsychological constraints on the child's behavior. • Employ an indirect consultation model and problem-solving approach model. • Identify the demand characteristics/solution strategies required for successful task completion. • Conduct systematic hypothesis testing.

school neuropsychological assessment will be presented. These models adhere to many of the same tenets of the functional organization approach, the transactional model, and the CHT model.

LEVELS OF ASSESSMENT MODEL

It is uncommon for a child to be referred for a neuropsychological evaluation without some prior history of formal or informal assessment. Typically, neuropsychological evaluations fall within a levels of assessment model. See Figure 4.1 for an illustration of the levels of assessment model.

When a child is evidencing signs of a learning problem (e.g., poor acquisition of reading skills), the first step in the assessment model is to identify the extent of the problem. The classroom teacher may try a variety of educationally sound teaching techniques to remediate the identified academic deficiency. The child's parent(s)/guardian(s) may be informed of these interventions and deficit skill levels through normal means (e.g., grade cards, parent-teacher conferences). At this level of intervention, the teacher may choose to use a variety of informal measures to assess the child's current skill levels. These assessments are typically criterion-referenced tests to determine skill strengths and weaknesses. This level of assessment and intervention would fall within the first tier of the Response-to-Intervention (RTI) model.

When a series of interventions have failed to produce the desired educational remediation, teachers often seek consultation from additional colleagues. Children with learning problems who have not responded to in-class interventions are often referred to student assistance teams. These teams are typically composed of regular education teachers, special education teachers, and specialized instructional support personnel (e.g., school psychologists, curriculum specialists). The purpose of these student assistance teams (note: these are referred to

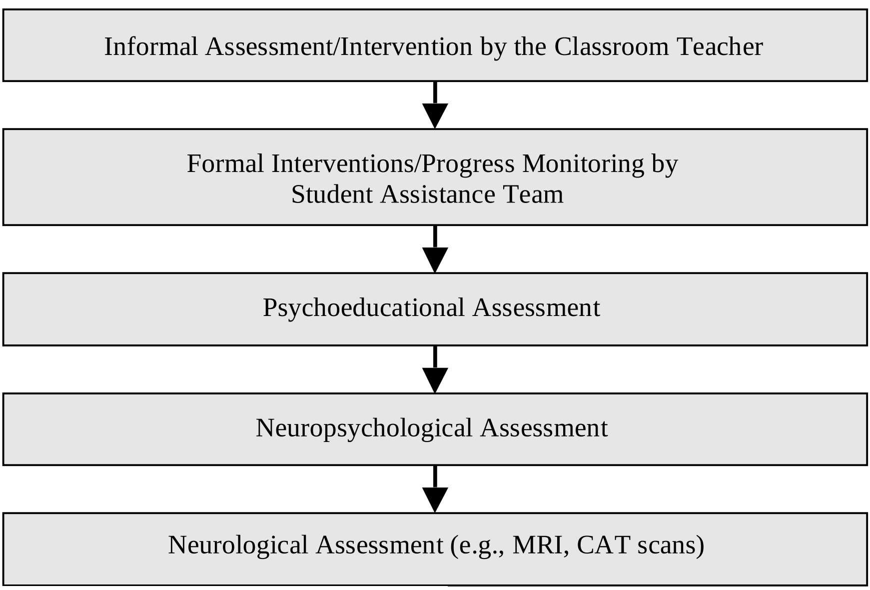


Figure 4.1 Levels of assessment model

by many different names across states but all serve the same function) is to suggest interventions to the teacher(s) of the child and to monitor the effectiveness of those interventions. Curriculum-based measurements would typically be used at this level to monitor the effectiveness of the intervention. This level of assessment and intervention would fall within the second tier of the RTI model.

If a child failed to respond to a series of research-based interventions, the pre-referral intervention team may choose to refer the child for a psychoeducational assessment. The purposes of the psychoeducational assessment may be two fold: (a) identify strengths and weaknesses that may be used to target prescriptive interventions, and (b) qualify the child for special education services. A traditional psychoeducational assessment will include a measure of intellectual/cognitive functioning, a measure of academic functioning, and perhaps a measure of visual-motor functioning and a social-emotional screener.

When a child fails to respond to special education services or if there is a suspected neurological basis for the child's learning difficulties, the child may be referred for a neuropsychological evaluation. A neuropsychological assessment is more thorough than a psychoeducational assessment (see Chapter 13 for a discussion of the differences between psychoeducational, psychological, and neuropsychological assessments). The purpose of the neuropsychological evaluation is typically not to qualify a child for special education services, except in the case of Traumatic Brain Injury, but rather to provide educators and parents with a comprehensive overview of the child's neurocognitive strengths and weaknesses and may be used to tailor instructional strategies. The psychoeducational and neuropsychological assessments would fall within the third tier of the RTI model.

There are times after a school neuropsychological (school-based) or pediatric neuropsychological (private practice-based) evaluation has been conducted that the child is referred to a neurologist for a consultation. For example, if the child is experiencing a rapid decline in global or specific cognitive functions that cannot be explained by social-emotional or environmental factors, a referral to a neurologist may be warranted. The child may be evidencing signs of a brain tumor or other degenerative neurological disease.

This level of assessment model is not an invariant sequence—meaning that the only way a child could get referred for a neurological consultation would be to first pass through all of the other levels of assessment. As an example, if a child has suspected seizures, a referral to a neurologist is recommended immediately without other formal assessments. Another example is referring a child for a neuropsychological evaluation if there is a suspected head injury. The further a child progresses down the levels of assessment model, there are additional costs in terms of money and time. Knowing when and when not to refer for additional assessments is a major role that school neuropsychologists can play in the schools to maximize the benefits for children that really need the additional evaluations.

SCHOOL NEUROPSYCHOLOGICAL ASSESSMENT MODEL OVERVIEW

Figure 4.2 illustrates a conceptual model for school neuropsychological assessment. A rationale for each component of the model, starting at the bottom and working up, will be presented.

Each of the areas within the conceptual model will be further defined and refined in other chapters; however, a brief overview is provided here. *Sensory-motor functions* and *attentional processing* serve as the essential building blocks for all other higher-order cognitive processes. *Sensory functions* include baseline assessments of vision, hearing, and touch. Motor functions include baseline assessments of fine and gross motor skills, visual-motor integration, and balance and coordination. An examiner does not want to attribute a poor performance on a higher-order cognitive task to a cognitive process like auditory short-term memory, if the

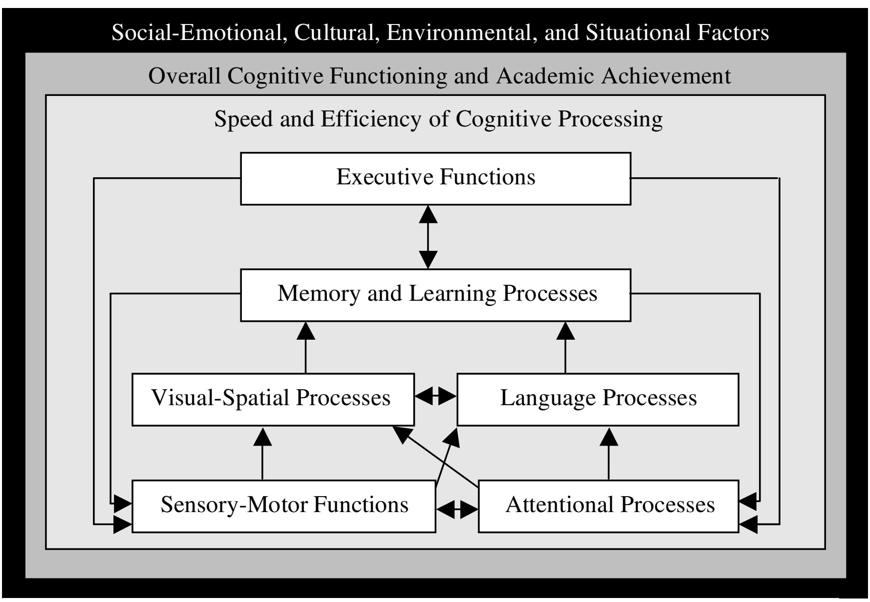


Figure 4.2 Conceptual model for school neuropsychological assessment

true reason for the poor performance is poor auditory acuity. Chapter 5 will review sensory-motor functions.

Attention is not a unitary construct. It is important for a school neuropsychologist to understand how *attentional processes* can be subdivided into selective/focused attention, sustained attention, shifting attention, and attentional capacity components. Chapter 6 will review attentional processes.

The cognitive processes considered next in the conceptual model are *visual-spatial* and *language processes*. Visual-spatial skills are subdivided into the following areas: visual perception (with motor response), visual perception (no motor response), visual-perceptual organization, and visual scanning/tracking. Chapter 7 will review visual-spatial processes. *Language processes* are subdivided into the following areas: phonological processing, receptive language, and expressive language. Chapter 8 will review language processes.

Memory and learning is dependent upon sensory-motor functions, attentional processes, visual-spatial processing, and language processes. In Chapter 9, memory and learning will be conceptually divided into five major classifications: immediate memory, long-term (delayed) memory, associative memory and learning, working memory, and semantic memory.

Executive functions are the command and controls for the other cognitive processes. In Chapter 10, executive functions will be classified based on their frontal-subcortical circuitry. *Speed and efficiency of cognitive processing* cuts across all of the processes. Chapter 11 will review three constructs of speed and efficiency: processing speed, cognitive efficiency, and cognitive fluency.

Intelligence tests measure a combined sum of the various processes presented in the conceptual model. From a school neuropsychological perspective, the overall *g* of intelligence will be the least useful measure; rather the quantitative and qualitative performance on the individual tests will be utilized the most. Chapter 12 will illustrate how not all cognitive abilities tests have the same mixture of processes and skills. Also, the cognitive processes presented in the conceptual model do not operate within a vacuum. Academic achievement is the manifestation of a child's cognitive profile. A brief overview of academic achievement will also be presented in Chapter 12.

Finally, the cognitive profile of a child must be considered within the social-emotional, cultural, environmental, and situational specific factors. Considerations of these factors were reviewed in Chapter 3.

Chapter 13 will illustrate how this conceptual model can be integrated into a school neuropsychological assessment, and Chapter 14 will present a sample report. After defining the subcomponents of the model, discussing the neuroanatomical bases for each, and methods to assess in each area, Chapter

15 will review some clinical interpretation guidelines. Chapter 16 will illustrate how the school neuropsychology conceptual model may be applied to a common neurodevelopmental disorder.

Prior to the 1990s, practitioners interested in conducting neuropsychological assessments with a pediatric population were limited to the Halstead-Reitan or Luria-Nebraska Batteries, as reviewed in Chapter 1. Currently there are three major test batteries designed to assess for neuropsychological functioning in school-aged children: the NEPSY, the WISC-IV Integrated, and the Delis-Kaplan Executive Functions System (D-KEFS). The remainder of this chapter will provide an overview of these three test batteries.

MAJOR NEUROPSYCHOLOGICAL TEST BATTERIES FOR CHILDREN

NEPSY/NEPSY-II: A Developmental Neuropsychological Assessment

The *NEPSY* (Korkman, Kirk, & Kemp, 1998) was the first neuropsychological test battery specifically designed for children ages 3 to 12. The NEPSY-II (Korkman, Kirk, & Kemp, 2007) has some major differences from the NEPSY. A significant, beneficial change is the upward extension of the test to 16 years-11 months. The NEPSY-II also includes new subtests and has removed the domain scores.

Marit Korkman originally developed the first version of the test in Finland in the 1980s. The NEPSY was expanded and restandardized on a large sample of U.S. children based on the 1995 U.S. census data. Likewise, the NEPSY-II was expanded and restandardized on a sample of U. S. children based on the 2000 U.S. census data. The NEPSY/NEPSY-II are based on Lurian theory and have a strong process-oriented approach embedded in the tests. Data obtained from the NEPSY/NEPSY-II are interpreted in both a quantitative and qualitative manner.

The NEPSY/NEPSY-II tests have four purposes:

1. to be sensitive to the subtle deficiencies across and within the five functional domains and to help to formulate interventions;
2. to aid in understanding of the effects of congenital or acquired brain damage so interventions can be planned;
3. to use in long-term follow-up of children with acquired or congenital brain damage or dysfunction; or
4. to study neuropsychological development in preschool-age children (Kemp, Kirk, & Korkman, 2001).

The NEPSY/NEPSY-II batteries assess five functional domains: Attention/Executive Functions, Language, Sensorimotor, Visuospatial, and Memory and Learning. Rapid Reference 4.3 shows the NEPSY subtests for each of the five functional domains.

Kemp, Kirk, and Korkman (2001) outlined the following strengths of the NEPSY:

- Child-friendly materials.
- Ease of administration.
- A large, fully represented standardization sample.
- Over sampling of minority groups and potential bias review.
- Qualified examiners collected standardization data.
- All subtests normed on the same standardization sample.
- Developmental trends can be observed within and across functional domains.
- Flexibility in administration (core or expanded batteries, or selective subtest).
- Inclusion of standard scores for cross-battery comparisons.
- Dissociation of subcomponents of deficits is possible when comparing subtest performance.
- Inclusion of supplemental scores used in process-oriented analyses.
- Inclusion of base rates for qualitative observations.

Kemp, Kirk, and Korman (2001) outlined the following weaknesses of the NEPSY:

- Subtests not highly correlated with the Core Domain scores.
- Complex recording and administration procedures (i.e., Auditory Attention and Response Set subtest).
- Complex scoring and different types of scores (i.e., standard scores, scaled scores, percentile classification rankings).
- No visual memory subtest.

These weaknesses appear to be addressed in the NEPSY-II. A description of the NEPSY-II subtests by domain is presented in Rapid Reference 4.4.

Wechsler Intelligence Scale for Children–Fourth Edition Integrated

The *WISC-IV Integrated* (Wechsler, 2004b) reflects the revision of the *WISC-IV* (Wechsler, 2003) and the updated process-assessment approach tasks and procedures originally used in the *WISC-III as a Processing Instrument* (*WISC-PI;*

Rapid Reference 4.3

NEPSY Subtests by Domain

Domain	Ages 3–4	Ages 5–12
Attention/ Executive Functions		Tower*
		Auditory Attention and Response Set*
	Visual Attention*	Visual Attention*
	Statue*	Statue
		Design Fluency
		Knock and Tap
Language	Body Part Naming*	
	Phonological Processing*	Phonological Processing*
	Comprehension of Instructions*	Comprehension of Instructions*
		Speeded Naming*
		Repetition of Nonsense Words
	Verbal Fluency	Verbal Fluency
	Oromotor Sequences	Oromotor Sequences
Sensorimotor	Imitating Hand Positions*	Imitating Hand Positions*
	Visuomotor Precision*	Visuomotor Precision*
		Fingertip Tapping*
	Manual Motor Sequences	Manual Motor Sequences
		Finger Discrimination
Visuomotor	Design Copying*	Design Copying*
		Arrows*
	Block Construction*	Block Construction
		Route Finding
Memory/ Learning		Memory for Faces*
		Memory for Names*
	Narrative Memory*	Narrative Memory*
	Sentence Repetition*	Sentence Repetition
		List Learning

* Part of the Core Assessment Battery.

Rapid Reference 4.4

NEPSY-II Subtests by Domain

Subtest	Age Range	Description
Measures of Executive Functioning		
Animal Sorting **(New)**	7–16	Assesses the ability to formulate basic concepts, sort those concepts into categories, and shift sets from between categories.
Auditory Attention and Response Set	5–16	The subtest has two parts. The first part assesses selective and sustained auditory attention. The second task adds a shifting attention component.
Clocks **(New)**	7–16	Assesses planning and organization, visuospatial skills, and the concept of time in relation to analogue clocks.
Design Fluency	5–12	Assesses the ability to generate unique designs by connecting dots presented in either a structured or random array.
Inhibition **(New)**	5–16	A timed test that assesses the ability to inhibit automatic responses in favor of novel responses.
Knock and Tap	5–12	Assesses self-regulation and inhibition.
Statue	3–6	Assesses motor persistence and inhibition.
Measures of Language		
Body Part Naming and Identification	3–4	Assesses confrontational naming, name recognition, and basic components of expressive and receptive language.
Comprehension of Instructions	3–16	Assesses the ability to perceive, process, and execute oral instructions of increasing syntactic complexity.
Oromotor Sequences	3–12	Assesses oromotor coordination.
Phonological Processing	3–16	Assesses phonological processing for word segments (syllables) and letter sounds (phonemes).
Recognition of Reversals **(New)**	5–16	Assesses recognition of reversals in letters and numbers.
Repetition of Nonsense Words	5–12	Assesses phonological encoding and decoding.

Subtest	Age Range	Description
Speeded Naming	3–16	Assesses rapid access to and production of names of colors, shapes, letters, numbers, or sizes.
Verbal Fluency	3–16	Assesses the ability to generate words within specific semantic or phonemic categories.
Measures of Memory and Learning		
List Learning	7–12	Assesses immediate and delayed recall, rate of learning, the role of interference, and retention after interference.
Memory for Designs **(New)**	3–16	Assesses spatial memory for novel visual material.
Memory for Faces	5–16	Assesses encoding of facial features, as well as face discrimination and recognition.
Memory for Names	5–16	Assesses verbal-visual associative immediate and delayed memory.
Narrative Memory	3–16	Assesses narrative memory under free recall, cued recall, and recognition conditions.
Sentence Repetition	3–6	Assesses the ability to repeat sentences of increasing complexity and length.
Word List Interference **(New)**	7–16	Assesses verbal working memory, repetition, and word recall following interference.
Measures of Sensorimotor Functioning		
Fingertip Tapping	5–16	The subtest has two parts. Part 1 assesses finger dexterity and motor speed. Part 2 assesses rapid motor programming.
Imitating Hand Positions	3–12	Assesses the ability to imitate hand/finger positions.
Manual Motor Sequences	3–12	Assesses the ability to imitate a series of rhythmic movement sequences using one or both hands.
Visuomotor Precision	3–12	Assesses graphomotor speed and accuracy.
Measures of Social Perception		
Affect Recognition **(New)**	3–16	Assesses the ability to recognize affect from photographs of children's faces.

(continued)

Subtest	Age Range	Description
Theory of Mind **(New)**	3–16	Assesses the ability to understand mental functions, such as belief, intention, deception, emotion, imagination, and pretending, as well as the ability to understand how emotion relates to social context and to recognize the appropriate affect given various social contexts.
Measures of Visuospatial Processing		
Arrows	5–16	Assesses the ability to judge line orientation.
Block Construction	3–16	A timed subtest that assesses the visuospatial and visuomotor ability to reproduce three-dimensional constructions from models or two-dimensional drawings.
Design Copying	3–16	Assesses the ability to copy two-dimensional geometric figures.
Geometric Puzzles **(New)**	3–6	Assesses mental rotation, visuospatial analysis, and attention to detail.
Picture Puzzles **(New)**	7–16	Assesses visual discrimination, spatial localization, and visual scanning, as well as the ability to deconstruct a picture into its parts and recognize part-to-whole relationships.
Route Finding	5–12	Assesses knowledge of visual-spatial relations and directionality, as well as the ability to use this knowledge to transfer a route from a simple schematic map to a more complex one.

Kaplan et al., 1999). Figure 4.3 shows the framework of the *WISC-IV Integrated* test structure. The *WISC-IV* yields a Full Scale score, which is composed of four indices: Verbal Comprehension, Perceptual Reasoning, Working Memory, and Processing Speed. Each index has core subtests and at least one supplemental subtest. A description of the *WISC-IV* subtests, what they measure, and how they can be used in a school neuropsychological evaluation will be discussed later in Chapter 12, General Intellectual Functioning and Academic Achievement.

The *WISC-IV Integrated* may be purchased as a supplement to the

DON'T FORGET

The *WISC-IV Integrated* tests are not routinely administered to all children. The tests are intended to be used on an as-needed basis to aid in the clinical interpretation of the *WISC-IV* test results.

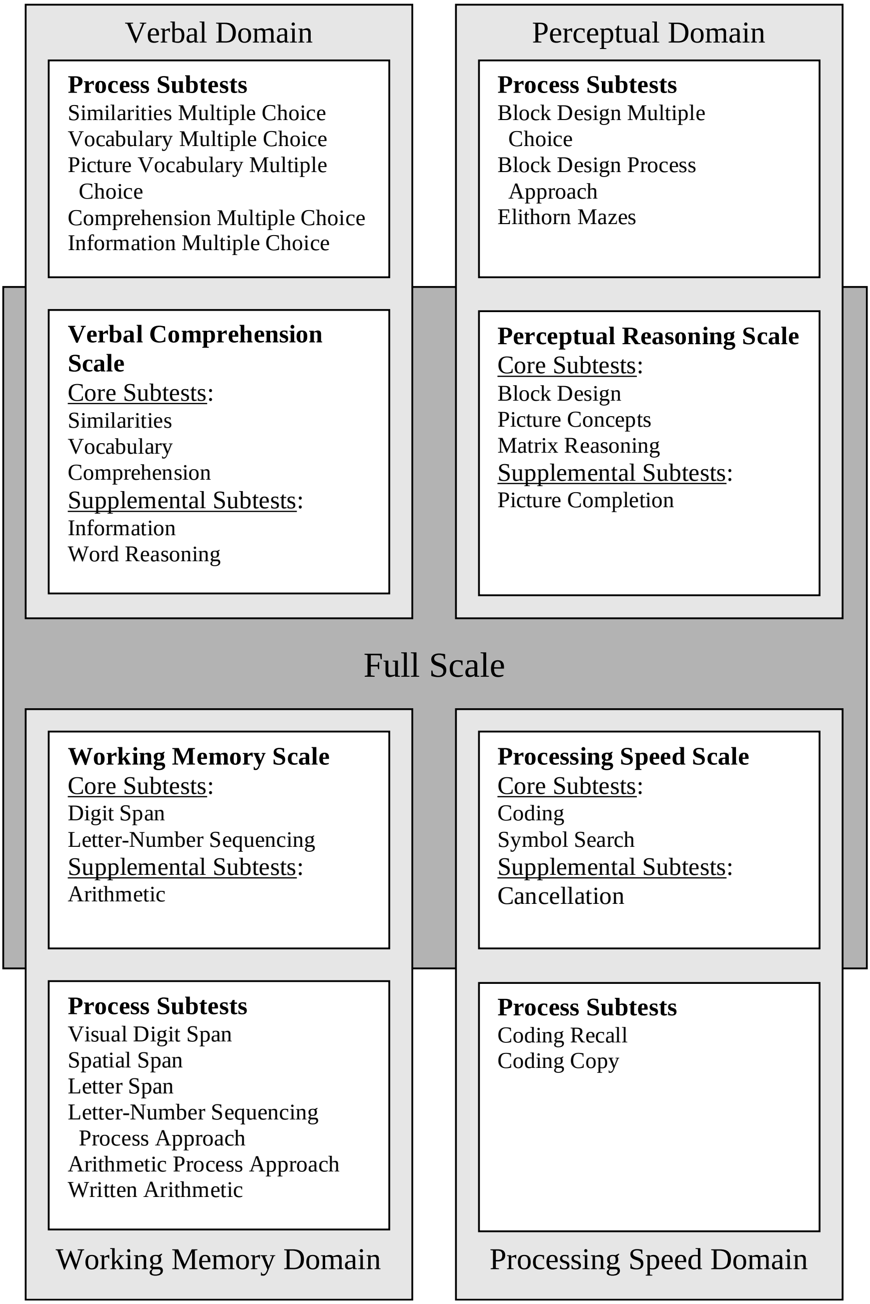


Figure 4.3 The WISC-IV Integrated test framework (adapted from Wechsler et al., 2004).

stand-alone *WISC-IV* kit or as a stand-alone product. The stand-alone version of the *WISC-IV Integrated* incorporates the process-assessment approach into one manual and record form and a combined set of stimulus booklets (Prifitera, Saklofske, & Weiss, 2005). There are sixteen process subtests on the *WISC-IV Integrated*. Some of the *WISC-IV Integrated* subtests help clinicians to better understand the cognitive processes that are involved in the performance of the core or supplemental *WISC-IV* tests (Design Multiple Choice, Block Design Process Approach, Coding Copy), while subtests from the *WISC-IV Integrated* modify the input modality or item content to better understand the cognitive processes that are involved in the performance of the core or supplemental WISC-IV tests (Elithorn Mazes, Visual Digit Span, Spatial Span, Letter Span, Letter-Number Sequencing Process Approach; McCloskey & Maerlender, 2005). Another important feature of the *WISC-IV Integrated* is the coding of qualitative observations during assessment. An example of a qualitative observation is the number of times a child asks for repetitions on the Arithmetic subtest. The frequency of these qualitative behaviors has been translated into norm-referenced base rates and may be used for clinical interpretation.

The *WISC-IV Integrated* subtests are not routinely administered to all children. McCloskey and Maerlender (2005) pointed out that the process subtests are intended to be used on an as-needed basis. For example, if a child performs poorly on the *WISC-IV* Vocabulary subtest, the examiner may want to "test the limits" and administer the *WISC-IV Integrated* Vocabulary Multiple Choice subtest. The Vocabulary Multiple Choice subtest from the *WISC-IV Integrated* is designed to measure word knowledge and verbal concept formation as is the Vocabulary subtest on the *WISC-IV*. The difference between the two measures is that the multiple-choice format decreases the demands for verbal expression and memory retrieval (Wechsler et al., 2004). The memory demands shift from a recall-memory task (*WISC-IV Vocabulary*) to a recognition-memory task (*WISC-IV Integrated Vocabulary Multiple Choice*). The *WISC-IV Integrated* process subtests are reviewed based on where they are conceptually located in the test framework (see Figure 4.3).

Verbal Comprehension Process Subtests

Similarities Multiple Choice, Vocabulary Multiple Choice, Picture Vocabulary Multiple Choice, Comprehension Multiple Choice and Information Multiple Choice subtests fall under the Verbal domain. These subtests use the same content as the WISC-IV version of the test, except the response format is changed from free recall to recognition. The goal of these subtests was to decrease the demands for verbal expression and memory retrieval. An example would be a Vocabulary item that asked the child "What is a banana?"; whereas, on the Vocabulary Multiple Choice subtest, the question would be: "Is a banana a: (a) vegetable, (b) mineral, (c) fruit, (d) meat. Generally, when the Multiple Choice scaled score is greater than the *WISC-IV* scaled score it supports the hypothesis that the child may have difficulty with retrieval of verbal concepts if external prompts or cues are not available. If the *WISC-IV* scaled score is higher than the Multiple Choice scaled score it may indicate that "the child may have difficulty rejecting salient but conceptually lower-level distracters, or impulsively choose responses without careful consideration of options" (Wechsler et al., 2004, p. 189).

Perceptual Reasoning Process Subtests

Block Design No Time Bonus

On the *WISC-IV* Block Design subtest, the child gets a higher scaled score if the designs are completed quickly. If a child has a processing speed deficit, a low score on Block Design may, in part, be due to the slow processing speed. The examiner may "test the limits" of the Block Design subtest by administering the test again but without the time bonus. If a child obtains a higher scaled score on Block Design with no Time Bonus compared to the Block Design subtest, then factors such as slow processing speed, poor visual-perceptual processing, weak motor skills, or slow rates of cognitive processing could account for the difference between the two scores (Wechsler et al., 2004).

Block Design Multiple Choice

This subtest is designed to measure visual-perceptual and perceptual-organizational skills while removing the motor planning and execution demands placed on the *WISC-IV* Block Design subtest. On the *WISC-IV* Block Design subtest, the child is shown a two-dimensional picture of a block design and the child is asked to construct the design using three-dimensional blocks. On the Block Design Multiple Choice subtest, the child is shown a two-dimensional design and must choose from four response options within a specified time limit. The multiple-choice format of the test decreases the motor response demands and relies more on visual-spatial processing. The Block Design Multiple Choice subtest also includes a section in which the child is shown a three-dimensional design and must choose from four response options within a specified time limit. This version of the test requires more mental imaging. The Block Design Multiple Choice subtest can be administered in timed and untimed conditions to test for the negative influences of processing speed, motor skills, and so on.

Block Design Process Approach

For each item of this subtest, the child is presented more blocks than needed to construct the block design. Part of the task is for the child to figure out the number of blocks needed to complete the task. The child is presented with a two-dimensional picture of a block design and asked to construct the design using the correct number of blocks. If the child does not construct the block design correctly within the time limits, a grid overlay is placed over the stimulus picture of the block design to provide additional visual cues for the child. Performance across the two conditions—no grid and grid is needed—are combined to form the test score. A child who has difficulties processing global details will often have an improved performance with the presence of the grid overlay (Wechsler et al., 2004). The types of errors made during the construction of the block designs is also recorded by the examiner and evaluated qualitatively.

Elithorn Mazes

On this subtest, the child is presented with a maze in the Response Booklet and instructed to draw a path through a specified number of dots to move from the bottom to the top of the maze. The test is administered in two conditions: timed and untimed. The test is designed to measure "scanning ability, visual and motor sequential processing, planning, organization, motor execution, and ability to inhibit impulsive responses" (Wechsler et al., 2004, p. 112). The examiner is instructed to record the time it takes the child to make the first move (i.e., latency time), which is a reflection of an impulsive or reflective style of processing. Low scores on this test may be due to a variety of factors including: poor comprehension of the instructions, poor planning and execution, impulsivity, slow processing speed, poor graphomotor speed, obsessive-compulsive tendencies, and so on (Wechsler et al., 2004).

Working-Memory Process Subtests

Visual Digit Span

On the *WISC-IV* Digit Span subtest, the child is presented with a set of digits with increasing length and asked to recall them in the exact order presented by the examiner. On the Visual Digit Span subtest, the length of the digit spans are the same but the digit sets are presented visually rather than verbally. The child is instructed to repeat the numbers in the same order in which they were presented. Visual Digit Span is principally a measure of visual short-term memory. This subtest does not have a backward repetition condition, like the *WISC-IV Digit Span* subtest, which would be a more direct measure of working memory.

Spatial Span

The Spatial Span subtest is designed to be a nonverbal analog to the *WISC-IV* Digit Span subtest. The child is presented with a board that has a series of raised blocks attached to it. The examiner touches the blocks one at a time in a sequence and asks the child to then touch the blocks in the same order. The task is divided into two trials: Spatial Span Forward (measuring visual short-term memory) and Spatial Span Backward (measuring visual-spatial working memory).

Letter Span

This subtest is a variation of the *WISC-IV* Digit Span subtest. The Letter Span subtest uses letter strings of the same span length rather than numbers. The subtest does include both rhyming (i.e., *t, g, e*) and nonrhyming (i.e., *g, r, s*) letter strings. Performance on this subtest may be compared to performance on the Digit Span subtest "as a means of assessing the differences between auditory encoding skills and auditory-verbal processing of letters versus numbers" (Wechsler et al., 2004, p. 113).

Letter-Number Sequencing Process Approach

This subtest is similar to the *WISC-IV* Letter-Number Sequencing subtest. Both versions measure sequencing ability, mental manipulation, attention, short-term auditory memory, working memory, visuospatial imaging, and processing speed (Wechsler et al., 2004). On the Letter-Number Sequencing Process Approach, the child is read a sequence of letters and numbers, some of which contain an embedded word. The child is instructed to first recall the letters from the original list in alphabetical order followed by the numbers in ascending order. The embedded word placed in some trials is designed to provide a memory cue that reduces the demands placed on auditory working memory.

Arithmetic Process Approach

This subtest contains the same items as the *WISC-IV* Arithmetic subtest, but rather than presenting the math problems verbally, the items are presented in different formats. In Part A, the math problem is read to the child while the child looks at the same item in writing on a page. In Part B, the child is given the same problems to solve with the addition of a paper and pencil to assist in calculations. The pairing of the visual–verbal presentation of items and the use of a paper and pencil help decrease the demands on attention and working memory (Wechsler et al., 2004).

Written Arithmetic

This subtest uses the same problems as in the Arithmetic and Arithmetic Process Approach subtests, but the problems are taken out of the story problem format and put in a mathematical calculation format. The subtest is timed. This subtest is designed to measure numerical reasoning ability while reducing the demands placed on attention and language-processing skills.

Processing-Speed Process Subtests

Coding Recall

The purpose of this subtest is to measure the amount of incidental learning that occurred after Coding B is administered. The subtest contains three parts. Part A (Cued Symbol Recall) shows the child the numbers that were part of the number–symbol associations learned in Coding B, and the child is asked to recall and fill in the symbols that were paired with the numbers. On Part B (Free Symbol Recall), the child is asked to write as many symbols as he or she can remember on a blank space in the Response Booklet. On Part C (Cued Digit Recall), the child is shown the symbols that were part of the symbol–number associations learned on Coding B, and the child is asked to recall and fill in the numbers that were paired with the symbols. Each of the parts of the subtest is timed. No standard scores are generated for the Coding Recall subtest. The results are evaluated qualitatively and interpreted in terms of the relative frequency within the normative population.

Coding Copy

The purpose of this subtest is to remove the paired associative learning part of the Coding B subtest and solely evaluate the child's graphomotor speed and accuracy. The child is presented with a page full of the same symbols used in the Coding B subtest and instructed to copy each one in the square below as quickly as possible. Poor performance on the Coding B test may be due to poor graphomotor speed and this subtest helps to isolate the contributions of graphomotor speed and accuracy to the overall Coding B performance.

Delis-Kaplan Executive Function System (D-KEFS)

The D-KEFS (Delis, Kaplan, & Kramer, 2001) is a comprehensive battery of tests that measure skills associated with executive functioning. All of the subsets may be administered to children aged 8 to adults aged 89, except for the Proverbs Test that can be administered to ages 16 through 89. The D-KEFS subtests are presented in Rapid Reference 4.5. Practitioners who are familiar with the neuropsychology field will recognize these tests. For example, the Trail-Making Test has its origins with the Halstead-Reitan Neuropsychological Battery (HRNTB; Reitan & Davidson, 1974; Reitan & Wolfson, 1993); the Color-Word Test is similar to the Stroop Color-Word Test (Lowe & Mitterer, 1982) that measures the Stroop Effect (Stroop, 1935); and the Tower Test was originally designed by Simon (1975).

Rapid Reference 4.5

Delis-Kaplan Executive Function System (D-KEFS) Tests

- Trail-Making Test
- Verbal Fluency
- Design Fluency
- Color-Word Interference Test
- Card Sorting Test
- Word Context Test
- Twenty Questions
- Tower Test
- Proverbs Test

The fundamental differences and advantages of the D-KEFS over the previous versions of these tests are: (a) the updated normative sample and (b) the integration of a process-assessment approach into each test. The goal of the process-assessment approach is to generate hypotheses or possible explanations for poor performance on a test. The approach uses a "testing of the limits" or a subtle variation of the presentation content. For example, if a task requires sequential processing with a motor output, then poor performance on the task could be caused by one or the other, or both, of the neurocognitive processes. Using a process-assessment approach, two additional trials would be added to the task—one that isolated the contribution of the motor output and another that isolated the contribution of the sequential processing.

The D-KEFS is a valuable contribution to the field but it needs to be used with caution until a body of research emerges on its clinical efficacy. Baron (2004) warned that "data are still needed to confirm its sensitivity and specificity across diagnostic groups and with normal subjects" (p. 233). The D-KEFS is best suited for an experienced school neuropsychologist. The test produces a large amount of quantitative data that can be overwhelming to a new user of the test. It is also important to recognize that while the test is marketed as a test of executive functions, the individual tests are also measuring interdependent neurocognitive processes such as: processing speed and cognitive efficiency, memory and learning, visual-spatial processing, sensory-motor functions, and language functions. Examples of the interrelated neurocognitive demands of these tasks will be addressed in Chapter 15. The D-KEFS tests will be discussed in more detail as they fit within the conceptual school neuropsychological assessment model.

In this chapter several school neuropsychology conceptual models were reviewed. A comprehensive model for school neuropsychological assessment was presented with a rationale for each component of the model. Finally, the major test batteries used for school neuropsychological assessment were reviewed.

TEST YOURSELF

1. **Brain-behavior relationships in adults directly relate to brain-behavior relationships in children.** True or False?
2. **The central focus of what model was to understand the traits of common developmental disorders well enough to identify those neurocognitive subcomponents that define the disorders?**
   (a) transactional model of child clinical neuropsychology
   (b) cognitive hypothesis-testing (CHT) model
   (c) functional organization approach
   (d) none of the above
3. **The basic tenets of which model were: the appreciation of the neuropsychological correlates of psychiatric, neurodevelopmental, and acquired disorders of childhood; the understanding of the neurodevelopmental course of those disorders; and a recognition of the importance of the moderating variables (e.g., cognitive, social, behavioral) on the overall adjustment of children who have neurodevelopmental disorders?**
   (a) transactional model of child clinical neuropsychology
   (b) cognitive hypothesis-testing (CHT) model
   (c) functional organization approach
   (d) none of the above
4. **Which of the theoretical models combines two approaches: (a) individual psychoeducational assessment, and (b) intervention development and monitoring, using both behavioral interventions and problem-solving consultation?**
   (a) transactional model of child clinical neuropsychology
   (b) cognitive hypothesis-testing (CHT) model
   (c) functional organization approach
   (d) none of the above
5. **According to the conceptual school neuropsychology model proposed by this author, which two functions or processes lay the foundations for all other higher-order processes?**
   (a) memory and learning
   (b) visual-spatial processes and language processes
   (c) executive functions and speed of cognitive processes
   (d) sensory motor functions and attentional processes
6. **What test battery was designed specifically to test for executive functions across the life span?**
   (a) NEPSY
   (b) D-KEFS
   (c) WISC-IV Integrated
   (d) WJIII-COG

Answers: 1. false; 2. c; 3. a; 4. b; 5. d; 6. b

Five

SENSORY-MOTOR FUNCTIONS

One of the unique components of a school neuropsychological evaluation as compared to a psychoeducational evaluation is the inclusion of the assessment of sensory-perceptual and motor functions. In the conceptual school neuropsychological model, the sensory-motor functions and the attentional processes (discussed in Chapter 6) serve as baselines for all of the higher-order processes (e.g., visual-spatial processing, language skills, memory and learning). For example, if basic auditory discrimination skills are impaired, then the higher-order skill of sound blending—a basic skill for reading—may be compromised. A school neuropsychologist should routinely investigate whether higher-order processing deficits (e.g., verbal working memory) are caused by underlying deficits in sensory-motor problems. In this chapter, sensory and motor functions will be defined, the neuroanatomy of each will be described, and the common tests used to assess sensory-motor functions will be presented.

SENSORY FUNCTIONS

Definitions

Jimmy does not like to wear long pants, even in the winter. He says that the fabric on his skin makes him feel "itchy." Jimmy is also a picky eater. He will not eat foods that have a certain texture. Finally, Jimmy likes to play with his fingers over and over again as a means of stimulating his senses. Jimmy is experiencing some symptoms of sensory dysfunctions.

Sensory Processing Disorder (SPD) is an umbrella term used to cover a variety of neurological disabilities that interfere with the normal ability to use sensory information to function smoothly in daily life (Kranowitz, 2005). Sensory functions encompass our ability to process visual, auditory, kinesthetic, and olfactory information. Dysfunctions in any single sensory system can have a dramatic effect on a child's learning capabilities and behavioral regulation. Sensory dysfunctions are manifested in multiple ways. Some children are *overstimulated* by sensory input to the point that sensory input may be painful. An example would be a child who is hypersensitive to touch. A light brush against the child's skin could feel as if the skin has been set on fire. Other children are *understimulated* by sensory input, which can be dangerous. For example, a child falls while roller-skating and injures herself but does not respond to the pain of the injury and returns to the activity. In addition, other children are *sensation seekers,* sometimes to the exclusion of all other activities. For example, some children chew on their shirt sleeves excessively to the point that their mouths are chafted and bleeding.

Sensory discrimination is also an important part of the overall sensory functions. A child with poor tactile sensory discrimination may have difficulty holding a pencil and producing legible writing. A child with poor auditory discrimination may have difficulty acquiring reading and language skills. The sensory systems of the body also interact with motor functions. Children with *sensory-motor integration* problems may have difficulties with balance, movement, using both sides of the body in a unified fashion, and confusion over right- versus left-sided movements.

Neuroanatomy of Sensory Functions

The primary visual cortex, *regulating the sense of sight,* is located in the striate cortex of the occipital lobe. The retina, located at the back of the eye, transmits information via the optic nerve. Before reaching higher cortical regions of the brain, the optic nerve splits into two parts. The temporal (lateral) part continues its path to higher cortical regions on the same side of the body. The nasal (medial) part continues its path to higher cortical regions by crossing over to the opposite side of the body at the optic chiasm. The temporal and nasal portions of the optic nerve terminate in the lateral geniculate nuclei or the pulvinar nucleus of the thalamus and the superior colliculus of the midbrain. The final pathway of the visual information is from the lateral geniculate nuclei to the primary visual area of the occipital lobe.

The primary auditory cortex, regulating the *sense of hearing,* is located in the superior part of the temporal lobe and buried within the sylvian fissure. The cochlea is the auditory sense organ in the inner ear. Projections from the cochlea pass through the subcortical relays of the medial geniculate of the thalamus, and then onto the supratemporal cortex.

The primary somatosensory cortex, *regulating the sense of touch, pain, temperature* *sense, and limb proprioception (limb position),* is located in the postcentral gyrus. There are two pathways for somatosensory information: the anterolateral system for pain and temperature sense, and the dorsal column-medial lemniscal system for touch, proprioception, and movement.

Vision, hearing, and touch, all have contralateral projections in the brain. This means that for a child having a defect in a right-sided sense organ, the deficit will show as damage in the left side of the brain that controls that sense organ. The sense of smell is the only sense organ that does not have a contralateral projection to the brain. The primary olfactory cortex, regulating the *sense of smell,* is located in the ventral region of the anterior temporal lobe. A secondary area for olfaction is located in the lateral parts of the orbitofrontal cortex (Sobel et al., 1998). Due to the unilateral projections of smell, a left-sided lesion in the right ventral region of the temporal lobe will produce a severe deficit when an odor is smelled in the right nostril. The sense of smell is the only sense not processed by the thalamus, but goes directly to the cortex. Also, the anterior portion of the insular cortex (insula) is a crucial brain region receiving input from all the senses as well as limbic regions, and is thought to integrate information for the perception of pain, as well as fear avoidance.

Damage along the sensory pathways can cause a variety of impairments. Some of the neuropsychological terms associated with sensory impairments are presented in Rapid Reference 5.1. These terms are used by physicians in medical records to describe neuropsychological deficits in children. It is important that school neuropsychologists understand the terminology, but it is recommended that use of these terms be minimized in school neuropsychological reports (see the "Avoiding the use of jargon" section in Chapter 13).

Sensory deficits have been associated with autism spectrum disorders, Attention-Deficit/Hyperactivity Disorder, learning disabilities, dyslexia, nonverbal learning disorder, genetic disorders (e.g., Down Syndrome), nongenetic disabilities (e.g., Fetal Alcohol Syndrome or Fetal Alcohol Effects), and psychological disorders (e.g., Obsessive-Compulsive Disorder; Kranowitz, 2005).

MOTOR FUNCTIONS

Definitions

Michelle is a third grader. Her least favorite subject is gym class and she hates to go outside on the playground at recess. In gym class, Michelle does not perform well on the gross motor tasks compared to her peers (e.g., running). On the playground, Michelle has tried

Rapid Reference 5.1

Neuropsychological Terms Associated with Sensory Impairments

- *Achromatopsia*—a rare disorder in which color is not recognized.
- *Ageusia*—loss of the sense of taste.
- *Anosmia*—impaired sense of smell.
- *Asterognosia*—inability to recognize an object on the basis of its three-dimensionality through palpation (a.k.a., tactile agnosia/dysnosia).
- *Auditory agnosia*—inability to recognize auditory stimuli.
- *Autotopagnosia*—disturbed body scheme that manifests itself by the inability to identify the parts of one's body.
- *Barognosia*—inability to estimate weight when objects are placed in the affected hand.
- *Finger agnosia*—inability to recognize a sensory stimulus via the fingers.
- *Graphestheia*—difficulty recognizing shapes or letters written on the hand.
- *Hemianopia*—a loss of vision for one-half of the visual field of either one or both eyes.
- *Hypesthesia*—decreased desensitivity to stimulation.
- *Kinesthesia*—the conscious awareness of joint position and body movement in space.
- *Pallinopsia*—visual perseveration of a stimulus no longer present.
- *Parosmia*—an abnormal sense of smell.
- *Proprioception* —the unconscious awareness of sensations coming from one's muscles and joints that helps regulate our position in three-dimensional space.
- *Tactile defensiveness*—the tendency to react negatively to unexpected, light touches.
- *Tactile localization disorder*—the inability to localize a stimulus on the skin.
- *Two-point discrimination disorder*—the inability to discriminate between sensations arising from a single touch versus two simultaneous and nearby touches.
- *Visual agnosia*—inability to recognize visual stimuli (e.g., signs or pictures).

Sources: Ayd, 1995; Loring, 1999.

to play hopscotch and tag with her friends but she is clumsy and her peers have started to make fun of her. Recently, Michelle has begun to play by herself on the playground and she has started to develop physiological complaints (e.g., stomachaches, headaches) to avoid gym class. Michelle's gross motor deficiencies are causing her to experience some anxiety-related disorders and social isolation.

Disorders of motor functions have been historically assigned many labels including: sensory-integrative dysfunction, perceptuo-motor dysfunction, developmental dyspraxia, minimal brain dysfunction, visuo-motor difficulties, clumsy child syndrome, and motor-learning difficulties (Ball, 2002). The *Diagnostic and Statistical Manual of Mental Disorders, 4th Edition* (American Psychiatric Association, 1994) includes the diagnostic criteria for developmental coordination disorders (DCD). Children with DCD are characterized as being *clumsy* or *awkward.* Children with DCD exhibit motor coordination that is substantially below expected levels compared to same-aged peers and measured cognitive capabilities. The essential feature of DCD is a marked impairment in the development of motor coordination. These children have marked delays in reaching developmental motor milestones (e.g., crawling, walking, sitting) and have difficulty mastering other gross motor tasks such as catching a ball or jumping and mastering fine motor tasks such as tying shoelaces or buttoning a shirt. Children with DCD may appear clumsy, have poor handwriting, and demonstrate poor performance in sports.

Prevalence of DCD has been estimated to be as high as 6 percent for children in the age range of 5 to 11 years (American Psychiatric Association, 1994). The etiology or prognosis of DCD is still not clear. The diagnosis of DCD can only be made when there is significant interference with daily living or academic achievement and it is not due to a medical condition such as cerebral palsy, hemiplegia, or muscular dystrophy. Children with DCD often have developmental delays in other areas, such as expressive and receptive language in isolation or combined, or in phonological processing.

Neuroanatomy of Motor Functions

The frontal regions of the cortex are involved in planning movements. The frontal region receives information about what is happening (the ventral stream terminating in the inferior temporal cortex) and where it is happening (the dorsal stream terminating in the posterior parietal lobe). Carlson (2007) noted that since the parietal lobes contain spatial information (perception of space and location of limbs), the connections between the parietal and frontal lobes are important in controlling both locomotion and hand movements. Figure 5.1 illustrates the interconnections of multisystems that help to regulate motor activity. The premotor cortex helps regulate preprogrammed or sequential motor responses. The premotor cortex is involved in learning and executing complex movements. The primary motor cortex helps to regulate the motor movements of our body. Finally, the cerebellum—the brain structure that lies at the back of the head about the brain stem—plays an important role in motor coordination.

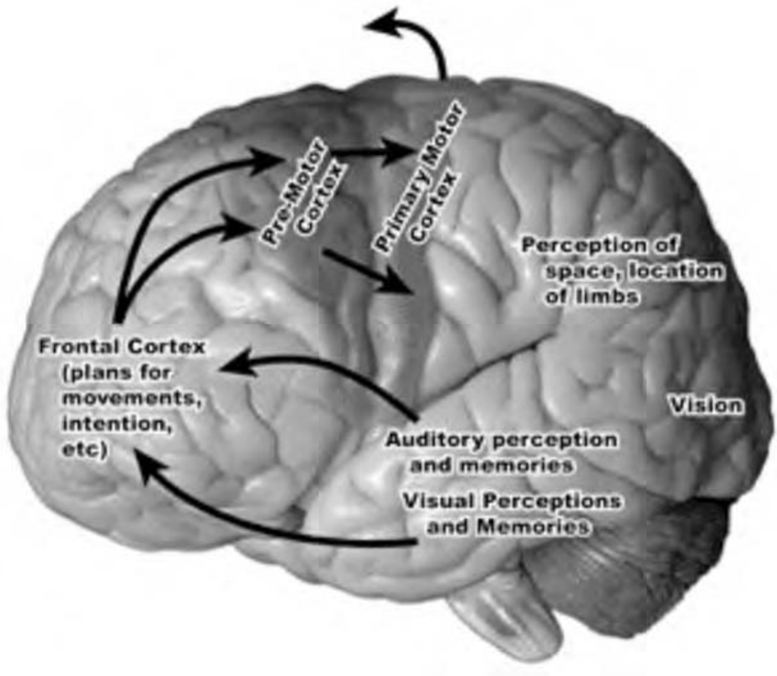


Figure 5.1 An illustration of the cortical control of movement

There are two semi-independent neural systems that help regulate motor activity in humans: the pyramidal system and the extrapyramidal system. The pyramidal system "is the executive system responsible for the initiation of voluntary skilled movements involving rapid and precise control of the extremities" (Tupper & Sondell, 2004, pp. 16–17). The pyramidal system is composed of the precentral motor cortex, the corticospinal tract, and its connections to the spinal motor neurons. Subcortical brain structures such as the cerebellum, basal ganglia, the red nucleus, and substantia niagra regions of the brain stem form the extrapyramidal system. The extrapyramidal system helps regulate motor coordination and maintain posture. Rapid Reference 5.2 presents some of the common neuropsychological terms associated with motor disorders. Examples of pyramidal motor disorders include: cerebral palsy, diplegia, paraplegia, hemiparesis, and hemiplegia. Examples of extrapyramidal motor disorders include: choreas, dystonias, postural disruptions, tics, and Tourette syndrome.

Rapid Reference 5.2

Neuropsychological Terms Associated with Motor Impairments

- *Apraxia*—inability to plan and execute a learned voluntary movement smoothly not due to muscle weakness or failure to understand directions.
- *Asterixis*—a motor disturbance characterized by a rapid, sporadic limb contraction followed by a slower return to extension.
- *Ataxia*—incoordination of movement, usually due to disease of sensory or cerebellar pathways.
- *Chorea*—involuntary performance of fragments of movement (e.g., suddenly raise arm, flex, extend, abduct, adduct, fragments of purposeful movement; usually associated with degeneration of the basal ganglia).
- *Clonus*—rapid repetitive alternating muscle contraction and relaxation.
- *Constructional apraxia*—inability to assemble, build, draw, or copy accurately, not due to apraxia of simple movements.
- *Diplegia*—a form of cerebral palsy primarily affecting the legs.
- *Dysphagia*—an impaired ability to chew or swallow food or liquid.
- *Dystonia*—characterized by involuntary muscle contractions, which force certain parts of the body into abnormal, sometimes painful, movements or postures.
- *Graphomotor apraxia*—inability to draw and write despite normal capacity to hold a writing instrument.
- *Hemiparesis*—weakness on one side of the body.
- *Hemiplegia*—paralysis of one half of body due to lesion leading to complete interruption of contralateral pyramidal tract.
- *Hypotonia*—absent or decreased muscle tone.
- *Ideational apraxia*—inability to perform gestures based on verbal command.
- *Monoplegia*—paralysis of one upper limb or lower limb due to cortical damage.
- *Optic ataxia*—can recognize objects but cannot use visual information to guide their action.
- *Paraplegia*—paralysis of two lower limbs due to interrupted nerve supply.
- *Quadriplegia*—all four limbs are paralyzed.
- *Spasticity*—a condition in which certain muscles are continuously contracted.
- *Tics*—a sudden, rapid, repetitive motor movement or vocalization. Tics can include eye blinking, repeated throat clearing or sniffing, arm thrusting, kicking movements, shoulder shrugging, or jumping.
- *Tourette Syndrome*—characterized by repeated and involuntary body movements (tics).

Sources: Ayd, 1995; Loring, 1999.

Summary of Sensory-Motor Functions

Sensory-motor functions are an essential building block for higher-order processes. For example, it is important to know if the child has adequate auditory processing at a basic discrimination level before administering a higher-order auditory test that requires sound blending. Likewise, motor-output problems (e.g., copying from the board, holding the pencil correctly, poor writing quality) may be caused by an underlying motor deficit. Children with diagnosed *sensory processing disorder* or *developmental coordination disorders* are at risk for secondary problems in academic achievement and social-emotional functioning.

Many of the developmental disorders have associated deficits in sensory-motor functions. When planning a neuropsychological assessment it is important to know when to include a sensory-motor component to the testing battery based on the referral question(s) and the suspected disability.

TESTS OF SENSORY-MOTOR FUNCTIONS

Rapid Reference 5.3 presents a list of tests commonly used to assess sensory and motor functions in children.

Sensory-Motor Tests for Infants Through Preschoolers

Bayley Scales of Infant Development–Third Edition (BSID-III) Motor Scale Kit

The BSID-III (Bayley, 2005a) is the latest revision of the test that was originally developed in 1969. The BSID-III measures cognitive, motor, language, social-emotional, and adaptive behaviors in children between the ages of 1 and 42 months of age. The cognitive, motor, and language scales are administered by a qualified professional, while the social-emotional and adaptive behavior scales are derived from questionnaires that parents/guardians/caregivers complete based on their knowledge of the child. Specific to the areas of sensory-motor functions, there is a stand-alone version of the test that contains only the motor items called the BSID-III Motor Scale Kit (Bayley, 2005b). The Motor Scale assesses fine motor skills such as—visual tracking, reaching, and grasping—as well as gross motor skills, such as sitting, crawling, standing, jumping, and walking up and down stairs. There is also a Bayley-III Screener Test that takes 15 to 25 minutes to administer and covers the cognitive, language, and motor domains.

Rapid Reference 5.3

Tests of Sensory-Motor Functions

Test	Functions Assessed	Age Range
Tests for Infants through Preschoolers		
Bayley-III Motor Scale Kit	Motor	1 to 42 months
Bayley-III Screener Test	Cognitive, language, and motor	1 to 42 months
Brigance Infant and Toddler Screen	Fine and gross motor and other early development skills	Infant: birth to 11 months Toddler: 12 to 23 months
Miller Assessment for Preschoolers	Gross, fine, and oral motor	2-9 to 5-8 years
McDowell Vision Screening Kit	Vision Screener	2-9 to 5-8 years
Posture and Fine Motor Assessment of Infants	Observation of infant's posture and fine-motor skills	2 to 12 months
Toddler and Infant Motor Evaluation	Motor development	4 months to 3-6 years
Tests for School-Aged Children		
Beery-Buktenica Developmental Test of Visual-Motor Integration, 5th Ed	Visual perception, motor coordination, and visual-motor integration	2 to 18 years
Bender® Visual-Motor Gestalt Test, 2nd Ed (Bender-Gestalt II)	Motor, visual perception, and visual-motor	4 to 85+ years
Dean-Woodcock Sensory-Motor Battery	Sensory and Motor	4 to 80+ years
Full Range Test of Visual-Motor Integration	Visual-motor integration	5 to 74 years

(*continued*)

Test	Functions Assessed	Age Range
Neitz Test of Color Vision	Screener for color vision	All ages
NEPSY/NEPSY-II		
• Design Copying[a]	• Visuospatial analysis and graphomotor skills.	3 to 12/3 to 16 years
• Fingertip Tapping	• Finger dexterity, fine motor speed, & motor programming	5 to 12/5 to 16 years
• Imitating Hand Positions	• Motor programming	3 to 12 years
• Manual Motor Sequences	• Motor programming	3 to 12 years
• Visuomotor Precision	• Graphomotor speed and accuracy	3 to 12 years
Quick Neuropsychological Screening–II	Manual dexterity, tactile perceptual, and motor skills	5 to 18 years
Test of Visual-Motor Skills–Revised and the Test of Visual-Motor Skills Revised Alternate Scoring Method	Visual-motor integration	3 to 13 years
The Smell Identification Test	Olfactory functioning	4 to 99 years
Visual Motor Assessments	Visual-motor integration based on degree of rotation, number of separations, and distortions	Ages 6 years to Adult
Wide Range Assessment of Visual Motor Abilities	Visual motor, visual-spatial, and fine motor	3 to 17 years
Tests Typically Administered by Occupational Therapists		
Bruininks-Oseretsky Test of Motor Proficiency	Gross and fine motor	4-6 to 14-5 years
Movement Assessment Battery for Children	Movement problems related to social integration at school	4 to 12 years
Peabody Developmental Motor Scales–2nd Ed	Gross, fine, and visual-motor	Birth to 5 years

Test	Functions Assessed	Age Range
Sensory Integration and Praxis Tests	Visual, tactile, and kinesthetic perception, and motor performance	4 to 8-11 years
Test of Gross Motor Development, Second Edition	Locomotion and Object Control	3 to 10 years

[a] On the NEPSY/NEPSY-II, the Design Copying test is categorized within the visuospatial domain.

Brigance Infant and Toddler Screen

The Brigance Infant and Toddler Screen (Brigance, 2002) is criterion referenced, curriculum referenced, and norm referenced. The Infant screen is for infants from birth to 11 months old and the Toddler screen is for ages 12 to 23 months. The test takes only 10 to 12 minutes to administer and the test may be administered in English or in Spanish. The test assesses developmental skills in: fine and gross motor, receptive and expressive language, self-help, and social-emotional. The Brigance assessment series covers the essential skills across preschool and school ages and is useful in developing individualized education programs.

Miller Assessment for Preschoolers (MAP)

The MAP (Miller, 1982) is a screener designed to assess children ages 2 years–9 months to 5 years–8 months with mild to moderate developmental delays. Specific to the areas of sensory-motor functioning, the MAP has a Coordination Index that is derived from items that assess gross, fine, and oral motor abilities. Miller also published an even shorter screening test called *FirstSTEP: Screening Test for Evaluating Preschoolers* (1993) and the *Toddler and Infant Motor Evaluation* (Miller & Roid, 1994), reviewed later in this section. These three tests, developed by Miller, all reflect the construct of sensory integration contributing to movement proficiency (Barnett & Peters, 2004).

McDowell Vision Screening Kit

The McDowell Vision Screening Kit (McDowell & McDowell, 1998) was designed to assess the most common vision problems in very young children (ages 2 years–9 months to 5 years–5 months) or severely disabled children. The test does not require the child to have verbal skills and takes only 10 to 20 minutes to administer. Visual performance is assessed in five areas: distance visual acuity, near-point visual acuity, ocular alignment and motility, color perception, and ocular function.

Posture and Fine Motor Assessment of Infants

The Posture and Fine Motor Assessment of Infants (Case-Smith & Bigsby, 2000) is a criterion-referenced measure that is based on the observations of a trained clinician. The purpose of the test is to determine if children ages 2 to 12 months show any signs of developmental motor delay or postural difficulties. Occupational therapists often use this instrument in medical or clinic settings. The test takes 25 to 30 minutes to administer.

Toddler and Infant Motor Evaluation (T.I.M.E.)

The T.I.M.E. test (Miller & Roid, 1994) is typically administered by an occupational therapist to evaluate the overall quality of infant and toddler movements. The test is designed for infants and toddlers from birth to 3.5 years of age and takes 15 to 45 minutes to administer.

Sensory-Motor Tests for School-Aged Children

Beery-Buktenica Developmental Test of Visual-Motor Integration, Fifth Edition (Beery VMI)

The Beery VMI (Beery, Buktenica, & Beery, 2003) assesses graphomotor production and visual-motor integration in children ages 2 to 18 years. Children are presented with individual drawings in a test booklet and asked to reproduce them in a defined space below each drawing. The geometric forms to be copied increase in difficulty as the items progress. The test can be individually or group administered using a Short Form or Full Form version. The Short or Full versions of the Beery VMI take approximately 10 to 15 minutes to administer and assess visual-motor integration. Two supplemental tests take approximately 5 minutes each to administer and parcel out the contributions of visual perception and motor coordination from the overall visual-motor performance.

Bender Visual-Motor Gestalt Test, Second Edition (Bender-Gestalt II)

The Bender-Gestalt II (Brannigan & Decker, 2003) measures visual-motor integration in children and adults ages 4 to 85+ years of age and measures memory in children and adults ages 5 to 85+ years of age. On the test, the examiner presents the child with a stimulus card that has a line drawing on it and the examiner asks the child to reproduce the drawing on a sheet of paper. The number of stimulus cards has been increased from nine to sixteen to allow for a greater age range administration of the test. Since the Bender Visual-Motor Gestalt Test's original publication in 1946, there have been numerous methods developed to score the original test (e.g., Koppitz, 1963, 1975). The Bender-Gestalt II uses a newly developed Global Scoring System to evaluate the overall quality of the reproduced drawings for both the copy and recall sections of the test based on a 5-point Likert scale. Similar to the Beery VMI Test, the Bender-Gestalt II also provides supplemental Motor and Perception Tests to detect deficits in motor performance or visual-perceptual skills that could adversely affect overall visual-motor performance.

Dean-Woodcock Sensory-Motor Battery (DWSMB)

The DWSMB is part of the Dean-Woodcock Neuropsychological Battery (DWNB; Dean & Woodcock, 2003b). The DWSMB is composed of eight simple and complex sensory tests and ten tests of motor functions (see Rapid Reference 5.4). The DWSMB tests are not new to the field of neuropsychology. Many of the tests were originally found on the Halstead-Reitan Neuropsychological Test Battery (HRNTB; Reitan, 1955; Reitan & Davidson, 1974; Reitan & Wolfson, 1993). The difference between the HRNTB and DWSMB versions of these tests is that the newer versions on the DWSMB are based on a broad-based standardization sample and they are conormed with the WJIII-COG (Woodcock, McGrew, & Mather, 2001c) and the WJIII-ACH (Woodcock, McGrew, & Mather, 2001a). The DWSMB may be administered to a broad age range from 4 through 80 years and older and takes approximately 45 minutes to administer the complete battery. Tests from the DWSMB may be administered together as a complete battery or selectively based on the referral questions. Not all subtests of the DWSMB need to be administered to every child. The DWNB also contains an Emotional Status Examination (Dean & Woodcock, 2003a) and a Structured Neuropsychological Interview (Dean & Woodcock, 2003c).

Full Range Test of Visual-Motor Integration (FRTVMI)

The FRTVMI (Hammill, Pearson, Voress, & Reynolds, 2006) assesses the ability to accurately relate visual stimuli to motor responses by asking the child to copy designs that become increasingly more difficult as the items progress. The test can be individually or group administered and takes approximately 15 to 30 minutes. The age range of the test is from 5 to 74 years.

Neitz Test of Color Vision

The Neitz Test of Color Vision (Neitz, Summerfelt, & Neitz, 2001) is a screener for color vision deficiencies that is suitable for all ages. The test may be administered individually or in groups and in a variety of lighted settings, making it very useful for mass screenings in the schools. The test can be administered in

Rapid Reference 5.4

Dean-Woodcock Sensory-Motor Battery

Test	Potential Deficits Assessed
Sensory Tests	
Near-Point Visual Acuity	Near-point vision deficits.
Visual Confrontation	Visual field defects or visual inattention.
Naming Pictures of Objects	Difficulty naming objects (a.k.a. dysnomia) or difficulty recognizing pictured objects (a.k.a. visual dysnosia).
Auditory Acuity	Vestibular and/or acoustic auditory problems.
Tactile Examination–Palm Writing	Difficulty recognizing shapes or letters written on the hand (a.k.a. graphesthesia).
Tactile Examination–Object Identification	Difficulty recognizing objects based on touch (a.k.a. asterognosia).
Tactile Examination–Finger Identification	Difficulty identifying fingers that are touched (a.k.a. finger agnosia).
Tactile Examination–Simultaneous Localization	Asomtognosia, tactile projection, and right-left confusion.
Motor Tests	
Lateral Preference Scale	Unclear lateral dominance.
Gait and Station	Gross motor incoordination.
Romberg	Poor joint, muscle, and balance control (proprioception).
Construction	Difficulty with spatial relations (a.k.a. constructional dyspraxia).
Coordination	Difficulties with motor coordination
Mime Movements	Difficulties with auditory and/or verbal agnosia and the inability to perform single motor tasks when requested to do so verbally or by visual imitation (a.k.a. ideomotor dyspraxia).

Left-Right Movements	Left-right confusion.
Finger Tapping	Difficulties with fine-motor movements.
Expressive Speech	Difficulties in articulating words (a.k.a. dysarthria).
Grip Strength	Poor upper-body strength.
Fingertip Tapping	Finger dexterity: Simple and complex motor programming.
Imitating Hand Positions	Ability to imitate a hand position from a model.

less than 5 minutes. On the test the child is asked to identify the colored shapes (circle, triangle, square, diamond, or nothing) within an array of grey dots. The test principally detects color loss for blue-yellow and red-green color blindness.

NEPSY/NEPSY-II—Sensorimotor Tests

One of the principle domains assessed by the NEPSY/NEPSY-II (Korkman, Kirk, & Kemp, 1998, 2007) is Sensorimotor Functions. On the NEPSY-II, there are four subtests that measure sensorimotor functions: Fingertip Tapping, Imitating Hand Positions, Manual Motor Sequences, and Visuomotor Precision. The Finger Discrimination subtest from the NEPSY was dropped on the NEPSY-II. The Design Copying subtest loads on the Visuospatial Domain but it was included here in this section because it is similar to the Beery VMI and the Bender-Gestalt II, which all require graphomotor production.

Fingertip Tapping. This subtest assesses the child's finger dexterity. The subtest contains two parts. On Part 1, the child is asked to tap his or her index finger against his or her thumb, as quickly as possible, 32 times (a simple movement). On Part 2, the child is asked to touch his or her thumb sequentially to each of the other fingers (index finger, middle finger, ring finger, and little finger) as quickly as possible. The examiner records how long it takes to complete 8 correct sequences. The subtest yields a scaled score (mean of 10, SD of 3) and percentile rank classifications for the completion time for the number of repetitions (across both hands), completion time for the number of sequences (across both hands), and completion time for the preferred hand and nonpreferred hand (repetition + sequences). There are several qualitative behaviors that are recorded if observed on this task. *Visual Guidance* is recorded if the child looks at his or her fingers as a compensatory aid in accomplishing the motor-output task. *Incorrect* *position* is recorded if the child makes errors such as tapping with straight fingers. Sometimes on a fine-motor task other areas of the motor strip are activated, as well, and motor overflow is observed. *Posturing* is recorded if the child's finger or hand on the opposite side of the body is extended stiffly during the performance of a unilateral item. *Mirroring* is recorded when the child involuntarily produces movement on the opposite side of the body in response to unilateral movements. *Overflow* is recorded when the lips, tongue, or jaw move involuntarily during the performance of a unilateral item.

Qualitative behaviors are important to note. When school neuropsychologists are first being trained, they often are so concerned about administering a test in a standardized fashion, that they lose focus on the child. Qualitative behaviors reveal clues to brain functions. For instance, overflow movement generally indicates poor motoric pruning between neurons in the motor cortex. Hence, too many neurons become activated for a relatively simple motor task, and task efficiency becomes compromised, especially on motor tasks such as writing.

Imitating Hand Positions. This subtest assesses the child's ability to imitate a hand position from the examiner's demonstrated model. A scaled score is generated for the total correct and supplemental scores are generated for the preferred and nonpreferred hands, individually. The qualitative behaviors that are recorded, if observed, include use of the *mirror hand* (the child shows right-left confusion) and uses the left hand when instructed to use the same hand as demonstrated by the examiner, and the use of the *other hand helps* (the child violates the instructions and uses one hand to help the other get in the position). Right-left confusion is actually a left-hemispheric issue, as overlearned visual-spatial tasks are actually modulated by the left hemisphere and not the right.

Visuomotor Precision. This subtest is designed to measure fine-motor speed and accuracy of eye-hand coordination. The child is presented with a drawing in which the child is asked to mark a pencil line (without lifting the pencil from the paper) from a starting point to an ending point while staying within a defined space. There are two trials on this task. The subtest yields an overall scaled score and supplemental scores for the Trial 1 completion time and errors and for the Trial 2 completion time and errors. The qualitative behaviors noted on this subtest relate to the level of maturity of the child's *pencil grip.*

Manual Motor Sequencing. This subtest is not part of the core battery for either the 3- to 4-year-old or 5- to 12-year-old versions of the NEPSY. It is part of the expanded battery for all ages. This subtest is designed to measure the ability to imitate a set of rhythmic hand movements using either one or both hands. Several qualitative behaviors are recorded if observed, including:

- *Changes in rate*—any changes in the tempo of movement responses (slowing down or speeding up).
- *Overflow*—spill over movement in another part of the body (e.g., mouth).
- *Perseveration*—movement continues for three or more sequences after the examiner indicates the trial is over and the child is to stop.
- *Loss of asymmetrical movement*—when the task requires each hand to alternate movements and the hands start performing the same motor act.
- *Body movement*—the child's whole body moves in synchrony with the hand movements.
- *Forceful tapping on the table*—the child cannot modulate the response and the tapping becomes louder during the production of the task.

Finger Discrimination. This subtest is designed to assess the child's ability to identify his or her fingers based only on the sense of touch. The child places his or her hand palm down under a shield. The shield is used to eliminate the visual cues. The examiner touches one or two fingers on the child's hand, the shield is removed, and the child is asked to point to the finger(s) that were touched. A total test score is generated as well as supplemental scores for the preferred and non-preferred hands. No qualitative behaviors are recorded on this test.

Design Copying. This subtest assesses the child's ability to copy geometric figures. This subtest is similar to the Beery VMI or the Bender-Gestalt II tests previously reviewed. One major difference between the NEPSY Design Copying subtest and other tests of visual-motor integration is that partial credit is given for each drawing. The only qualitative behavior recorded is an evaluation of the quality of the child's pencil grip.

Quick Neuropsychological Screening Test–II (QNST-II)

The QNST-II (Mutti, Sterling, Martin, & Spalding, 1998) is designed to measure soft neurological signs that may coexist with learning difficulties. The QNST-II assesses the following areas: manual dexterity, visual tracking, spatial orientation, tactile perception abilities, and fine- and gross-motor movements. The test is individually administered in approximately 20 minutes and criterion-referenced scores are generated. The QNST-II Manual provides samples of scoring patterns and suggestions for further diagnostic assessments and/or interventions.

Test of Visual-Motor Skills–Revised (TVMS-R) and TVMS-R Alternative Scoring Methods (TVMS-R-ASM)

The TVMS-R (Gardner, 1995) is designed to assess visual-motor skills in children ages 3 through 13 years. The child is asked to copy up to 23 geometric designs. The original scoring is based on eight classifications: closure, angles, line intersections, size, rotation, line length, under/over representation, and design modification. Gardner (1997) also developed an Alternate Scoring Method for the TVMS-R as an abbreviated method to score the test. Each reproduction is assigned a score from 0 (unable to copy) to 3 (copy with precision).

The Smell Identification Test (SIT)

The SIT (Doty, 1999) provides a standardized means of assessing olfaction in children and adults (ages 4–99 years). The test is also known as the University of Pennsylvania Smell Identification Test (UPSIT). The test was standardized on 4,000 individuals. The test focuses on the ability of the individual to detect and identify a number of odors at the suprathreshold level. The directions for the test are available in English, French, German, and Spanish.

Visual Motor Assessments (ViMo)

The ViMo (Fuller, 2006) is a reformatted version of The Minnesota Perception Diagnostic Test. The ViMo is designed as a screener of visual-motor impairment for children and adults, ages 6 years and older. On the test, the child is asked to reproduce six Gestalt designs. Scoring is based on the degree of rotations, number of separations, and number of distortions. The test is based on over 35 years of visual-motor performance research and normative data are based on a total sample size of 12,000.

Wide Range Assessment of Visual Motor Abilities (WRAVMA)

The WRAVMA (Adams & Sheslow, 1995) assesses visual-motor abilities in children ages 3 to 17 years. The Drawing Test assesses visual-motor integration and graphomotor production and the Matching Test measures visual-spatial processing. The Pegboard Test measures fine motor coordination and is modeled after the classic Grooved Pegboard Test (Klove, 1963; Reitan & Wolfson, 1985). On the Pegboard Test, the child is given a pegboard and a set of pegs. The child is instructed to insert one peg at a time sequentially in the grooved slots using first his or her dominant hand, then his or her nondominant hand on separate trials. Similar to the Beery VMI Test and the Bender-Gestalt II, the WRAVMA supplemental Motor and Perception tests allow for the detection of deficits in motor performance or visual-perceptual skills that could adversely affect overall visual-motor performance.

Sensory-Motor Tests Typically Administered by Occupational Therapists

Brief descriptions of the following tests were included in this section even though school neuropsychologists probably will not administer them. Occupational therapists will typically administer these tests to school-age children but school neuropsychologists need to be familiar with what the tests are measuring and when to refer a child for a particular assessment.

Bruininks-Oseretsky Test of Motor Proficiency (BO)

The BO (Bruininks, 1978) was designed to measure gross- and fine-motor skills in children ages 4.6 to 14.5 years. A short form of the test takes 15 to 20 minutes to administer, while the complete battery takes 45 to 60 minutes to administer. Gross-motor development is assessed by four subtests including: Running Speed and Agility, Balance, Bilateral Coordination, and Strength. Gross and fine motor development combined is measured by one subtest: Upper-limb Coordination. Fine-motor development is assessed by three subtests: Response Speed, Visual-Motor Control, and Upper-Limb Speed and Dexterity.

Movement Assessment Battery for Children (Movement ABC)

The Movement ABC (Henderson & Sudgen, 1992) is a screening checklist for identifying movement problems in children ages 4 to 12 years. The purpose of the test is to evaluate the extent to which movement problems will affect the child's social integration into the school environment. The test takes approximately 20 to 30 minutes to administer. The Movement ABC yields both normative and qualitative measures of movement competence, manual dexterity, ball skills, and static and dynamic balance.

Peabody Developmental Motor Scales, Second Edition (PDMS-2)

The PDMS-2 (Folio & Fewell, 2000) is designed to assess and remediate gross and fine motor skills in young children (birth to 5 years). The six PDMS-2 subtests include: Reflexes, Stationary, Locomotion, Object Manipulation, Grasping, and Visual-Motor Integration. There is an intervention program linked to the assessment called the Peabody Motor Activities Program (P-MAP) and a developmental motor milestone chart is also available as a reference guide.

Sensory Integration and Praxis Tests (SIPT)

Jean Ayers is commonly referred to as the founder of the Sensory Integration approach. She designed and developed a standardized test called the Southern California Sensory Integration Tests that was later revised and given the SIPT name (Ayers, 1989). The SIPT is a diagnostic assessment instrument designed for children ages 4 to 8-11 years to distinguish between normal children and those with sensory integration deficits. The SIPT measures visual, tactile, and kinesthetic perception as well as motor performance. It is composed of 17 brief tests. Typically the test is administered across two sessions totaling approximately 1.5 to 2 hours plus an additional 30 to 45 minutes to score the protocols. The test protocols are computer scored through the publishing company (Western Psychological Services) or via a computer-scoring program. Administration of the SIPT requires special training and is usually reserved for occupational therapists.

Test of Gross Motor Development, Second Edition (TGMD-2)

The TGMD-2 (Ulrich, 2000) is designed to measure gross motor skills in children ages 3 to 10 years. The test includes two subtests: Locomotor and Object Control. The test takes approximately 20 minutes to administer and the scores are norm referenced.

In this chapter, the terminology, neuroanatomy, major behavioral tests, and rating scales associated with sensory-motor functioning were reviewed. Sensory-motor functions lay a foundation for all other higher-order processes and should be systematically assessed by a school neuropsychologist. Sensory-motor dysfunctions are observed in many common developmental disorders. As an example in Chapter 16, the school neuropsychological conceptual assessment model will be used to review the presence of sensory-motor deficits in autism-spectrum disorders.

TEST YOURSELF

1. **Sensory Processing Disorder is an umbrella term used to cover a variety of neurological disabilities that interfere with the normal ability to use sensory information to function smoothly in daily life.** True or False?
2. **Which of the following neuropsychological terms means the unconscious awareness of sensations coming from one's muscles and joints?**
   (a) graphestheia
   (b) visual agnosia
   (c) proprioception
   (d) asterognosia
3. **All of the following are types of subtypes of sensory processing difficulties except one; which one?**
   (a) understimulated
   (b) sensation seekers
   (c) overstimulated
   (d) hypervigilance
4. **The pyramidal and extrapyramidal neural systems help regulate motor activity in humans.** True or False?

5. What neuropsychological term means an inability to assemble, build, draw, or copy accurately, not due to apraxia of simple movements?

(a) constructional apraxia
(b) ataxia
(c) dystonia
(d) clonus

6. Which one of the following sensory-motor batteries is typically administered by an occupational therapist?

(a) Wide Range Assessment of Visual Motor Abilities
(b) Sensory Integration and Praxis Tests
(c) Dean-Woodcock Sensory-Motor Battery
(d) Beery-Butkenica Developmental Test of Visual-Motor Integration

7. The inability to perform gestures based on verbal command is called

(a) ideational apraxia.
(b) dysphagia.
(c) constructional apraxia.
(d) ataxia.

8. The pyramidal system helps regulate motor coordination and maintain posture. True or False?

Answers: 1. true; 2. c; 3. d; 4. true; 5. a; 6. b; 7. a; 8. false

Six

ATTENTIONAL PROCESSES

In this chapter attention functions will be defined, the neuroanatomy of attention will be described, and the common tests used to assess attention will be presented.

In addition to sensory-motor functions, attentional processes also serve as a baseline for all of the higher-order processes (e.g., visual-spatial processing, language skills, memory and learning). For example, a verbal list-learning test can be contaminated by a child's poor ability to pay attention. Difficulties with attention are often a symptom of other underlying neurological disabilities. Attentional processing disorders are very common in children who have compromised brain functioning as a result of neurodevelopmental disorders, exposure to environmental toxins, traumatic and acquired brain injuries, and so on. It is estimated by Barkley (1990) that approximately 20 percent of all children in the United States evidence attention-deficit symptoms. Unfortunately, too many children are misdiagnosed as having Attention-Deficit/Hyperactivity Disorder (ADHD) without a satisfactory evaluation to determine the root cause of the inattention, the type of attention deficit, and the proper course of treatment. Consequently, the true disability often goes undiagnosed, misdiagnosed, and inappropriately untreated.

The *Diagnostic and Statistical Manual of Mental Disorders, 4th Edition* (American Psychiatric Association, 1994) classifies ADHD within four subtypes: 314.00 ADHD, Predominantly Inattentive Type; 314.01 ADHD, Predominantly Hyperactive-Impulsive Type; 314.01 ADHD, Combined Type; and 314.9 is ADHD Not Otherwise Specified (NOS). Unfortunately, these four *DSM-IV* ADHD diagnoses do not address the neuropsychological subtypes of attention that have been documented in the literature.

THEORIES OF ATTENTION

Mirsky and his colleagues (Mirsky, 1987, 1996; Mirsky et al., 1991) conducted a factor analysis of neuropsychological test data, each of which measured some aspect of attention. The data were based on more than 600 subjects including many subjects with clinical disorders of attention. Based on the factor analysis, Mirsky and his colleagues proposed a taxonomy of attention functions including: *focus/execute, sustain* and *stabilize, shift,* and *encode.* This Mirsky model of attention has been applied to several clinical populations (e.g., Barkley, 1996 [children with ADHD]; Ewing-Cobbs et al., 1998 [children with traumatic brain injury]; Loss, Yeates, & Enrile, 1998 [children with myelomenigocele]; and Mirsky, Pascualvaca, Duncan, & French, 1999 [children with ADHD]).

The *focus/execute, sustain,* and *shift* subcomponents identified have endured in the neuropsychological literature, some with different names. Posner and Peterson (1990) theorized the existence of three attentional systems: *orienting, selection,* and *alerting or sustained attention.* The orienting system lies in the posterior regions of the brain and directs spatial attention and is implicated in neglect syndromes (the failure to attend to stimuli presented in the hemispace contralateral to a brain lesion that cannot be attributed to primary sensory or motor deficits; Loring, 1999). The selection system in the Posner and Peterson model is similar to Mirsky's focus/execute attention functions. The third Posner and Peterson attentional system, alerting or sustained attention, is comparable to Mirsky's sustained attention function.

Mirsky's *stability* subcomponent was related to the variability of reaction time to the target stimuli on a Continuous Performance Test. Mirsky's *encode* component described the abilities required to perform the Digit Span and Arithmetic subtests of the Wechsler (1981). The tasks that loaded on the encode component of attention all required a memory capacity to hold information briefly in store while performing some action or cognitive operation on it. In recent literature, this encode subcomponent would be considered to measure working memory.

See Baron (2004) for a more thorough review of theories of attention. The attentional processing labels that have been adopted for the school neuropsychology conceptual model are selective/focused, sustained, shifting, divided, and capacity. Each of these subcomponents of attention will be discussed in more detail in the next sections.

Selective/Focused Attention

Johnny is sitting in a classroom and is supposed to be paying attention to the teacher for a lesson. The classroom environment is filled with potential distracters including: Mary sitting next to him tapping her pencil on her desk, the richly colored bulletin boards posted on the wall, and the lack of air-conditioning on that particular day. Johnny has some potential internal distracters to deal with as well, including: the uncomfortable chair he is sitting in that is hurting his back, the hungry feeling he has in his stomach because *he forgot to eat breakfast, and the band aid on his finger that is loose. Johnny's ability to choose to pay attention to the teacher and ignore the potential external and internal distracters requires selective or focused attention.*

Mirsky and colleagues (Mirsky, 1987, 1996; Mirsky et al., 1991) referred to the ability to scan an array of stimuli and selectively respond as *focus/execute*. *Focused attention* is the perceptual ability to scan a stimulus array, while the *execute component* is the ability to make a response. Mirsky and his colleagues were unable to separate the focusing aspect from the executed response component, so they used the term *focus/execute* to describe this subtype of attention. An interchangeable term used in the neuropsychology literature for focus-attention is *selective attention*. Selective attention is defined as "the ability to maintain a cognitive set in the presence of background 'noise' or distraction" (Baron, 2004, p. 222). An example of a neuropsychological test that measures selective attention is the Stroop Color-Word Test (SCWT). On SCWT, the child is presented with a list of color words (e.g., red, blue, green) that are printed in different colors of ink (e.g., the word *red* printed in green ink or the word *green* printed in blue ink). The child is asked to *selectively attend* to the color of the ink that the word is printed in and name that color, while ignoring the name of the color word itself.

Sustained Attention

Nisha is at home and she is trying to watch a television show with her mother. Nisha is able to watch the first 5 minutes of the show but she quickly loses interest and moves on to another activity. According to her mother, Nisha "flits" from one activity to another because she cannot maintain her attentional focus for prolonged periods of time. Nisha is experiencing difficulty with her sustained attention.

Mirsky and his colleagues (Mirsky, 1987, 1996; Mirsky et al., 1991) referred to the ability to stay on task in a vigilant manner for a prolonged period of time as *sustained attention*. In a sense, sustained attention is applying selective attention or vigilance over a prolonged period of time. A classic sustained attention task is a Continuous Performance Test (CPT) in which the child is asked to attend to a "target" event (e.g., pressing a counter when an *X* is followed by an *O*) while ignoring all other events over a prolonged period of time.

Shifting Attention

Tamara is working on a math assignment in the classroom and the teacher asks the class to put away their math work and get out their reading books. Tamara continues *to work on her math assignment. Tamara may be experiencing difficulties with shifting her attention.*

Mirsky and colleagues (Mirsky, 1987, 1996; Mirsky et al., 1991) labeled the ability to consciously reallocate attentional resources from one activity to another as *shifting attention.* A classic task that measures the ability to shift attention is the *Wisconsin Card Sorting Test* (WCST; Heaton, 1981). On the WCST, the child is given a set of cards that have colored objects on them (e.g., yellow star, red triangle, three blue crosses). The child is asked to sort the cards based on some property of the objects (color, form, or number). The examiner provides feedback after every card to indicate if the child is sorting the cards correctly; for example, based on the color of the objects. At multiple points in the task, the examiner switches the rule for sorting. For example, the sorting rule changes from the color of the object to the number of objects on the card. After figuring out the first rule, which was color, and being told that each of the card sorts was correct, suddenly the sort rule changes to number, and the child must learn to shift attention to a new property of the cards in order to be correct. It is called a *perseveration error,* when a child cannot shift attention from one activity to another and thus tends to get stuck. In this case, if the child continually sorts by color when the sort rule has changed to number, that is an example of perseveration errors.

Divided Attention

Roberto does not have any difficulty listening to his teacher lecture and he does not have any difficulty writing stories on his own. Roberto does have difficulty with listening to his teacher and taking notes about what she is saying at the same time. Roberto may be having difficulty with divided attention.

Mirsky and his colleagues (Mirsky, 1987, 1996; Mirsky et al., 1991) did not find a subcomponent of attention called divided attention because the neuropsychological tasks that were factor analyzed did not require those skills. “Divided attention refers to the ability to respond to more than one task or event simultaneously” (Baron, 2004, p. 222). Divided attention is part of our daily lives. Think of the example of driving a car while talking on the cell phone. Any time multitasking is required by a task, divided attention is involved. Some of the tests that measure divided attention also require working memory. For example, the Auditory Working Memory test from the Woodcock-Johnson III Tests of Cognitive Abilities (Woodcock, McGrew, & Mather, 2001a) requires both divided attention and working memory to successfully complete the task. On this test, the child is required to listen to a mixed series of numbers and objects verbally presented by the examiner (e.g., 1–shoe–5–car). The child is then instructed to repeat the objects, first in the order in which they were presented, followed by the numbers in the order in which they were presented. Thus, the child should recall the numbers and objects in the following order: shoe–car–1–5. The test requires the child to hold information in working memory while dividing the stimuli into two groups, and then focus attention on the new groups to facilitate the correct sequential recall.

Attentional Capacity

Tonya can attend to small bits of information but she quickly becomes overwhelmed if too much information is presented to her at once. Tonya may be experiencing problems with attentional capacity.

Mirsky and his colleagues (Mirsky, 1987, 1996; Mirsky et al., 1991) did not find a subcomponent of attention called attention capacity because the neuropsychological tasks that were factor analyzed did not require those skills. Attentional capacity is related to other cognitive processes such as short-term memory and behavioral factors such as distractibility and motivation. A typical test that measures attentional capacity is a digit span test, in which the child is asked to recall digits of increasing length. Other tests that measure attentional capacity are tests that measure memory for words, memory for sentences, memory for stories. All of these tests obviously have a strong memory component, but they also require attentional skills.

NEUROANATOMY OF ATTENTIONAL PROCESSES

The neuroanatomy of attention includes the subcortical portions of the brain (e.g., the reticular activating system) that help regulate and maintain arousal, to higher cortical regions (e.g., prefrontal lobes and anterior cingulate cortex) that help allocate attentional resources, selectively attend, and regulate response inhibition. The frontal-subcortical pathways that help regulate attention are also involved in regulating executive functions (see a broader review on this circuit in Chapter 10, Executive Functions). Mirsky and his colleagues (1991) believed that the brain structures involved with the regulation of *selective/focused attention* were the superior temporal cortex, the inferior parietal cortex, and the corpus striatum structures (including the caudate, putamen, and globus pallidus). Posner and Peterson (1990) believed that selective attention was linked to the functions of the anterior cingulate and the supplemental motor areas. Mirsky and his colleagues believed that the brain structures involved with regulating *sustained attention* were the subcortical rostral midbrain structures (including the tectum, mesopontine, reticular formation, and midline and reticular thalamic nuclei). Posner and Peterson (1990) believed that sustained attention is regulated by the right side of the brain, particularly the anterior, prefrontal regions. Mirsky and his colleagues believed that the dorsolateral prefrontal cortex and the anterior cingulate gyrus were the brain structures involved with *shifting attention*.

Since Mirsky's research in the early 1990s, the neuroanatomical structures that play a role in attention have been of particular focus to researchers using a variety of neuroimaging and neurosurgical techniques, and evaluation of clinical populations (e.g., ADHD). Castellanos and colleagues (1996) used magnetic resonance imaging (MRI) to study the brain volumes in a sample of boys with and without ADHD. They found that the ADHD boys had right-sided, decreased volume in the prefrontal cortex, caudate nucleus, and globus pallidus. Other neuroimaging studies with ADHD samples also implicated deficiencies in the frontal-subcortical, and possibly limbic regions (Benson, 1991; Heilman et al., 1991; Zametkin et al., 1993; Zametkin et al., 1990). Neuroimaging studies have shown the right prefrontal regions of the brain being activated during tasks that require sustained attention (Lewin et al., 1996; Pardo, Pardo, Janer, & Raichle, 1991). Adult patients who had portions of their right frontal lobes surgically removed had difficulty with performing a sustained visual attention task (Koski, 2001).

Benedict and colleagues (1998) used positron emission tomography (PET) scans to measure the brain activation in adult males performing an auditory continuous performance task (CPT) that required both selective/focused, and divided attention. Performance of the auditory CPT task produced activation in the bilateral anterior cingulate and the mesial and anterior parts of the right prefrontal cortex. In a sample of normal adults using PET scans, Lombardi and colleagues (1999) found that the right dorsolateral frontal-subcortical circuit was activated during the performance of a shifting attention task: the Wisconsin Card Sorting Test (WCST: Heaton, 1981). Casey, Tottenham, & Fossella (2002) used functional magnetic resonance imaging (fMRI) to measure the brain activation and localization that occurred during the performance of a go/no go task in a sample of normal children and adults. Go/no go tasks are designed to measure response inhibition (e.g., Knock and Tap subtest on the NEPSY; Korkman, Kirk, & Kemp, 1998). Casey and his colleagues found that performance of the go/no go task produced activation in the orbitofrontal, dorsolateral, and right anterior cingulate cortex. The orbitofrontal and right anterior cingulate

Rapid Reference 6.1

Neuropsychological Terms Associated with Attention Impairments

- *Divided attention*—the ability to attend to more than one stimulus at a time.
- *Hemispatial neglect/inattention*—frequently used to describe a milder form of neglect.
- *Neglect*—the failure to respond to visual, auditory, or tactile stimuli presented in the hemispace contralateral to a brain lesion that cannot be attributable to primary sensory or motor deficits.
  —*Unilateral neglect*—the tendency to ignore information presented in the hemispace contralateral to a cerebral lesion.

Sources: Ayd, 1995; Loring, 1999.

cortex areas were significantly correlated with behavioral performance and the activation of the dorsolateral cortex was much higher in children than adults. Perhaps some of the variability in linking specific attentional processes with specific neuroanatomical structures can be attributed to differences in neuroimaging techniques, adult versus child populations, and tasks that required more *bottom-up* versus *top-down* attentional processes. Rapid Reference 6.1 presents some neuropsychological terms associated with attention deficits.

SUMMARY OF ATTENTIONAL PROCESSES

It is important to remember that attention is not a unitary process and that it serves as a baseline function for all other higher-order processes. Consistent with the current literature in the field, the proposed school neuropsychology model conceptualizes attention in the subdomains of selective/focused attention, sustained attention, shifting attention, divided attention, and attentional capacity. Many of the neuroimaging studies support the frontal-subcortical bases of attention, though precise anatomical locations of specific attentional subtypes have shown varying results.

TESTS OF ATTENTIONAL PROCESSES

Rapid Reference 6.2 presents a list of tests commonly used to assess attention in school-aged children. The tests are subdivided into the attention subcomponents outlined in previous sections of this chapter along with some behavioral rating scales specifically designed to measure attention.

Rapid Reference 6.2

Tests of Attention

Test: Subtest	Age Range
Selective/Focused Attention	
CAS: Expressive Attention Number Detection Receptive Attention	5 to 17 years
D-KEFS: Color-Word Interference Test	8 to 89 years
d2–Test of Attention	9 to 60 years
NEPSY/NEPSY-II: Auditory Attention & Response Set–Parts A & B Visual Attention (NEPSY only)	 5 to 12/5 to 16 years 3 to 12 years
Ruff 2 & 7 Selective Attention Test	16 to 70 years
TEA-CH: Map Mission Sky Search	6 to 16 years
WISC-IV: Coding Symbol Search	6 to 16-11 years
WJIII-COG: Auditory Attention	2 to 80+ years
Sustained Attention	
CAS: Number Detection Receptive Attention	5 to 17 years
Continuous Performance Tests	See Rapid Reference 6.4
NEPSY/NEPSY-II: Auditory Attention & Response Set–Parts A & B Visual Attention (NEPSY only)	 5 to 12/5 to 16 years 3 to 12 years
Ruff 2 & 7 Selective Attention Test	16 to 70 years

(*continued*)

Test: Subtest	Age Range
TEA-CH: Score! Score DT Walk Don't Walk Code Transmission	6 to 16 years
WISC-IV: Cancellation	6 to 16-11 years
WJIII-COG: Pair Cancellation	2 to 80+ years
Shifting Attention	
CAS: Expressive Attention	5 to 17 years
D-KEFS: Trail-Making (Condition 4) Verbal Fluency (Condition 3) Color-Word Interference Test (Condition 4) Design Fluency (Condition 3)	8 to 89 years
NEPSY/NEPSY-II: Auditory Attention & Response Set–Part B	5 to 12/5 to 16 years
TEA-CH: Creature Counting Opposite Worlds	6 to 16 years
Wisconsin Card Sorting Test	6-5 to 89 years
Divided Attention	
TEA-CH: Sky Search DT	6 to 16 years
WISC-IV Integrated: Letter-Number Sequencing Process Approach	6 to 16-11 years
WJIII COG: Auditory Working Memory	2 to 80+ years
Attentional Capacity	
Children's Memory Scale (CMS): Numbers (Forward)	5 to 16 years

Test: Subtest	Age Range
KABC-II: Word Order (without color interference) Number Recall Hand Movements	 3 to 18 years 3 to 18 years 4 to 18 years
NEPSY: Sentence Repetition	3 to 12 years
Test of Memory and Learning (TOMAL): Digits Forward Letters Forward Manual Imitation	5 to 19-11 years
WISC-IV: Digit Span	6 to 16-11 years
WISC-IV Integrated: Letter Span Letter-Number Sequencing Visual Digit Span Spatial Span	6 to 16-11 years
WRAML2: Finger Windows Number/Letter	5 to 90 years
Rating Scales	
Attention Deficit Disorders Evaluation Scales–Third Edition	4 to 18 years
Attention Deficit Disorders Evaluation Scale: Secondary-Age	11.5 to 18 years
ADHD Symptoms Rating Scale	5 to 18 years
Attention-Deficit/Hyperactivity Disorder Test	2 to 23 years
Brown Attention-Deficit Disorder Scales	3 to 7; 8 to 12; 12 to 18 years
Conners' Scales ADHD/*DSM-IV*™ Scales	3 to 17 years

TEST BATTERY FOR ASSESSING ATTENTION

The Test of Everday Attention for Children (TEA-CH; Manly, Robertson, Anderson, & Nimmo-Smith, 1999) is a battery of nine subtests designed to assess different components of attention in children and adolescents ages 6 to 16 years. There are several *positive features* of the TEA-CH including:

- The TEA-CH is an operationalization of Mirsky's model of attention including measures of selective/focused attention, sustained attention, divided attention, and attentional control/switching (a.k.a., shifting) attention.
- The test has two parallel forms, which makes it useful for retesting after an intervention.
- The effects of intelligence and memory have been minimized.

The only limitation of the test is the fact that the test was standardized on a sample of Australian children, bringing the question of generalizability of the results into question. The test was standardized on 293 Australian children and stratified into six age bands: 6–7, 7–9, 9–11, 11–13, 13–15, and 15–16. Scaled scores (mean of 100, standard deviation of 15) are provided based on the age by gender bands. The TEA-CH test would be strengthened if it were restandardized on a U.S. population.

The attentional factors that the nine TEA-CH subtests measure are shown in Rapid Reference 6.3. The TEA-CH subtests will be described in each section that addresses the subcomponents of attention.

TESTS OF SELECTIVE/FOCUSED ATTENTION

Das-Naglieri Cognitive Assessment System (CAS)

The CAS (Naglieri & Das, 1997) is a comprehensive measure of cognitive abilities for children ages 5 to 17-11 years. The test measures components of planning, attention, simultaneous, and successive processes. The CAS measures of attention will be explained in this section.

Expressive Attention

This test is similar to a classic Stroop test. The child must selectively focus on naming the color ink the word is printed in, rather than reading the word.

Number Detection

On this test the child is presented with a page that contains the numbers 1, 2, and 3. The child is instructed to selectively mark all of the target stimuli (the numbers

Rapid Reference 6.3

Test of Everyday Attention for Children (TEA-CH) Factors

Subtest	Selective/ Focused Attention	Sustained Attention	Divided Attention	Attentional Control/ Shifting
Sky Search	•			
Map Mission	•			
Score!		•		
Score DT		•		
Walk, Don't Run		•		
Code Transmission		•		
Sky Search DT			•	
Creature Counting				•
Opposite Worlds				•

1, 2, and 3 printed in an open font) while ignoring the distracters (the numbers 1, 2, and 3 printed in a different font).

Receptive Attention
For children ages 8 and older, there are two pages to the task. On the first page, letters that are physically the same (e.g., TT but not Tt) are the targets to be attended to. On the second page, letters that have the same name (e.g., Aa not Ba) are the targets of attention.

Delis-Kaplan Executive Function System (D-KEFS): Color-Word Interference Test

The D-KEFS: Color-Word Interference Test (Delis, Kaplan, & Kramer, 2001) is a Stroop-like test. The third condition of the test requires the student to name the color of the printed word rather than name the color word (e.g., red). This portion of the test requires selective/focused attention.

d2–Test of Attention

The d2 Test (Brickenkamp & Zilmer, 1998) is a measure of visual selective attention designed for children and adults, ages 9 to 60 years. The standardization sample is based on over 6,000 German subjects. This test was originally developed in Europe and has undergone eight revisions in the past 35 years. The test is available in five languages. The task consists of a single piece of paper with demographic information and a practice trial on one side and the actual test page on the other side. On the test page, stimuli (*d* or *p* marked with one, two, three, or four dashes) are arranged in a landscaped fashion across the page in 14 lines. The child is asked to scan the lines and cross out all of the letter *d*s with two dashes while ignoring other distracter stimuli. The number of correctly identified targets, commission, and omission errors are calculated to form the basis of the scores on the test.

NEPSY/NEPSY-II Subtests

Auditory Attention and Response Set (AARS)–Parts A and B

The AARS subtest (Korkman, Kirk, & Kemp, 1998; 2007) measures several components of attention. In Part A, the child listens to a tape recording of a voice saying words at a rate of one per second. The child is instructed to pick up a red foam chip and put it in a box lid every time the word *red* is spoken. There are many distracter words spoken, so the child must selectively attend to the target *red* word while ignoring the distracters. The test is 3 minutes long, so the child must also be vigilant and sustain his/her attention as well. In Part B, the child is asked to put a red square in the box every time the word *yellow* is spoken, a yellow square in the box every time the word *red* is spoken, and a blue square in the box every time the word *blue* is spoken. AARS Part B is a more demanding task and requires selective, sustained, and shifting attention, as well as working memory and executive functioning skills. Both parts of the test have supplemental scores for commission and omission errors and a qualitative measure for off-task behaviors.

> **DON'T FORGET**
>
> Some tests measure more than one subcomponent of attention. For example, the NEPSY/NEPSY-II Auditory Attention and Response Set–Part A requires selective and sustained attention, while Part B requires selective, sustained, and shifting attention.

Visual Attention

This subtest assesses the child's ability to visually scan a stimulus array and locate a target. Part A of the task requires the child to find as many pictures of cats among other pictures of common objects and animals as quickly and accurately as possible. Part B of the task requires the child to match each picture of a face in a large stimulus array to one of two target faces at the top of the page. Part A of this test measures selective and sustained attention, and Part B measures selective, sustained, and shifting attention. Both parts of the test give separate scores for completion time, commission errors, and omission errors. It is important to analyze the completion time as a function of the errors. Some children slow down in order to be more accurate, other children hurry through the test and make many mistakes, and other children are both slow and inaccurate. Both parts of the test give a qualitative measure for off-task behaviors.

Ruff 2 & 7 Selective Attention Test (Ruff 2 & 7)

The Ruff 2 & 7 (Ruff & Allen, 1996) was designed to measure visual selective and sustained attention for adolescents and adults, ages 16 to 70 years. The test has 20 trials of a visual search and cancellation task. Across all trials, the child is instructed to find and mark all occurrences of the numbers *2* and *7* as quickly as possible. The trials differ based on the distracters. In the first 10 trials, the targets (2 and 7) are embedded in alphabetical characters and in the last 10 trials the targets are embedded in other numbers. The test generates scores for both speed and accuracy.

Test of Everyday Attention for Children (TEA-CH)

The TEA-CH (Manly et al., 1999) has two subtests that measure selective attention:

Map Mission
On this test, the child is asked to search a map and find as many target symbols as possible in one minute.

Sky Search
This test has two parts. On Part 1, the child is instructed to find as many "target" spaceships as quickly as possible on a sheet of paper that is filled with target and nontarget spaceships. On Part 2, the child is instructed to circle all of the target spaceships but this time there are no nontarget, distracter spaceships. The score for the test is derived by subtracting Part 2 from Part 1 to remove any influence of the motor output aspect of the test.

Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV)

Coding

The WISC-IV Coding test (Wechsler, 2003) requires several cognitive processes including selective/focused attention, short-term memory, motor output, and visual-spatial associative learning. On the test, the child is presented with a piece of paper that has a series of codes at the top of the page that associates a different symbol with a different single-digit number. Below the code is a series of boxes with the symbols in the top of each box but the numbers missing below. The child is instructed to copy the numbers that go with each symbol in the empty boxes as quickly as possible. Some children quickly learn the symbol–number associations and perform well on the test, while others never learn the associations and have to look up each association every time. This task requires the child to selectively attend to the symbol–number pairs to complete the task successfully.

Symbol Search

The WISC-IV Symbol Search test (Wechsler, 2003) requires several cognitive processes including selective/focused attention, short-term memory, motor output, processing speed, and visual-spatial associative learning. On the test, the child is shown a page with a group of symbols. The child is instructed to visually scan the page and mark any of the symbols that matches target symbol(s). The test is timed.

Woodcock-Johnson III Tests of Cognitive Abilities: Auditory Attention

On this test (Woodcock, McGrew, & Mather, 2001a), the child listens to a word while looking at four pictures and is asked to point to the correct picture that matches the word. The task becomes more difficult as a tape player presents the target word in ever-increasing background noise. The child must selectively attend to the target word, while ignoring the background noise. The added visual cues of the pictures sometimes help the child compensate for poor auditory discrimination skills or to guess partially perceived words.

TESTS OF SUSTAINED ATTENTION

Das-Naglieri Cognitive Assessment System (CAS)

The CAS Number Detection and Receptive Attention tests were described in the previous selective/focused attention section and both tests also require sustained attention.

Continuous Performance Tests

Riccio, Reynolds, and Lowe (2001) provided a comprehensive review and comparison of the Continuous Performance Tests. The Continuous Performance Test (CPT) was originally designed to be a measure of vigilance or sustained attention, whereby the subject is asked to respond to a target event repeatedly over time while ignoring distracter or nontarget events. Riccio, Reynolds, Lowe, and Moore (2002) reported that while CPT performance does seem to reflect attentional disturbances, the various versions of the test do not discriminate particular disorders well (e.g., ADHD). Rapid Reference 6.4 presents some of the commonly used CPT tests. The methods used to administer the CPT vary tremendously. Some CPT tests are computer administered; others use a stand-alone electronic device; and others are paper-and-pencil versions. Some of the CPT tests use only an auditory mode of processing. The CPT tests in Rapid Reference 6.4 will be briefly reviewed.

Auditory Continuous Performance Test (ACPT)

The ACPT (Keith, 1994) was designed to measure both auditory selective/focused and auditory sustained attention in children with ADHD or auditory

Rapid Reference 6.4

Continuous Performance Tests

Test Name	Age Range	Modality
Auditory Continuous Performance Test	Ages 6 to 11-11	Auditory
Conners' Continuous Performance Test II Version 5	Ages 6 to Adult	Visual
Conners' Continuous Performance Test for Windows®: Kiddie Version	Ages 4 to 5	Visual
Gordon Diagnostic System	Ages 4 to 16	Auditory Only Visual Only Auditory & Visual
Integrated Visual and Auditory Continuous Performance Test	Ages 6 to 96	Auditory & Visual
Test of Variables of Attention	Ages 6 to 16	Auditory Only Visual Only

processing disorder. The ACPT was standardized on 510, 6- to 11-11-year-old children. On the test, children are instructed to listen to a series of words presented one at a time and then to raise their thumbs every time they hear a target one-syllable word. Errors of attention (missed targets) and errors of commission (incorrectly identified nontargets) are calculated.

Conners' Continuous Performance Test II–Version 5 for Windows®

The Conners' CPT-II Test (Conners & Multihealth Systems Staff, 2004a) is a computerized version of a CPT task designed for children and adults ages 6 and older. The advantage of using a computer to present the CPT stimuli is that more dependent variables can be monitored including: response time, errors, change in reaction time speed and consistency, signal detection theory statistics, and overall statistics. The Conners' CPT-II Test uses only a visual mode of presentation. There is a computerized version of the test available for children ages 4 to 5 called the Conners' Kiddie Continuous Performance Test (K-CPT; Conners & Multihealth Systems Staff, 2004b). The K-CPT uses pictures of objects as the targets rather than letters due to the age of the normative group.

Integrated Visual and Auditory Continuous Performance Test (IVA+Plus)

The IVA+Plus (Sandford & Turner, 1993–2006) is also a computerized version of a CPT task, but this test has an integrated visual and auditory presentation developed for children and adults ages 6 to 96 years.

Gordon Diagnostic System (GDS)

The GDS (Gordon, 1983; Gordon et al., 1996) is a stand-alone electronic device that is designed to measure sustained attention in children ages 4 to 16. The GDS was standardized on over 1,300 non-ADHD boys and girls. The GDS was modified in recent years to include a visual only presentation, an auditory only presentation, and a visual-auditory combined presentation of the CPT stimuli.

Test of Variables of Attention (T.O.V.A.)

The T.O.V.A. test (Greenberg & Waldman, 1993) is a computerized version of a CPT task; unfortunately the test only runs under MS-DOS™ and does not work with Microsoft® Windows®. The T.O.V.A has a strong normative sample for children based on 775 children ages 6 to 16 (Greenberg & Waldman, 1993); however, the test will not garner new users or support existing users until it is upgraded to be compatible with a newer computer operating system.

NEPSY/NEPSY-II Subtests

As previously mentioned in the Selective/Focused Attention section, the first part of the Auditory Attention and Response Set subtest on the NEPSY and NEPSY-II measures selective/focused attention as well as sustained attention. Likewise, the Visual Attention subtest on the NEPSY measures sustained attention.

Ruff 2 & 7 Selective Attention Test (Ruff 2 & 7)

The Ruff 2 & 7 (Ruff & Allen, 1996) was designed to measure visual selective and sustained attention for adolescents and adults, ages 16 to 70 years. The test is reviewed in the previous selective/focused attention section.

Test of Everyday Attention for Children (TEA-CH)

The TEA-CH (Manly et al., 1999) has four subtests that measure sustained attention:

Score!
On this subtest, the child is instructed to keep count of the number of *scoring* sounds they hear on a tape recording, just as if they were keeping score on a computer game.

Score DT
On this subtest, the child is instructed to count the *scoring* sounds while performing another listening task. As the child counts the *scoring* sounds, the child is also instructed to listen for an animal name spoken during a spoken newscast. The animal names serve as a distracter for the *scoring* sounds that are the real attentional targets.

Walk Don't Walk
On this subtest, the child is presented with a piece of paper that has a pathway drawn on it. The child is instructed to take a pencil and, without lifting it from the paper, start making a line down the pathway (a.k.a., walking) each time the child hears a tone. The child must sustain attention and inhibit the tendency to keep drawing a path before a tone is heard.

Code Transmission
On this subtest, the child is presented with a monotone series of spoken numbers. Occasionally, two *5*s will be spoken in a row. The child is instructed to name the number that came before the two *5*s.

Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV): Cancellation

The Cancellation test on the WISC-IV (Wechsler, 2003) requires the child to scan both a random and structured array of pictures and then mark "target" pictures as quickly as possible.

Woodcock-Johnson III Tests of Cognitive Abilities: Pair Cancellation

On this test (Woodcock, McGrew, & Mather, 2001a), the child is required to find and mark a pattern of objects on a page as quickly as he or she can within a designated time period. The test measures multiple cognitive processes including sustained attention, executive functioning related to the interference control, and processing speed.

TESTS OF SHIFTING ATTENTION

Das-Naglieri Cognitive Assessment System (CAS): Expressive Attention

This test is similar to a classic Stroop test. The child must selectively focus on naming the color ink the word is printed in, rather than reading the word. This test requires both selective and shifting attention.

Delis-Kaplan Executive Function System (D-KEFS)

One of the key components of the D-KEFS battery of tests (Delis, Kaplan, & Kramer, 2001) is the inclusion of measures of shifting of attention. The D-KEFS has four major measures of shifting:

Trail-Making Test (Condition 4)
Condition 4 of the Trail-Making Test is modeled after the classic rendition of trails when the child is instructed to switch between the number and letter sequences (e.g., 1-A-2-B-3-C . . .).

Verbal Fluency Test (Condition 3)
Condition 3 of the Verbal Fluency test requires the child to switch between naming a fruit and then naming a piece of furniture. This task measures verbal shifting ability and word-retrieval skills.

Design Fluency Test (Condition 3)
On Condition 3 of the Design Fluency test, the child is asked to switch between connecting the solid dots and the empty dots.

Color-Word Interference Test (Condition 4)
Condition 4 of the Color-Word Interference Test requires the child to name the color of the ink the color word is printed in, then switch at some point in the task to naming the word itself while ignoring the ink color of the printed word.

NEPSY/NEPSY-II Auditory Attention and Response Set

As previously mentioned in the Selective/Focused Attention section, the second part of the Auditory Attention and Response Set subtest on the NEPSY and NEPSY-II measures selective/focused attention, sustained attention, and shifting attention.

Test of Everyday Attention for Children (TEA-CH)

The TEA-CH (Manly et al., 1999) has two subtests that measure shifting attention:

Creature Counting
On this subtest, the child is instructed to count aliens in their burrows. There are arrows on the page that indicate whether the child is to be counting up in ascending order (i.e., 1, 2, 3, 4) or down in descending order (i.e., 10, 9, 8, 7). The child must switch between counting up and counting down.

Opposite Worlds
On this subtest, the child is shown pictures of two "worlds" labeled "same world" or "opposite world." In the "same world" the child is instructed to follow a path and name the digits 1 and 2 that appear along the way. In the "opposite world" section, the child is instructed to follow a path and say "2" when he or she encounters a number 1 and say "1" when he or she encounters a number 2. The speed that the child can perform the "opposite world" sections is the important variable for measuring shifting attention.

Wisconsin Card Sorting Test (WCST)
The WCST (Heaton, 1981) is a classic measure of shifting attention along with other cognitive processes. This test is described in more detail in Chapter Ten, Executive Functions. The WCST is principally a measure of perseveration and abstract thinking, however, the test does requires elements of attention as well. The WCST is designed for children and adults (ages 6-5 to 89 years).

TESTS OF DIVIDED ATTENTION

Test of Everyday Attention for Children (TEA-CH): Sky Search

The TEA-CH (Manly et al., 1999) has one subtest that measures divided attention: Sky Search DT. Once the child has completed the Sky Search and Score! subtests on the TEA-CH, the child is asked to combine the two tasks of finding the spaceships and keeping count of the "scoring" sounds.

Wechsler Intelligence Scale for Children–Fourth Edition Integrated: Letter-Number Sequencing Process Approach

On the Letter-Number Sequencing Process Approach test (Wechsler et al., 2004), the child is read a sequence of letters and numbers, some of which contain an embedded word. The child is instructed to first recall the letters from the original list in alphabetical order, followed by the numbers in ascending order. The embedded word placed in some trials is designed to provide a memory cue that reduces the demands placed on auditory working memory.

Woodcock-Johnson III Tests of Cognitive Abilities: Auditory Working Memory

On this test—Auditory Working Memory—the child is asked to listen to a series of object names and numbers mixed together, then recall and repeat the objects' names in the order presented followed by the numbers in the order presented. This task requires divided attention and working memory.

TESTS OF ATTENTIONAL CAPACITY

The following tests of attentional capacity could also be categorized under short-term memory (see Chapter 9). The attentional capacity component of these tests requires the child to attend to stimuli of increasing lengths and complexity within a particular test.

Children's Memory Scale (CMS): Numbers Subtest

On the CMS (Cohen, 1997a) there is a Numbers subtest that includes a Forward and Backward portion. On the Forward portion of the test, the child is asked to listen to the examiner read a string of numbers then repeat the numbers back to the examiner in the same order.

KABC-II Tests

On the KABC-II (Kaufman & Kaufman, 2004), there are three subtests that measure attentional capacity and/or short-term memory:

KABC-II: Word Order (without color interference)
The examiner says names of common objects and asks the child to then touch a series of silhouettes of those objects in the same order spoken by the examiner.

This trial of the task does not include an interference condition. The word-order series increase in length as the task progresses.

Number Recall

The examiner says a sequence of numbers ranging from two to nine numbers and asks the child to recall those numbers in the same sequence.

Hand Movements

The examiner shows the child a series of hand movements on the table and asks the child to reproduce those movements in the same order. The number of hand movements increases as the task progresses.

NEPSY/NEPSY-II

The NEPSY (Korkman et al., 1998, 2007) includes one subtest that measures attentional capacity and short-term memory—Sentence Repetition. The subtest is designed to assess the ability to repeat sentences of increasing complexity and length. It is the "increasing complexity and length" that requires attentional capacity.

Test of Memory and Learning (TOMAL)

The TOMAL (Reynolds & Bigler, 1994) has three tests that indirectly measure attentional capacity. Digits Forward and Letters Forward are similar to the other memory and learning tests, where the child repeats a sequence of numbers or letters that were presented by the examiner. The Manual Imitation subtest is similar to the KABC-II Hand Movements subtest, with the hand movement sequences increasing in length as the test progresses.

Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV): Digit Span

On the WISC-IV (Wechsler, 2003), the Digit Span test has two sections—Digits Forward and Digits Backward. The Digits Forward portion of the test is a measure of short-term memory and attentional capacity. The child is asked to recall a series of digits that are presented verbally to him or her and that increase in length as the test progresses. The Digit Span Backward portion of the test requires the child to recall the list of numbers in reverse order.

Wechsler Intelligence Scale for Children–Fourth Edition Integrated

Letter Span

On the WISC-IV Integrated (Wechsler et al., 2004), a Letter Span test is included as a means of testing the limits of the child's performance on the WISC-IV Digit Span–Forward test. The WISC-IV Integrated Letter Span test uses letter strings of the same span length, rather than the numbers used on Digit Span. Similar to the Digit Span test, the child is asked to recall a series of letters that are presented verbally to him or her and that increase in length as the test progresses.

Letter-Number Sequencing Process Approach

This test was reviewed under the divided attention section of this chapter. The test also measures attentional capacity because the lengths of the object name–number series increase in length as the test progresses.

Visual Digit Span

This test is the same as the WISC-IV Digit Span test except that the digits are presented to the child visually rather than verbally.

Spatial Span Forward

The Spatial Span subtest is designed to be a nonverbal analog to the WISC-IV Digit Span subtest. The child is presented with a board that has a series of raised blocks attached to it. The examiner touches the blocks one at a time in a sequence and asks the child to then touch the blocks in the same order. The child is presented with visual sequences in increasing length as the test progresses. The test measures visual short-term memory and attentional capacity.

Wide Range Assessment of Memory and Learning–Second Edition (WRAML2)

On the WRAML2 (Sheslow & Adams, 2003), there are two subtests that indirectly measure attentional capacity: Finger Windows and Number Letter. On the Finger Windows test, the child is shown a rigid piece of plastic that has random holes cut out. The examiner inserts the tip of a pencil approximately one inch into a series of holes one at a time in a prescribed order, then the child is asked to stick his or her finger in the holes following the same pattern. Finger Windows requires visual-spatial processing, visual-sequential memory, fine motor coordination, and as the sequence lengths increase, it requires attentional capacity. The Number Letter test is similar to all of the digit span and letter span tests previously described. This version includes intermixed numbers and letters that must be recalled in order rather than separating out the two.

BEHAVIORAL RATING SCALES FOR ADHD

There are multiple behavioral rating scales for assessing ADHD and attentional processing disorders. Rapid Reference 6.5 lists some of the commonly used ADHD rating scales and lists the areas that are assessed. The following tests with their abbreviations are listed in Rapid Reference 6.5:

- *ACTeRS–Parent:* ADHD-H: Comprehensive Teacher's Rating Scale: Parent Form (Ullmann, Sleator, Sprague, & Metritech Staff, 1996).
- *ADHD-H–Teacher:* ADHD-H: Comprehensive Teacher's Rating Scale–Second Edition (Ullmann, Sleator, & Sprague, 1991).
- *ACTeRS Self Report:* ADHD-H: Comprehensive Self-Report Rating Scale (Metritech Staff, 1998).
- *ADDES/ADDES-S:* Attention Deficit Disorders Evaluation Scale Third Edition/Attention Deficit Disorders Evaluation Scale: Secondary-Age (McCarney, 2004b, 2004a; *available in English or Spanish).*
- *ADHD-SRS:* ADHD Symptoms Rating Scale—*Available in English or Spanish* (Holland, Gimpel, & Merrell, 1998).
- *ADHD-SC4:* ADHD Symptoms Checklist–4 (Gadow & Sprafkin, 1997).
- *ADHDT:* Attention Deficit Hyperactivity Disorder Test (Gilliam, 1995).
- *CADS:* Conners' ADHD/*DSM-IV*™ Scales–Parent, Teacher, & Adolescent Self Reports (Conners, 1997).

There are other behavioral rating scales that assess attention within a broader construct. The *Brown Attention-Deficit Disorder Scales for Adolescents and Adults* (Brown, 1996), the *Brown Attention-Deficit Disorder Scales for Child and Adolescents* (Brown, 2001), and the *Clinical Assessment of Attention Deficit–Child* (CAT-C: Bracken & Boatwright, 2005) are three examples of rating scales for attention within a broader context.

Brown Attention-Deficit Disorder Scales (BADDS)

The Brown ADD Scales (Brown, 1996) have both Adult and Adolescent versions. The focus for this book will be the Adolescent Version for ages 12 to 18 years. The Brown ADD Scales are not designed to replace the *DSM-IV* diagnostic criteria for ADHD, but rather to evaluate five clusters of cognitive and affective symptoms of ADHD. The 40-item questionnaire is available for parent, teacher, and adolescent self-report raters, and yields five measures:

Rapid Reference 6.5

ADHD Rating Scales

	ACTeRS–Parents	**ACTeRS–Teacher**	**ACTeRS–Self**	**ADDES/ ADDES-S**	**ADHD-SRS**	**ADHD-SC4**	**ADHDT**	**CDAS**
Scales	Grades K–8	Grades K–8	Adolescents & Adults	Ages 4–18/ Ages 11.5–18	Ages 5–18	Ages 5–18	Ages 2–23	Ages 3–17
Attention/Inattention	✓	✓	✓	✓	✓	✓	✓	✓
Hyperactivity	✓	✓	✓		✓	✓	✓	
Hyperactivity-Impulsivity				✓		✓		✓
Social Skills	✓	✓						
Oppositional Behaviors	✓	✓						
Early Childhood Behaviors	✓							
Impulsivity			✓				✓	
Social Adjustment			✓					
Peer Conflicts Scale						✓		
Oppositional Defiant Disorder						✓		
Stimulant Side Effects Checklist						✓		
ADHD Index								✓

- *Organizing, prioritizing and activating to work*—This cluster was designed to measure any excessive difficulties in the organizational aspects of work-related tasks such as prioritizing and beginning work. This cluster also deals with self-initiation activities for daily routines (e.g., getting out of bed in the morning).
- *Focusing, sustaining, and shifting attention to tasks*—This cluster was designed to measure any chronic problems with sustained attention to everyday chores. Issues such as excessive daydreaming, distractibility during listening or reading activities, or losing track of the current task are also contained within this section.
- *Regulating alertness, sustaining effort, and processing speed*—This cluster was designed to measure any difficulties in retaining constant energy and effort in work-related settings. Problems assessed include: daytime drowsiness, inadequate task completion, and inconsistency of cognitive processes.
- *Managing frustration and modulating emotions*—This cluster was designed to measure any difficulties with mood and oversensitivity to criticism. Problems assessed include: irritability, frustration, chronic discouragement, depression, and apparent lack of motivation.
- *Utilizing working memory and accessing recall*—This cluster was designed to measure forgetfulness that may occur during the daily routines. Problems with excessive difficulty in recalling learned material of importance are included in this cluster.

There is also a version of the Brown ADD Scales for Children (Brown, 2001). The test has two versions: the Primary/Preschool Scale for children ages 3 to 7 and the School-Aged Scale for children ages 8 to 12. The Brown ADD Scales for Children includes the same five clusters as found on the adolescent and adult version of the test and one additional cluster:

- *Monitoring and self-regulating action*—This cluster is designed to measure any difficulties of children in regulating their own actions, such as problems with impulse control, failing to notice the emotional reactions of others to their own actions, and failure to modify their own behavior in response to circumstances.

See Brown (2005) for a complete review of a model of executive functions impaired in ADD Syndrome.

Clinical Assessment of Attention Deficit–Child (CAT-C)

The CAT-C (Bracken & Boatwright, 2005) is a behavioral rating scale that may be completed by a parent, teacher, or child. It was standardized for use with children and adolescents ages 8 to 18 years. The CAT-C includes three clinical scales that align with the *DSM-IV* ADHD diagnoses: Inattention, Impulsivity, and Hyperactivity. What makes this test unique is that there are also three context scores that measure the extent that the ADHD symptoms appear in the Personal, Academic/Organizational, or Social areas of the child's or adolescent's life. The CAT-C also measures whether the ADHD behaviors are expressed as internal sensations (Internal Locus) or overt behaviors (External Locus). Finally, the CAT-C includes three validity scales: overt negative impression, infrequency, and overt positive impression.

In this chapter, the terminology, neuroanatomy, major behavioral tests, and rating scales associated with attentional processes were reviewed. Attentional processes play a major role in all of the higher-order processes and should be systematically assessed by a school neuropsychologist. Attentional dysfunctions are observed in many common developmental disorders. As an example, in Chap-ter 16 the school neuropsychological conceptual assessment model will be used to review the presence of attention deficits in autism-spectrum disorders.

TEST YOURSELF

1. Mirsky's model of attention included all of the following except which one?

(a) encoding
(b) orienting
(c) sustained
(d) focus/selective

2. Jimmy has trouble paying attention in class because he is distracted by other things going on in the classroom (e.g., noises made by the air conditioner). What subcomponent of attention is Jimmy probably having the most trouble with?

(a) sustained attention
(b) shifting attention
(c) attentional capacity
(d) selective/focused attention

3. Neuroimaging studies have shown that the right prefrontal region of the brain helps regulate sustained attention. True or False?

4. What is the name of the test battery for children that measures attention based on Mirsky's model?
(a) Test of Everyday Attention for Children
(b) Wisconsin Card Sorting Test
(c) NEPSY
(d) Das-Naglieri Cognitive Assessment System

5. Which of the following types of attention is related to short-term memory?
(a) attentional capacity
(b) sustained attention
(c) selective attention
(d) divided attention

6. The ability to attend to more than one stimulus at a time is called?
(a) shifting attention
(b) attentional capacity
(c) divided attention
(d) selective attention

7. Which of the following types of attention is related to working memory?
(a) attentional capacity
(b) divided attention
(c) selective attention
(d) sustained attention

Answers: 1. b; 2. d; 3. true; 4. a; 5. a; 6. c; 7. b

Seven

VISUAL-SPATIAL PROCESSES

Much of what is learned in school has either a visual-spatial or a language basis. Visual-spatial skills and language skills are essential for a child to achieve academic success. Visual perceptual skills play a major role in the development of a child's handwriting skills, and math and reading fluency. The school neuropsychologist should include measures of visual-spatial processes in any comprehensive school neuropsychological evaluation. The neuropsychology of visual-spatial processes will be reviewed in this chapter and the neuropsychology of language processes will be reviewed in Chapter 8. In this chapter, subcomponents of visual-spatial functions will be defined, the neuroanatomy of visual-spatial functions will be described, and the common tests used to assess visual-spatial functions will be presented.

VISUAL-SPATIAL PROCESSES

Alicia is a poor reader. She can name individual letters, and some letters in a word, but she has great difficulty combining or integrating the letters to make a whole word. In Alicia's artwork, she pays great attention to detail but lacks the ability to see any relationships between the details. Alicia's teacher describes Alicia as "not being able to see the forest for the trees." Alicia is having difficulties with the perception of a part-to-whole relationship that is a subcomponent of visual-spatial functions.

Subcomponents Associated with Visual-Spatial Processing

Visual-spatial processing is a broad cognitive process that encompasses many subcomponents. Many of the visual-spatial subcomponents involve other cognitive processes such as attention, sensory-motor, memory, and executive functions. Any neurocognitive task that uses visual stimuli involves a certain degree of visual processing. Some neurocognitive tasks require visual attention to detail, as in a visual sustained-attention task (e.g., WJIII-COG: Pair Cancellations). Other neurocognitive tasks require visual-motor integration (e.g., Beery VMI, WRAVMA), visual-motor planning (e.g., WJIII-COG: Planning, WISC-IV Integrated: Elithorn Mazes), visual memory (e.g., CMS: Dot Localization, WRAML2: Design Memory), visual perception with a motor response (e.g., Jordan Left-Right Reversal Test–Revised), motor-free visual perception (e.g., WJIII-COG: Spatial Relations), visual perceptual organization (e.g., Extended Complex Figure Test), visual perceptual reasoning (e.g., WISC-IV: Block Design), and visual scanning or tracking (e.g., D-KEFS: Trail Making Test [Condition 1]). Rapid Reference 7.1 lists the subcomponents associated with visual-spatial processing and indicates where in the conceptual model the subcomponents are covered.

Neuroanatomy of Visual-Spatial Functions

Visual perception is distributed across two distinct subsystems (Gazzaniga, Ivry, & Mangun, 2002). Ninety percent of the optic nerve axons terminate in the lateral geniculate nuclei of the thalamus, the relay station of the brain. The remain-

Rapid Reference 7.1

Visual-Spatial Processing Subcomponents

Subcomponent	Where Covered in Conceptual Model
Visual Attention	Covered under attentional processes
Visual-Motor Integration	Covered under sensory-motor processes
Visual-Motor Planning	Covered under executive functions
Visual (Spatial) Memory	Covered under memory and learning
Visual Perception (motor response)	Covered in this section
Visual Perception (motor free)	Covered in this section
Visual Perceptual Organization	Covered in this section
Visual Perceptual Reasoning	Covered under executive functions
Visual Scanning/Tracking	Covered in this section

ing 10 percent of the optic nerve axons terminate at other subcortical structures, including the superior colliculus of the midbrain and the pulvinar nucleus of the thalamus. The final axonal pathway leaves the lateral geniculate nuclei and terminates in the primary visual cortex of the occipital lobe.

The primary visual cortex within the occipital lobe has many specialized areas. Visual perception appears to involve a "divide and conquer" strategy (Gazzaniga, Ivry, & Mangun, 2002, p. 161). While each of the visual areas within the primary visual cortex help to provide a visual map of the external world, some neuronal areas are sensitive to variations in color, others to movement, and so on. The specialized visual areas provide distributed and specialized analyses that are integrated into perceptual wholes at higher levels of processing.

The outputs from the primary visual cortex follow two general pathways: the superior longitudinal fasciculus and the inferior longitudinal fasciculus. The superior longitudinal fasciculus fibers terminate in the posterior parietal cortex and the inferior longitudinal fasciculus fibers terminate in the inferior temporal cortex. Ungerleider and Mishkin (1982) proposed that the ventral or occipital-parietal pathway (superior longitudinal fasciculus) is specialized for object perception and object recognition. Ungerleider and Mishkin refer to the occipital-parietal pathway as the *where* pathway, where an object is relative to different objects. The dorsal or occipital-temporal pathway (inferior longitudinal fasciculus) is specialized for spatial perception. Ungerleider and Mishkin refer to the occipital-temporal pathway as the *what* pathway, as in, what we are looking at. Both the *what* and the *where* aspects of visual perception are important. We need to recognize what we are looking at and know where it is.

Visual Object Recognition

The common neuropsychological terms associated with visual-spatial impairments are presented in Rapid Reference 7.2. The label *visual agnosia* is used to describe a child who has difficulty recognizing visually presented objects. A child with visual agnosia will not be able to identify a pencil based on sight alone, but may be able to quickly identify the pencil when it is placed in his or her hand. *Apperceptive agnosia* is a subtype of visual agnosia in which failures in object recognition are linked to problems with visual perceptual processing. However, *associative agnosia* is used to describe a child who has normal visual representations but cannot use that information to recognize an object. Warrington (1985) proposed a two-stage, neuroanatomical model of object recognition. Warrington proposed that visual processing would initially be bilateral and involve both occipital cortices. Next, perceptual categorization within the

Rapid Reference 7.2

Neuropsychological Terms Associated with Visual-Spatial Impairments

- *Apperceptive agnosia*—a form of visual agnosia in which the deficit is caused by impaired visual perception.
- *Associative agnosia*—a failure of visual object recognition that cannot be attributed to perceptual abilities.
- *Astereopsis*—inability to perceive the depth of objects.
- *Color agnosia*—inability to appreciate differences between colors or to relate colors to objects in the presence of intact color vision.
- *Integrative agnosia*—a failure in integrating the parts of an object into a coherent whole.
- *Pantomime agnosia*—inability to comprehend pantomimes, even when the ability to copy them remains intact.
- *Prosopagnosia*—impaired face recognition.
- *Simultanagnosia*—impaired recognition of the meaning of whole pictures or objects, but intact ability to describe the parts of the pictures/objects.
- *Visual agnosia*—impaired ability to recognize visual information.

Sources: Ayd, 1995; Loring, 1999.

right parietal hemisphere is employed. Perceptual inputs are aligned with visually stored representations of objects. This stage is thought to be presemantic, in that a child may be able to recognize two pictures that illustrate the same object without having to name the object or describe its function. The second stage of object recognition, according to Warrington's model, is semantic categorization within the left hemisphere. In the second stage, visual information is linked to knowledge in long-term memory concerning the name and function of the object (e.g., Woodcock-Johnson III Tests of Achievement: Picture Vocabulary). Warrington found that adults with lesions in their right hemisphere were more likely to demonstrate characteristics of apperceptive agnosia and adults with lesions in their left hemispheres were more likely to demonstrate characteristics of associative agnosia.

Face Recognition

An important subset of object recognition is face recognition. We can be walking down the street and meet an old friend from high school and instantly recognize his or her face. *Prosopagnosia* is a term used to describe the inability to recognize faces. Prosopagnosia rarely occurs with unilateral, left lesions. It is more likely associated with bilateral lesions caused by multiple strokes, head injury, encephalitis, or poisoning (Gazzaniga, Ivry, & Mangun, 2002), or right hemispheric lesions that include the ventral regions of the occipital and temporal lobes (De Renzi, Perani, Carlesimo, Silveri, & Fazio, 1994).

TESTS OF VISUAL-SPATIAL PROCESSES

Rapid Reference 7.3 presents a list of common tests of visual-spatial functions for school-aged children. The tests are categorized based on tests of visual perception, visual perception (motor free), visual-perceptual organization, and visual scanning/tracking.

TESTS OF VISUAL PERCEPTION

Benton Facial Recognition Test (BFRT)

The BFRT (Benton, Sivan, Hamsher, Varney, & Spreen, 1994) is a matching unfamiliar faces discrimination test. The test consists of 22 target black-and-white photos that are each presented to the child along with six multiple-choice pictures below the target. As the task progresses, the matching becomes more difficult as the stimulus properties of the faces change (e.g., face orientation, lighting). See Baron (2004) for a more detailed review and some supplemental norms for children.

Jordan Left-Right Reversal Test–Revised

The Jordan Left-Right Reversal Test–Revised (Jordan, 1990) was designed to assess for reversals of letters, numbers, and words in children ages 5 to 12 years. The test includes an informal laterality checklist to survey a child's preference for one side of his or her body over the other; and a Remedial Checklist that can be used to offer suggestions to the teacher(s) and parent(s) to improve the child's laterality. The test takes approximately 20 minutes to administer.

KABC-II Visual Processing Subtests

There are four subtests on the KABC-II that are designed to measure different aspects of visual processing: Block Counting, Gestalt Closure, Rover, and

Rapid Reference 7.3

Tests of Visual-Spatial Functions

Test	Functions Assessed	Age Range
Tests of Visual Perception		
Benton Facial Recognition Test	Face discrimination	6 to 11; 13 to 14 years
Jordan Left-Right Reversal Test–Revised	Visual reversals of letters, numbers, and words	5 to 12 years
KABC-II: Block Counting	Visualization and math achievement	7 to 18 years
KABC-II: Gestalt Closure	Visual closure speed	3 to 18 years
KABC-II: Triangles	Spatial relations, visualization	3 to 18 years
NEPSY-II:		
Geometric Puzzles	Mental rotation and visuospatial analysis	3 to 6 years
Picture Puzzles	Visual discrimination, spatial localization, and visual scanning	7 to 16 years
Recognition of Reversals	Visual recognition of reversals of letters and numbers	5 to 16 years
Stanford-Binet Intelligence Scales (5th ed.): Form Board (nonverbal); Form Patterns (nonverbal); Position and Direction (verbal)	Visualize and solve spatial and figural problems or ability to use common visual/spatial terms (e.g., behind, next to).	2 to 85+ years
Test of Pictures/Forms/Letters/Numbers/Spatial Orientation and Sequencing Skills (TPFLNSOSS)	Visual reversals	5 to 8-11 years

(continued)

Test	Functions Assessed	Age Range
WISC-IV: Block Design Matrix Reasoning Picture Completion Picture Concepts	Visual perceptual reasoning	6 to 16-11 years
Tests for Visual Perception (Motor free)		
Benton Judgment of Line Orientation Test	Visuospatial perceptual ability	7 to 14 years
Developmental Test of Visual Perception, 2nd Edition (DTVP-2)	Visual perceptual and visual-motor integration	4 to 10 years
Developmental Test of Visual Perception–Adolescent and Adult (DTVP-A)	Visual perceptual and visual motor abilities	11 to 74-11 years
Motor-Free Visual Perception Test–3	Visual-perceptual ability with no motor involvement	4 to 95 years
NEPSY/NEPSY-II: Arrows	Judgment of line and angle orientation	5 to 12/5 to 16 years
Test of Visual Perceptual Skills–3	Visual discrimination, visual memory, visual-spatial relationships, visual form constancy, visual sequential memory, visual figure-ground, and visual closure	4 to 18-11 years
WJIII-COG: Spatial Relations	Visualization of spatial configurations	2 to 89 years
Tests of Visual-Perceptual Organization		
Rey Complex Figure Test and Recognition Trial	Visuospatial ability and visuospatial memory	6 to 89 years
Extended Complex Figure Test	Perceptual organization and visual memory	6 to 18 years

Test	Functions Assessed	Age Range
Developmental Scoring System for the Rey-Osterrieth Complex Figure	Visuospatial accuracy, organization, style, and errors	5 to 14 years
Tests for Visual Scanning/Tracking		
D-KEFS: Trail Making Test (Condition 1)	Visual scanning	8 to 89 years
KABC-II: Rover	Spatial scanning, general sequential reasoning, and math achievement	6 to 18 years
Letter/Number Cancellation Tests:	Visual scanning	
WJIII: Pair Cancellations		5 to 89 years
Ruff 2 & 7 Selective Attention Test		16 to 70 years
NEPSY: Visual Attention	Visual scanning	3 to 12 years
NEPSY-II: Picture Puzzles	Visual scanning	7 to 16 years
WISC-IV: Coding Symbol Search	Visual scanning	6 to 16-11 years

Triangles (Kaufman & Kaufman, 2004). The Rover subtest is discussed under the Visual Scanning section, while the other three subtests measure some aspect of visual perception.

Block Counting

The child is shown a picture of three-dimensional cubes and asked to count them. The blocks are configured in such a way that some of them may be obscured or hidden and the child has to infer their existence. The task requires reasoning and visualization skills.

Gestalt Closure

The child is shown a picture of an object that has been partially erased or obscured. The child is asked to name or describe the incomplete object. The task measures closure speed and part-to-whole visual closure.

Triangles

The child uses foam triangles that are blue on one side and yellow on the other to create shapes from a picture or a model created by the examiner. The task requires spatial relations and visualization skills.

NEPSY-II Subtests

The NEPSY-II (Korkman, Kirk, & Kemp, 2007) has two subtests that assess visual perception: Geometric Puzzles and Picture Puzzles.

Geometric Puzzles

The child is shown a picture of a large grid containing several shapes. For each item, the child matches two shapes outside of the grid to two shapes within the grid. This subtest measures the ability to perform mental rotations, visuospatial analyses, and attention to detail.

Picture Puzzles

The child is presented with a large picture divided by a grid and four smaller pictures taken from sections of the larger picture. The child is asked to identify the location on the grid of the larger picture from which each of the smaller pictures was taken. This subtest measures visual discrimination, spatial localization, and visual scanning.

Recognition of Reversals

In the prepublication version of the NEPSY-II, this subtest was classified under the Language Domain subtests. The subtest seems to measure visual perceptual skills more than language skills. On the subtest, the child is shown a list of letters and numbers, some of which have been reversed. The child is asked to circle the letters and numbers that are reversed.

Stanford-Binet Intelligence Scale, Fifth Edition (SB5)

The SB5 (Roid, 2003) contains subtests that measure both nonverbal visual-spatial processing and verbal visual-spatial processing. The nonverbal visual-spatial processing tests use a form board to assess visualization of common shapes or require the child to identify form patterns in pictures. The verbal visual-spatial processing tests require the child to understand verbal spatial concepts like “over” or “behind.” For older children, the Position and Direction test requires the child to verbally describe a path to take on a map.

Test of Pictures/Forms/Letters/Numbers/Spatial Orientation and Sequencing Skills (TPFLNSOSS)

The TPFLNSOSS (Gardner, 1991) was designed to assess reversals of pictures, forms, letters, and numbers, and to assess letter-sequencing errors. The test takes approximately 10 to 15 minutes to administer.

Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV) Subtests

The WISC-IV (Wechsler, 2003) was conceptually developed to include four measures of perceptual reasoning including: Block Design, Matrix Reasoning, Picture Concepts, and Picture Completion. Each of these tasks requires multiple cognitive processes, which make them difficult to place within the school neuropsychological model. For example, Block Design and Matrix Reasoning both require visual reasoning or problem-solving skills, which entail some aspect of executive functions. A confirmatory factor analysis of the WISC-IV subtests by Keith and colleagues (2004) suggested that Block Design, Matrix Reasoning, and Picture Completion all loaded on a visual-spatial thinking (*Gv*) factor; while Picture Concepts loaded on a fluid reasoning (*Gf*) factor.

Block Design

The child is presented with a set of red and white blocks and asked to replicate a set of modeled or printed two-dimensional geometric patterns. Performance on the Block Design subtest may be affected by the child's reflective or impulsive style of responding, field dependence or field independence style of visual-spatial processing, flexible or inflexible style of problem solving, planning ability, and/or the ability to perform under time constraints (Flanagan & Kaufman, 2004).

Matrix Reasoning

The child is asked to complete the missing component of a nonverbal picture matrix by selecting one of five picture pieces. Performance on the Block Design subtest may be affected by the child's reflective or impulsive style of responding, field dependence or field independence style of visual-spatial processing, flexible or inflexible style of problem solving, and/or planning ability (Flanagan & Kaufman, 2004).

Picture Concepts

The child is asked to choose one picture from each of the two or three rows of pictures presented to form a group that has a common characteristic (e.g., all food items). Performance on the Picture Concepts subtest may be more reflective of nonverbal problem solving or reasoning rather than visual-spatial thinking. Performance on the Picture Concepts test is also affected by the extent of the child's prior educational opportunities and experiences, early language and environmental stimulation, and alertness to the environment (Flanagan & Kaufman, 2004).

Picture Completion

The child is asked to view a picture, then name the essential missing part within a specific time limit. Performance on this test may be influenced by poor vision, alertness to the environment, and/or a field dependence or field independence style of visual-spatial processing (Flanagan & Kaufman, 2004).

TESTS FOR VISUAL PERCEPTION (MOTOR FREE)

Benton Judgment of Line Orientation Test (JLOT)

The JLOT (Benton, Sivan, Hamsher, Varney, & Spreen, 1994) was designed to measure nonverbal, visuospatial perceptual ability in children ages 7 to 14 years. The test does not require a motor response. On the JLOT, the child is shown a single line or a set of single lines whose position(s) can be matched to the positions of eleven full-length lines drawn in 18 degree intervals on a multiple-choice card. The multiple-choice lines are numbered for a verbal matching response from the child. See Baron (2004) for a detailed review of the JLOT test and a set of supplemental norms.

Developmental Test of Visual Perception, Second Edition (DTVP-2)

The DTVP-2 (Hammill, Pearson, & Voress, 2003) is designed to measure visual perception and visual-motor integration skills in children ages 4 to 10 years. The DTVP-2 has eight subtests: Eye-Hand Coordination, Copying, Spatial Relations, Position in Space, Figure-Ground, Visual Closure, Visual-Motor Speed, and Form Consistency. The test yields summary scores for visual perception with no motor response and a score for visual-motor integration ability. In the conceptual school neuropsychological assessment model, tests of visual perception may be found in various sections of the report. For instance, the nonmotor visual perception score could be reported in the visual-spatial functions section, and the visual-motor integration score could be reported in the sensory-motor functions section.

Developmental Test of Visual Perception–Adolescent and Adult (DTVP-A)

The DTVP-A (Reynolds, Pearson, & Voress, 2002) is a comprehensive battery of tests designed to measure visual perceptual and visual-motor abilities in children and adults, ages 11 to 74-11 years. The DTVP-A is an upward extension of the DTVP-2 (Hammill et al., 2003). The DTVP-A has six subtests: Copying, Figure-Ground, Visual-Motor Search, Visual Closure, Visual-Motor Speed, and Form Constancy. The test yields the following index scores: Visual-Perceptual, Motor-Reduced Visual Perception, and Visual-Motor Integration Index. Similar to the DTVP-2, the Visual-Perceptual and Motor-Reduced Visual Perception Indices could be reported in the visual-spatial section of a school neuropsychological report, and the Visual-Motor Integration Index score could be reported in the sensory-motor section.

Motor-Free Visual Perception Test–3 (MVPT-3)

The MVPT-3 (Colarusso & Hammill, 2003) was designed to assess visual-perceptual ability in children and adults, ages 4 through 70. As the name of the test implies, no motor response is required to perform this test. On the MVPT-3, the child is shown a line drawing and then asked to choose a matching drawing on the next page from a set of four possible choices. The MVPT-3 measures five areas of visual perception including: spatial relationship, visual closure, visual discrimination, visual memory, and figure ground. The test takes approximately 25 minutes to administer. The MVPT-3 has norms for response time and yields a perceptual quotient and a perceptual age score.

NEPSY/NEPSY-II: Arrows

The Arrows subtest on the NEPSY and NEPSY-II (Korkman, Kirk, & Kemp, 1998, 2007) was designed to measure the ability to judge line orientation and directionality in children ages 5 to 12. The child is shown a page with a picture of a target and eight arrows pointing toward the center. Two of the arrows point directly to the center of the target, and the child is instructed to identify those two arrows. The test does not require a motor response. The test is constructed in such a way that one of the *correct* arrows that points toward the center of the target is always on the right side of the page and the other *correct* arrow is on the left side of the page. Supplemental scores are available for right and left visual field errors.

Test of Visual Perceptual Skills–3 (TVPS-3)

The TVPS-3 (Martin, 2006) replaced the Test of Visual-Perceptual Skills (nonmotor)–Revised Test and the Test of Visual-Perceptual Skills (nonmotor) Upper Level–Revised). The TVPS-3 was designed to measure visual-perceptual strengths and weaknesses in children ages 4 to 18-11. On the test, the child is presented with a black-and-white drawing that needs to be matched with a multiple-choice response card. The child may vocalize the letter of the correct response or point to the correct response. The visual-perceptual areas assessed by the TVPS-3 include: visual discrimination, visual memory, visual-spatial relationships, form consistency, visual sequential memory, figure-ground relationships, and visual closure.

WJIII-COG: Spatial Relations

The WJIII: Spatial Relations test (Woodcock, McGrew, & Mather, 2001a) is designed to measure visual-spatial thinking. On the test, the child is asked to identify two or more pieces that go together to form a complete target shape. As the test progresses, the items become more difficult (e.g., target shape is rotated from the potential pieces).

TESTS OF VISUAL-PERCEPTUAL ORGANIZATION

Rey Complex Figure Test and Recognition Trial (RCFT)

The Rey-Osterrieth Complex Figure Test (CFT: Rey & Osterrieth, 1993) was originally designed in the 1940s to measure both perceptual organization and visual memory in persons with brain injury. The RCFT (Meyers & Meyers, 1995) standardized the procedures and materials used to administer the Rey Complex Figure Test. The RCFT was designed to measure visuospatial ability and visuospatial memory in children ages 6 to 17, and adults ages 18 to 89 years. The 8.5" × 11" stimulus card is a replica of the original Rey complex figure. On the RCFT, the child is shown the stimulus card and asked to: (a) copy the stimulus on a separate sheet of paper, (b) copy the stimulus from immediate memory, and (c) copy the stimulus after a delayed recall. The RCFT also includes a recognition trial.

Extended Complex Figure Test (ECFT)

The ECFT (Fastenau, 1996) is also a revision of the original Rey-Osterrieth Complex Figure Test (CFT). The ECFT added a recognition and matching trials component to the test that is similar to the RCFT (as described previously). The ECFT was designed to measure perceptual organization and visual memory in brain-injured children ages 6 to 18 and in brain-injured adults, ages 19 to 85 years.

Developmental Scoring System for the Rey-Osterrieth Complex Figure (DSS-ROCF)

The DSS-ROCF (Bernstein & Waber, 1996) provides examiners with developmental norms for the Rey-Osterrieth Complex Figure Test (CFT) based on a sample of 5- to 14-year-old children. The DSS-ROCF measures four parameters of CFT performance: organization, style, accuracy, and errors.

TESTS FOR VISUAL SCANNING/TRACKING

Children with significant visual-scanning deficits often have difficulty with reading, writing, performing paper-and-pencil tasks, and telling time (Diller et al., 1974). Tests of sustained attention (described in Chapter 6), as well as other tests that measure processing speed (described in Chapter 11), require visual scanning. Examples of several visual-scanning tests are described in this section.

Delis-Kaplan Executive Functions System (D-KEFS): Trail Making Test (Condition 1)

On Condition 1 of the D-KEFS: Trail Making Test (Delis, Kaplan, & Kramer, 2001), the child is asked to find all of the number 3s on the page as quickly as possible and mark them. This task requires visual scanning.

Kaufman Assessment Battery for Children–Second Edition (KABC-II): Rover

On the KABC-II Rover subtest (Kaufman & Kaufman, 2004), the child is shown a checkerboard-like grid that contains a toy dog, a bone, and some obstacles (rocks and weeds). The child is instructed to move the Rover dog from the starting point to the bone in the least number of moves while avoiding any obstacles. The task measures spatial scanning, general sequential reasoning, and math achievement.

Letter/Number Cancellation Tests

Cancellation tests that principally measure sustained attention also require visual or spatial scanning. Examples include the Ruff 2 & 7 Selective Attention Test (Ruff & Allen, 1996) and the WJIII COG: Pair Cancellations test (Woodcock, McGrew, & Mather, 2001a).

NEPSY: Visual Attention

On the NEPSY Visual Attention subtest (Korkman, Kirk, & Kemp, 1998), the child must visually scan a page and find all of the target stimuli while ignoring the nontarget stimuli.

NEPSY-II: Picture Puzzles

The Picture Puzzles subtest on the NEPSY-II (Korkman, Kirk, & Kemp, 2007) was previously described in the Visual Perception section of this chapter. The test does require visual scanning.

Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV): Coding & Symbol Search

On the WISC-IV Coding test (Wechsler, 2004), the child must initially scan top to bottom between the symbol codes at the top of the page and the response items on each line. On the Symbol Search test, the child must visually scan a group of visual stimuli to match target symbol(s).

In this chapter, the terminology, neuroanatomy, and major assessment measures associated with visual-spatial processes were reviewed. Visual-spatial processes have a strong influence on academic achievement (e.g., handwriting, math and reading fluency) and should be systematically assessed by a school neuropsychologist. Visual-spatial processing disorders are observed in many common developmental disorders. As an example in Chapter 16, the school neuropsychological conceptual assessment model will be used to review the presence of visual-spatial deficits in autism-spectrum disorders.

TEST YOURSELF

1. What term means an impaired ability to recognize visual information?
(a) simultanagnosia
(b) astereopsis
(c) prosopagnosia
(d) visual agnosia

2. What term means impaired face recognition?
(a) simultanagnosia
(b) astereopsis
(c) prosopagnosia
(d) visual agnosia

3. Ungerleider and Mishkin refer to occipital-parietal pathway as the *where* pathway. True or False?

4. Warrington found that adults with lesions in their right hemisphere were more likely to demonstrate characteristics of:
(a) apperceptive agnosia
(b) integrative agnosia
(c) associative agnosia
(d) color agnosia

5. An inability to perceive the depth of objects is called
(a) simultanagnosia.
(b) astereopsis.
(c) prosopagnosia.
(d) visual agnosia.

6. The KABC-II Block Counting subtest is an example of a motor-free visual perception test. True or False?

7. All of the following are tests that require visual scanning except one; which one?
(a) NEPSY Visual Attention
(b) WISC-IV Coding
(c) WJIII-COG: Spatial Relations
(d) D-KEFS Trail Making Test Condition 1

Answers: 1. d; 2. c; 3. false; 4. a; 5. b; 6. false; 7. c

Eight

LANGUAGE PROCESSES

Much of what is learned in school has a language basis. Language enables us to share our experiences with each other and pass our knowledge gained from those experiences on to the next generation (Carlson, 2007). Language skills are essential for a child to achieve academic success. In this chapter the neuroanatomy of language will be described and the common tests used by school neuropsychologists and speech and language pathologists to assess language processes will be presented.

NEUROANATOMY OF LANGUAGE

Virginia has difficulty producing oral language. Her speech could be characterized as slow, laborious, and nonfluent. Virginia can understand what others say to her much better than she can produce language. Virginia also has some moderate articulation problems and she experiences difficulty in finding the right word to say. Virginia exhibits symptoms of a type of disorder called expressive aphasia.

Lateralization of Language

Language skills are lateralized in the left side of the brain in 90 percent of the total population (Carlson, 2007). Knecht et al. (2000) found that left-hemispheric speech is dominant in 96 percent of healthy, right-handed people; 85 percent of ambidextrous people; and 73 percent of left-handed people. Vikingstad et al. (2000) reported that if the left hemisphere is malformed or damaged early in development, then the right hemisphere might take over language functions. While the left hemisphere plays a major role in the production and understanding of language, the right hemisphere plays a role in the spatial aspect of language.

Speech Production (Oral Expression)

Much of what we know about the neuropsychology of language stems from the study of patients with *aphasia*. Aphasia is a deficit in the ability to produce or understand language caused by some form of brain damage or dysfunction. In 1861, Paul Broca was the first practitioner to notice damage to the inferior prefrontal cortex of the left hemisphere in postmortem examinations of the brains of patients who had expressive aphasias. This area became known as *Broca's area*. More recent research has suggested that damage to Broca's area alone does not produce expressive aphasia. For expressive aphasia to occur, damage must extend to brain tissue surrounding Broca's area within the frontal lobe and to underlying subcortical white matter (Naeser et al., 1989). Also, lesions within the head of the caudate nucleus within the basal ganglia can produce Broca-like aphasia (Damasio, Eslinger, & Adams, 1984). Lesions within the left precentral gyrus of the insula, located on the anterior wall of the cerebral hemisphere, directly behind the temporal lobe, have been found to cause *apraxia of speech*—an impairment in the ability to program movements of the lips, tongue, and throat for the production of speech (Dronkers, 1996).

Broca's aphasia is characterized by slow, laborious, and nonfluent speech. Children with Broca's aphasia, or expressive aphasia, can comprehend speech much better than they can produce it. Broca's aphasia has several common deficits associated with it, including: poor programming of oromotor movements used to produce speech, agrammatism, anomia, and articulation difficulties (Carlson, 2007). *Agrammatism* refers to a child's difficulty or inability to produce a grammatical or intelligible sentence. *Anomia* refers to word-finding difficulty. Anomia is often characteristic of many forms of aphasia but it is very apparent in expressive or Broca's aphasia. *Articulation difficulties* are often observed in children with expressive or Broca's aphasia. Children have trouble pronouncing words and may alter the sequence of the sounds (Carlson, 2007).

Speech Comprehension (Receptive Language or Listening Comprehension)

In 1874, Carl Wernicke identified another area of the brain that was damaged in clinical patients with aphasia. This additional language area was located in the left temporal lobe, posterior to the primary auditory cortex in an area known as the planum temporale. This area became known as *Wernicke's area* and damage to this area became known as *Wernicke's aphasia*. Wernicke's aphasia is characterized by poor speech comprehension and fluent but meaningless speech, also referred to as *word salad* (Carlson, 2007). Wernicke also discussed the importance of the pathway that connected Broca's and Wernicke's areas called the *arcuate fasciculus*. Damage to the arcuate fasciculus can cause a third type of aphasia, which he called *conduction aphasia*. Wernicke suggested that patients with damage to the arcuate fasciculus would have intact comprehension and spontaneous speech but would have difficulty repeating words they had just heard.

Language comprehension difficulties, such as the inability to understand the meaning of words and the inability to express thoughts in meaningful speech, appear to involve the cortical associational areas immediately surrounding Wernicke's area. These areas are often referred to collectively as the posterior language area (Carlson, 2007). The posterior language area plays a major role in "interchanging information between the auditory representation of words and the meanings of these words, stored as memories in the rest of the sensory association cortex" (Carlson, 2007, p. 490). A fourth type of aphasia occurs when the damage to the language system is isolated to Wernicke's area alone and does not extend to the posterior language area. This type of aphasia is known as *transcortical sensory aphasia*. Children with transcortical aphasia can repeat what others say to them, but they can neither comprehend the meaning of what they hear, nor produce meaningful speech on their own (Carlson, 2007).

Rapid Reference 8.1 summarizes the various forms of aphasias, their neuroanatomical bases, and their associated characteristics. Figure 8.1 illustrates the major brain structures involved with expressive and receptive language.

Right Hemispheric Language Involvement

While the various forms of language disorders previously described seem to have a left hemispheric focus, the right hemisphere does appear to play a role in language as well. Our oral language usually has a cadence or rhythm to it. Our speech also contains intonations and changes in pitch and volume. Finally, our speech contains hints of our emotional states. The rhythmic, emotional, and melodic aspects of speech are referred to as *prosody of speech*. "Prosody is the use of changes in intonation and emphasis to convey meaning in speech besides that specified by the particular words" (Carlson, 2007, p. 500). Prosody appears to be a right-hemispheric function.

Rapid Reference 8.2 provides a list of neuropsychological terms associated with language impairments.

Rapid Reference 8.1

Summary of Aphasias

Type of Aphasia	Brain Regions Involved	Characteristics
Expressive Aphasias		
Broca's (Expressive) Aphasia	• Inferior prefrontal cortex of the left hemisphere (Broca's area). • Head of the caudate nucleus in the basal ganglia. • Subcortical white matter below Broca's area and surrounding cortical areas.	• Slow, laborious, and nonfluent speech. • Comprehend speech much better than produce it.
Apraxia of Speech	• Left precentral gyrus of the insula.	• Impairment in the ability to program movements of the lips, tongue, and throat for the production of speech.
Receptive Aphasias		
Wernicke's Aphasia	• Left temporal lobe just posterior to the primary auditory cortex in an area known as the planum temporale (Wernicke's area).	• Poor speech comprehension and fluent but meaningless speech.
Conduction Aphasia	• Damage to the arcuate fasiculus pathway connecting frontal and posterior language areas.	• Intact comprehension and spontaneous speech but would have difficulty repeating words that they had just heard.
Transcortical Sensory Aphasia	• Damage to Wernicke's area alone, isolating it from the posterior language areas.	• Can repeat what others say to them, but they can comprehend neither the meaning of what they hear, nor produce meaningful speech on their own.

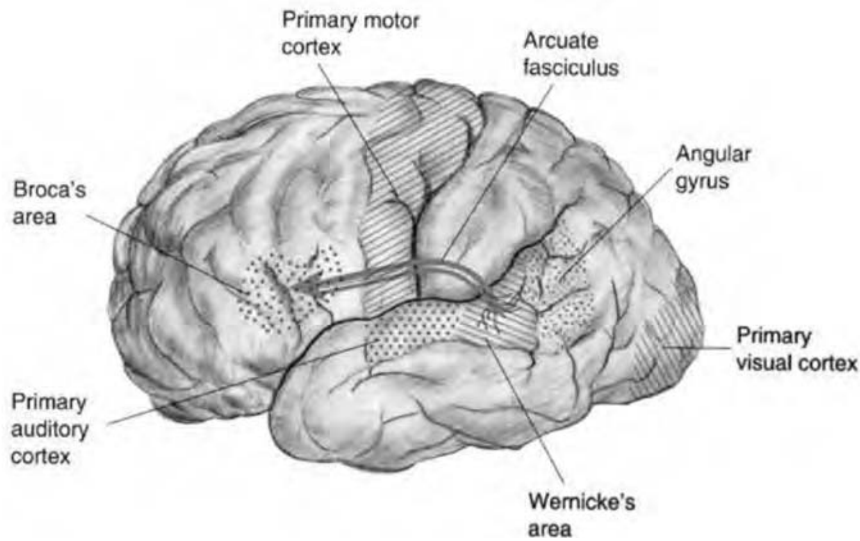


Figure 8.1 Wernicke-Geschwind model of language

TESTS OF LANGUAGE PROCESSES

Rapid Reference 8.3 presents a list of common tests of language for school-aged children. The tests are divided into three language subcomponents: phonological processing, receptive language, and expressive language.

Tests for Assessing Phonological Processing

Auditory Processing Abilities Test (APAT): Linguistic Processing Tasks

The APAT (Swain & Long, 2004) is designed to screen children ages 5-0 to 12-11 for an auditory processing disorder. The test takes 45 minutes to administer and yields a Global Index score; a Linguistic Processing Index score, composed of discrimination, sequencing, and cohesion scales; and an Auditory Memory Index, composed of immediate recall, delayed recall, sequential recall, and cued recall scales.

Comprehensive Test of Phonological Processing (CTOPP): Phonological Awareness Quotient Subtests

The CTOPP (Wagner, Torgensen, & Rashotte, 1999) is designed to assess phonological processing skills across a wide age range. There are two forms of the test: one form for ages 5 to 6 and one form for ages 7 to 24. The CTOPP generates three composite scores: Phonological Awareness Quotient (PAQ), Phonological

Rapid Reference 8.2

Neuropsychological Terms Associated with Language Impairments

Anomia—inability to find the correct word or name objects.

Amusia—inability to process music.

Aphasia—impairment of some aspect of language not due to defects in speech or hearing organs, but due to brain impairment.

- *Broca's aphasia*—nonfluent aphasia characterized by effortful, often agrammatic speech production.
- *Conduction aphasia*—fluent aphasia with severely impaired repetition but relatively preserved language comprehension.
- *Expressive aphasia*—nonfluent output is the prominent feature.
- *Global aphasia*—involves the complete loss of all linguistic functions including fluency, comprehension, repetition, reading, and writing.
- *Mixed aphasia*—aphasia with both expressive and receptive deficits.
- *Receptive aphasia*—impaired comprehension is the prominent feature.
- *Transcortical motor aphasia*—impaired expressive aphasia, similar to Broca's aphasia except for preserved repetition.
- *Transcortical sensory aphasia*—fluent aphasia in which language comprehension is severely impaired but repetition is relatively preserved. Similar to Wernicke's aphasia except that repetition is preserved.
- *Wernicke's aphasia*—receptive language and repetitions are severely impaired.

Aprosodia—impairment in the prosody or melodic component of speech.

Auditory agnosia—impaired ability to recognize sounds despite normal hearing.

Circumlocution—discourse that begins with a specific subject, wanders to various other subjects, and then returns to the original topic.

Color anomia—a loss of color-naming ability.

Coprolalia—vocal tic consisting of either a vulgarity or its initial phoneme.

Dysarthria—difficulty with pronunciation due to weakness or poor coordination of the muscles of lips, tongue, jaw, and so on.

Dysnomia—difficulty finding the correct word.

Mental lexicon—a mental store of information about words.

Orthographic representation—a visual-based storage of a word.

Phonological representation—a sound-based storage of a word.

Prosody—the inflections and intonations of speech.

Sources: Ayd, 1995; Loring, 1999.

Rapid Reference 8.3

Tests of Language Functions

Test	Functions Assessed	Age Range
Tests for Assessing Phonological Processing		
Auditory Processing Abilities Test (APAT): Linguistic Processing tasks	Designed to identify children with Auditory Processing Disorder.	5-0 to 12-11 years
CTOPP Phonological Awareness Composite:		
Elision, Blending Words, and Sound Matching	Phonetic Coding–Analysis & Synthesis	5-0 to 6-0 years
Elision and Blending Words		7-0 to 24-11 years
Hodson Assessment of Phonological Patterns (HAPP-3)	Phonological Patterns in children with unintelligible speech	3 to 8 years
KTEA-II		
Phonological Awareness (Section 1–Rhyming; Section 2–Sound Matching; Section 4–Segmenting; Section 5–Deleting Sounds)	Phonetic Coding–Analysis	Grades K–6
Phonological Awareness (Section 3–Blending)	Phonetic Coding–Synthesis	
NEPSY/NEPSY-II:		
Phonological Processing	Part A: Identifying sounds from word segments and from auditory gestalts. Part B: Phonological segmentation at the letter and word segment level.	3 to 12 years/3 to 16 years
Process Assessment Battery for the Learner (PAL)	Orthographic processing Phonological processing	Grades K to 6
Screening of Reading Readiness (SORR)	Phonological awareness, verbal memory, verbal fluency, and book and print awareness.	4-0 to 6-11 years

Test	Functions Assessed	Age Range
Test of Auditory Processing Skills–3 (TAPS-3): Basic Auditory Skills subtests	Basic Auditory Skills (Word Discrimination, Phonological Segmentation, and Phonological Blending)	4-0 to 18-11 years
Test of Phonological Awareness Skills (TOPAS)	Phonological Awareness	5 to 10 years
Test of Phonological Awareness–Second Edition: PLUS (TOPA-2+)	Phonological Awareness	5 to 8 years
Test of Phonological Awareness in Spanish (TPAS)	Phonological Awareness in Spanish-speaking children.	4-0 to 10-11 years
Wepman's Auditory Discrimination Test	Auditory Discrimination	4 to 8 years
WJIII-ACH: Sound Awareness	Auditory Discrimination	2 to 89 years
WJIII-COG: Sound Blending Incomplete Words	 Sound synthesis Auditory analysis/closure	 2 to 89 years 2 to 89 years
Tests of Receptive Language		
Boehm Test of Basic Concepts–3rd Edition	Semantics (Vocabulary and Morphology)	Grades K to 2
Comprehensive Receptive and Expressive Vocabulary Test (CREVT–2): Receptive Vocabulary Test	Receptive vocabulary	4-0 to 89-11 years
Kaufman Test of Educational Achievement–Second Edition (KTEA-II) Listening Comprehension	Literal and inferential comprehension	4-6 to 25-11 years
NEPSY/NEPSY-II: Comprehension of Instructions	Ability to process and respond to verbal instructions of increasing syntactic complexity.	3 to 12 years/3 to 16 years
OWLS: Listening Comprehension (LC)	Listening Comprehension	3-0 to 21-11 years

(*continued*)

Test	Functions Assessed	Age Range
Peabody Picture Vocabulary Test–Fourth Edition (PPVT-IV)	Receptive Vocabulary	2-6 to 90+ years
Receptive One-Word Picture Vocabulary Test–2000 Edition (ROWPVT-2000)	Receptive Vocabulary	4-0 to 12-11 years
Receptive One-Word Picture Vocabulary Test: Spanish-Bilingual Edition (ROWPVT-SBE)	Receptive Vocabulary for children bilingual in English and Spanish.	4-0 to 12-11 years
Test de Vocabulario en Imágenes Peabody (TVIP)	Receptive Vocabulary for Spanish speaking and bilingual students.	2-6 to 17-11 years
Test for Auditory Comprehension of Language (TACL-3)	Receptive spoken vocabulary, grammar, and syntax.	3-0 to 9-11 years
Wechsler Individual Achievement Test–Second Edition (WIAT-II) Listening Comprehension	Receptive language skills	4 to 85 years
WJIII-ACH Listening Comprehension Cluster Score: Understanding Directions Oral Comprehension	Listening ability and language development	2 to 89 years
Tests of Expressive Language		
Comprehensive Receptive and Expressive Vocabulary Test (CREVT–2): Expressive Vocabulary Subtest	Expressive oral vocabulary	4-0 to 89-11 years
CTOPP Rapid Naming Composite: Rapid Color Naming and Rapid Object Naming Rapid Digit Naming and Rapid Letter Naming	Rapid automatic naming (fluency)	 5-0 to 6-0 years 7-0 to 24-11 years
Expressive One-Word Picture Vocabulary Test–2000 Edition (EOWPVT-2000)	Verbal Expression of Language	2-0 to 18-11 years

Test	Functions Assessed	Age Range
Expressive One-Word Picture Vocabulary Test: Spanish-Bilingual Edition (EOWPVT-SBE)	Verbal Expression of Language for Children who are bilingual in English and Spanish.	4-0 to 12-11 years
Expressive Vocabulary Test–Second Edition (EVT-2)	Expressive Vocabulary	2-6 to 90+ years
NEPSY/NEPSY-II:		3 to 4 years
Body Part Naming (and Identification)	Naming ability in relation to body parts.	3 to 12 years
Oromotor Sequences	Oromotor coordination.	5 to 12 years
Repetition of Nonsense Words	Phonological encoding or decoding of sound patterns, and articulation of complex nonwords.	5 to 12 years/ 3 to 16 years
Speeded Naming	Rapid access to and production of names of colors, shapes, numbers, or sizes.	3 to 12 years
Verbal Fluency	Word retrieval according to phonemic and semantic categories.	3 to 16 years
OWLS: Oral Expression (OE)	Oral Expression	3-0 to 21-11 years
Process Assessment of the Learner (PAL)	Orthographic and phonological coordination (fluency)	Grades K to 6
Rapid Automatized Naming and Rapid Alternating Stimulus Tests (RAN/RAS)	Rapid Naming Facility	5 years to Adult
Structured Photographic Expressive Language Test–Preschool 2 (SPELT-P 2)	Expressive vocabulary related to everyday situations and objects.	3-0 to 5-11 years
Structured Photographic Expressive Language Test–3 (SPELT-3)	Expressive vocabulary related to everyday situations and objects.	4-0 to 9-11 years
Test of Word Finding–Second Edition (TWF-2)	Word-finding ability	4-0 to 12-11 years
Test of Adolescent/Adult Word Finding (TAWF)	Word-finding ability	12 to 80 years

(continued)

Test	Functions Assessed	Age Range
WISC-IV Subtests: Comprehension Information Similarities Vocabulary Word Reasoning	Verbal Comprehension	6 to 16-11 years
WORD Test-2	Expressive vocabulary	12 years to Adult
WJIII-COG Oral Expression Cluster Score: Story Recall Picture Vocabulary	Linguistic competency and vocabulary knowledge	2 to 89 years

Memory Quotient (PMQ), and a Phonological Naming Quotient (PNQ). The subtests that comprise the PAQ will be discussed in this section. The subtests that comprise the PNQ will be discussed under the Expressive Language section of this chapter and the subtests that comprise the PMQ will be discussed in Chapter 8, Memory and Learning. The PNQ is composed of three subtests: Elision (i.e., *mistaken* leaving out the *mis* becomes *taken*), Blending Words, and Sound Matching.

Hodson Assessment of Phonological Patterns (HAPP-3)

The HAPP-3 (Hodson, 2004) is a norm-referenced and criterion-referenced test designed to assess children with highly unintelligible speech. The test can be administered in less than 20 minutes. Objects and a few pictures are used to elicit 50 stimulus words that are transcribed, analyzed, and summarized. Phonological deviations are recorded on a test record form.

Kaufman Test of Educational Achievement–Second Edition (KTEA-II): Phonological Awareness Subtest

The Phonological Awareness subtest on the KTEA-II (Kaufman & Kaufman, 2004) is suitable for administration to children in grades K through 6. The subtest requires the child to respond orally to items that require manipulation of sounds. The subtest is divided into five sections, each of which require a different aspect of phonological awareness: rhyming, sound matching, blending of sounds, segmenting of phonemes, and deleting sounds.

NEPSY/NEPSY-II: Phonological Processing Subtest

The Phonological Processing subtest on the NEPSY/NEPSY-II (Korkman, Kirk, & Kemp, 1998, 2007) is subdivided into two parts. Part 1—Word Segment Recognition—requires the child to identify a word from word segments using visual and verbal cues. Part 2—Phonological Segmentation—is a test of elision. The child is asked to repeat a word and then create a new word by omitting a syllable or a phoneme, or substituting one phoneme for another. The NEPSY Phonological Processing subtest is suitable for children ages 3 to 12, while the NEPSY-II extends the age range from 3 to 16 years.

Process Assessment of the Learner (PAL): Test Battery for Reading and Writing

The PAL (Berninger, 2001) is designed to assess the reading and writing processes of children in kindergarten through sixth grades. The PAL has eight subtests that measure either orthographic or phonological processing. Orthographic processing involves the mental representation of written words into short-term memory and is an important component of both reading and writing (Berninger, 2001).

Screening of Reading Readiness (SORR)

The SORR (Miller & Hammond-Budge, 2003) is designed to measure reading-readiness skills in children ages 4 to 6 years. The SORR has seven subtests and one supplemental test. Four of the subtests measure phonemic awareness (Rhyming Words in Context, Rhyming Words in Isolation, Identifying Sounds, and Blending of Sounds). Two of the subtests measure auditory memory (Verbal List Learning and Memory for Sentences). One subtest measures verbal fluency (Rapid Picture Naming). All of these seven tests are norm-referenced and several tests include qualitative measures in addition to the quantitative scores. The supplemental subtest is a criterion-referenced test. It is called Print and Book Awareness and measures a child's concepts of print and book awareness.

Test of Auditory Processing Skills–3 (TAPS-3): Basic Auditory Skills Subtests

The TAPS-3 (Martin & Brownell, 2005) is designed to comprehensively assess auditory processing skills in children ages 4 through 18 years. A total score is generated along with three cluster scores: Basic Auditory Skills (Word Discrimination, Phonological Segmentation, and Phonological Blending subtests), Auditory Memory (Number Memory Forward, Number Memory Reversed, Word Memory, and Sentence Memory subtests), and Auditory Cohesion (Auditory Comprehension and Auditory Reasoning subtests). The Basic Auditory Skills subtests fall within this conceptual area of the school neuropsychological model. The Auditory Memory subtests fall within the Memory and Learning Domain and the Auditory Cohesion subtests fall within the Receptive Language and Executive Functioning Reasoning areas.

Test of Phonological Awareness Skills (TOPAS)

The TOPAS (Newcomer & Barenbaum, 2003) is designed to assess phonological awareness in children ages 5 to 10 years. The test takes 10 to 15 minutes to administer and has four subtests: Rhyming, Incomplete Words, Sound Sequencing, and Sound Deletion.

Test of Phonological Awareness–Second Edition: PLUS (TOPA-2+)

The TOPA-2+ (Torgensen & Bryant, 2004) is a group or individually administered, norm-referenced test designed to measure phonological awareness in children ages 5 through 8 years. The test has two versions: Kindergarten and Early Elementary. The Kindergarten TOPA-2+ has two subtests: Initial Sound–Same and Initial Sound–Different. The child is asked to mark which letter from a set of four corresponds to a specific phoneme. The Early Elementary TOPA-2+ is similar to the Kindergarten version except that the child is asked to identify initial and final sounds in words, which makes the task more difficult.

Test of Phonological Awareness in Spanish (TPAS)

The TPAS (Riccio, Imhoff, Hasbrouck, & Davis, 2004) is designed to measure phonological awareness in Spanish-speaking children ages 4 to 10-11 years. The TPAS has four subtests: Initial Sounds, Final Sounds, Rhyming Words, and Deletions. The normative sample is over 1,000 children and encompasses different dialects of Spanish.

Wepman's Auditory Discrimination Test–Second Edition (ADT)

The ADT (Wepman & Reynolds, 1987) is designed to measure a child's ability to recognize subtle differences between English phonemes. The test is suitable for children ages 4 through 8 years and only takes 5 minutes to administer.

WJIII-COG/ACH Phonemic Awareness Cluster Subtests

The Phonemic Awareness Clinical Cluster Score on the WJIII-COG (Woodcock, McGrew, & Mather, 2001a) measures the ability to attend to the sound structures of language. The basic Phonemic Awareness Clinical Cluster is composed of two subtests: Sound Blending and Incomplete Words. It is possible to get a broader representation of phonemic awareness by administering the Sound Awareness subtest from the WJIII-ACH (Woodcock, McGrew, & Mather, 2001c). When all three subtests—Sound Blending, Incomplete Words, and Sound Awareness—are administered, a Phonemic Awareness III Clinical Cluster score is generated.

Sound Blending—measures a child's skill in synthesizing language sounds. The child listens to a series of syllables or phonemes and is then asked to blend the sounds to form a whole word.

Incomplete Words—measures auditory analysis, auditory closure, aspects of phonemic awareness, and phonetic coding. The child hears a word from a tape player that is missing one or more phonemes. The child is asked to identify the complete word.

Sound Awareness—This subtest consists of four phonological awareness measures: Rhyming, Deletion, Substitution, and Reversal. On the Rhyming section, the items start out by having the child point to a picture of an object or animal that rhymes with a word spoken by the examiner. Later items require more expressive output of rhyming words in phrases of identifying words that rhyme with a target word (e.g., hat–bat). On the Deletion section of the subtest, the child is required to listen to a word, mentally delete a specified phoneme, and orally pronounce the new word. On the Substitution section of the subtest, the child is asked to listen to a word, mentally substitute a specified portion of the word, and then orally pronounce the new word. Finally, the Reversal section of the subtest requires the child to listen to a word and then mentally reverse the sounds and then pronounce the new word.

Tests of Receptive Language

Boehm Test of Basic Concepts–Third Edition (Boehm-3)

The Boehm-3 (Boehm, 2000) assesses a child's ability to identify basic concepts. The test is group administered to children ages 3 to 5-11 years. The examiner states a particular concept and children are asked to mark a picture that they think best describes a particular concept related to size, direction, quantity, time, classification, or other general concepts. The test measures receptive language and knowledge of semantics (concepts, vocabulary, and word finding). The Boehm-3 is available in English or Spanish.

Comprehensive Receptive and Expressive Vocabulary Test (CREVT-2): Receptive Vocabulary Subtest

The CREVT-2 (Wallace & Hammill, 2002) is designed to measure both receptive and expressive vocabulary in children and adults ages 4 to 89-11 years. On the Receptive Vocabulary Subtest, the examiner says a word and asks the child to point to one of four pictures on a page that corresponds to that word.

Kaufman Test of Educational Achievement–Second Edition (KTEA-II) Listening Comprehension

The Listening Comprehension subtest of the KTEA-II (Kaufman & Kaufman, 2004) measures literal and inferential comprehension. On the task, the child is asked to listen to a CD recording and then orally respond to questions asked by the examiner.

NEPSY/NEPSY-II: Comprehension of Instructions

The Comprehension of Instructions subtest on the NEPSY/NEPSY-II (Korkman, Kirk, & Kemp, 1998, 2007) is designed to assess the ability of a child to process and respond quickly to verbal instructions of increasing complexity. The NEPSY Comprehension of Instructions subtest is suitable for children ages 3 to 12, while the NEPSY-II extends the age range from 3 to 16 years.

OWLS: Listening Comprehension (OWLS[LC])

The OWLS (LC) subtest (Carrow-Woolfolk, 1995) is a measure of receptive language for children ages 3 through 21-11 years. The examiner reads a verbal stimulus aloud and asks the child to point to a picture from some choices that corresponds to the verbal stimulus.

Peabody Picture Vocabulary Test–Fourth Edition (PPVT-IV)

The PPVT-IV (Dunn & Dunn, 2006) is a measure of receptive language for children and adults ages 2-6 through 90+ years. The test is similar in format to many of the receptive language tests, in which the examiner says a word aloud and asks the child to point to a picture from four possible pictures that correspond to the spoken word.

Receptive One-Word Picture Vocabulary Test–2000 Edition (ROWPVT-2000)

The ROWPVT-2000 (Brownell, 2000c) is designed to measure receptive language in children ages 2 through 18-11 years. The test uses the same format as other receptive language tests described in this section.

Receptive One-Word Picture Vocabulary Test: Spanish-Bilingual Edition (ROWPVT-SBE)

The ROWPVT-SBE test (Brownell, 2000d) is a Spanish version of the ROWPVT-2000. Norms are available for both combined and separate Mexican and Puerto Rican standardization samples.

Test de Vocabulario en Imágenes Peabody (TVIP)

The TVIP test (Dunn, Lugo, Padilla, & Dunn, 1986) is a Spanish translation of the Peabody Picture Vocabulary Test. The TVIP is for children ages 2-6 to 18 years.

Test for Auditory Comprehension of Language (TACL-3)

The TACL-3 (Carrow-Woolfolk, 1999b) is designed to measure receptive language in children ages 3-0 through 9-11 years. The TVIP has three subtests: Vocabulary, Grammatical Morphemes, and Elaborating Phrases and Sentences.

Wechsler Individual Achievement Test–Second Edition (WIAT-II): Listening Comprehension

The Listening Comprehension subtest on the WIAT-II (Wechsler, 2001) assesses word knowledge and the ability to listen to details. The test is divided into three sections: Receptive Vocabulary, Sentence Completion, and Expressive Vocabulary. These tasks require the child to select a picture that matches a verbally presented word (Receptive Vocabulary) or sentence (Sentence Completion), or generate a word that matches a picture and a verbal description (Expressive Vocabulary).

WJIII-ACH Listening Comprehension Cluster Subtests

The Listening Comprehension Cluster score on the WJIII-ACH (Woodcock, McGrew, & Mather, 2001c) measures both listening ability and verbal comprehension. The cluster score is composed of two subtests: Understanding Directions and Oral Comprehension.

Understanding Directions—the child is asked to listen to a sequence of tape-recorded instructions and then point to various objects in a colored picture. The test measures listening ability (receptive language) and language development.

Oral Comprehension—the child is asked to listen to a short passage and provide the final word that completes the passage. The test measures listening ability and language development.

Tests of Expressive Language

Comprehensive Receptive and Expressive Vocabulary Test (CREVT-2): Expressive Vocabulary Subtest

The CREVT-2 (Wallace & Hammill, 2002) is designed to measure both receptive and expressive vocabulary in children and adults ages 4 to 89-11 years. On the Expressive Vocabulary subtest, the examiner says a stimulus word and then asks the child to define the word.

Comprehensive Test of Phonological Processing (CTOPP): Rapid Naming Quotient Subtests

The Rapid Naming Quotient (RNQ) on the CTOPP (Wagner, Torgensen, & Rashotte, 1999) measures word fluency, an important expressive language skill related to reading. The RNQ is composed of two subtests: Rapid Color Naming and Rapid Object Naming. The CTOPP has a version for young children ages 5 to 6 and a version for older children, adolescents, and young adults, ages 7 to 24-11 years.

Expressive One-Word Picture Vocabulary Test–2000 Edition (EOWPVT-2000)

The EOWPVT-2000 (Brownell, 2000a) is a measure of verbal expression for children ages 2 to 18-11 years. The EOWPVT-2000 is a good companion test with the Receptive One-Word Picture Vocabulary Test (Brownell, 2000c) described in the previous section. On the EOWPVT-2000, the child is asked to provide names for a series of pictures. The test does not require reading or writing skills. The administration time is approximately 10 to 15 minutes.

Expressive Vocabulary Test–Second Edition (EVT-2)

The EVT-2 (Williams, 2006) is often used in conjunction with the PPVT-4. The EVT-2 is designed to measure expressive vocabulary in children and adults, ages 2-6 to 90+ years. The test takes approximately 10 to 15 minutes to administer and has two parallel forms.

NEPSY/NEPSY-II: Language Domain Subtests

The NEPSY/NEPSY-II (Korkman, Kirk, & Kemp, 1998, 2007) contains several measures of expressive language including: Body Part Naming (and Identification), Oromotor Sequences, Repetition of Nonsense Words, Speeded Naming, and Verbal Fluency.

Body Part Naming (and Identification)—assesses naming of body parts in young children, ages 3 to 4 years. For the Naming items, the child is asked to point to a body part on a picture of a child, or point to a body part on his or her own body. For the Identification items, the child points to corresponding body parts on a figure as the examiner names them.

Oromotor Sequences—assesses oromotor coordination. The child is asked to repeat articulatory sequences like *tongue twisters.*

Repetition of Nonsense Words—assesses phonological encoding (receptive language) and decoding (expressive language). The child is asked to repeat nonsense words that are presented by the examiner auditorially.

Speeded Naming—assesses rapid access (verbal fluency) to and production of names of colors, shapes, letters, numbers, and sizes. The child is shown an array of colors, shapes, letters, and so on and asked to quickly name their attributes (e.g., a big-red-circle).

Verbal Fluency—the child is asked to generate words as quickly as he or she can follow phonemic categories (e.g., words that start with a particular letter), or words that belong to a semantic category (e.g., words that belong in the category of food). This test is categorized within the Language Domain by the test authors, but this author categorizes the test under executive functions, particularly memory retrieval.

The NEPSY-II has expanded the age range for the Speeded Naming subtest from 5 to 12 years, to 3 to 16 years; and expanded the age range for the Verbal Fluency subtest from 3 to 12 years, to 3 to 16 years.

OWLS: Oral Expression (OWLS [OE])

The OWLS (OE) subtest (Carrow-Woolfolk, 1995) is a measure of expressive language for children ages 3 through 21-11 years. The child is asked to answer questions, complete sentences, and generate one or more sentences in response to a visual/verbal stimulus.

Process Assessment of the Learner (PAL): Test Battery for Reading and Writing

The PAL (Berninger, 2001) is designed to assess the reading and writing process of children in kindergarten through sixth grades. The PAL has four subtests that measure orthographic and phonological coordination, another name for reading fluency. The subtests include Rapid Auditory Naming–Letters, Rapid Auditory Naming–Words, Rapid Auditory Naming–Digits, and Rapid Auditory Naming–Words and Digits.

Rapid Automatized Naming and Rapid Alternating Stimulus Tests (RAN/RAS)

The RAN/RAS (Wolf & Denckla, 2005) was designed to measure verbal fluency in children ages 5 years through adulthood. The RAN and RAS tests are administered individually. The tests require the examinee to recognize a visual symbol such as a letter or color and then name it accurately and quickly. The tests consist of rapid automatized naming tests (Letters, Numbers, Colors, and Objects), and two rapid alternating stimulus sets (2-Set Letters and Numbers, 3-Set Letters and Numbers, Numbers, and Colors). The group of six tests takes approximately 5 to 10 minutes to administer.

Structured Photographic Expressive Language Test–Preschool (SPELT-P 2)

The SPELT-P 2 (Dawson et al., 2005) was designed by speech and language pathologists to assess expressive vocabulary in children ages 3-0 through 5-11 years. The test is designed to elicit a young child's ability to generate early developing morphological and syntactic forms in expressive language.

Structured Photographic Expressive Language Test 3 (SPELT-3)

The SPELT-3 (Dawson, Stout, & Eyer, 2003) is similar to the SPELT-P 2 but was designed for children ages 4-0 to 9-11 years. The test measures the child's use of morphology and syntax in expressive language.

Test of Word Finding–Second Edition (TWF-2) / Test of Adolescent / Adult Word Finding (TAWF)

The TWF-2 (German, 2000) is designed to measure expressive word finding in children ages 6-6 through 12-11 years. There is also a version of the test for adolescents and adults (ages 12 to 80 years) called the TAWF (German, 1989). The tests include four sections: Picture Naming Nouns, Sentence Completion Naming, Picture Naming Verbs, and Picture Naming Categories.

Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV) Subtests

The WISC-IV (Wechsler, 2003) was conceptually developed to include four measures of verbal comprehension including: Comprehension, Information, Similarities, Vocabulary, and Word Reasoning. The Comprehension, Information, and Vocabulary subtests are also conceptually grouped under the semantic memory/comprehension-knowledge area.

Comprehension—The child is asked to answer a series of questions based on his or her understanding of general principles or social conventions. Performance on the Comprehension subtest may be affected by the child's early language and environmental stimulation, alertness to the environment, the child's prior educational opportunities and experiences, or the child's prior cultural opportunities and experiences (Flanagan & Kaufman, 2004).

Information—The child is asked to answer questions that address a wide range of general knowledge topics. Performance on the Information subtest may be affected by the child's early environmental stimulation, alertness to the environment, the child's prior educational opportunities and experiences, the child's prior cultural opportunities and experiences, or the child's intellectual curiosity (Flanagan & Kaufman, 2004).

Similarities—The child is asked to describe how two words that have a common concept are similar. Performance on the Similarities subtest may be affected by the child's early language and environmental stimulation, the child's prior educational opportunities and experiences, or the child's prior cultural opportunities and experiences (Flanagan & Kaufman, 2004).

Vocabulary—The child is asked to name pictures (young children) or provide word definitions (older children). Performance on the Vocabulary subtest may be affected by the child's early language and environmental stimulation, the child's intellectual curiosity, alertness to the environment, the child's prior educational opportunities and experiences, or the child's prior cultural opportunities and experiences (Flanagan & Kaufman, 2004).

Word Reasoning—The child is asked to identify a common concept that is being described by a series of clues. Performance on the Word Reasoning subtest may be affected by the child's early language and environmental stimulation, or the child's prior educational opportunities and experiences (Flanagan & Kaufman, 2004).

WORD Test-2

The Word Test-2 (Bowers, Huisingh, LoGiudice, & Orman, 2004) has two versions: Elementary for ages 6-0 to 11-11, and Adolescent for ages 12 and older. Each test has six subtests designed to assess expressive vocabulary in different ways: Associations, Synonyms, Semantic Absurdities, Antonyms, Definitions, and Flexible Word Use.

\WJIII-COG Oral Expression Cluster Subtests

The Oral Expression Cluster score on the WJIII-COG (Woodcock, McGrew, & Mather, 2001a) measures linguistic competency and vocabulary knowledge. The cluster is composed of two subtests: Story Recall and Picture Vocabulary.

Story Recall—the child is asked to listen to a story and then recall elements of the story. Story recall measures aspects of both receptive and expressive language.

Picture Vocabulary—the child is shown pictures of familiar to less familiar objects and asked to name them.

Tests for Speech and Language Pathologists

The brief descriptions of the following tests in Rapid Reference 8.4 are included in this section even though school neuropsychologists probably will not administer them. Speech and language pathologists will typically administer these tests to school-age children, but school neuropsychologists need to be familiar with what the tests are measuring and when to refer a child for a particular assessment. School neuropsychologists need to work collaboratively with speech and language pathologists in planning their respective assessments to avoid overlap and to maximize the opportunities to answer the referral question(s).

In this chapter the lateralization of language and the neuroanatomy of oral and receptive language were reviewed. The major tests that school neuropsychologists use to assess phonological processing, receptive language, and expressive language were presented. Finally, a list of common tests used by speech and language pathologists was presented. Language dysfunctions are observed in many common developmental disorders. As an example in Chapter 16, the school neuropsychological conceptual assessment model will be used to review the presence of language deficits in autism-spectrum disorders.

Rapid Reference 8.4

Tests of Speech and Language Functions Typically Administered by Speech and Language Pathologists

Test	What is Measured	Age Range
Comprehensive Assessment of Spoken Language (CASL; Carrow-Woolfolk, 1999a)	• Language Processing Skills (comprehension, expression, and retrieval) • Language structure (lexical/semantic, syntactic, supralinguistic, and pragmatic)	3 to 21 years
Clinical Evaluation of Language Fundamentals–Fourth Edition (CELF-4; Semel, Wiig, & Secord, 2003)	• Receptive language • Expressive language • Language Structure • Language Content • Language Content and Memory • Working Memory	5 to 21 years
Goldman-Fristoe Test of Articulation 2 (Goldman & Fristoe, 2000)	• Articulation of consonant sounds	2-0 to 11 years
KLPA-2: Khan-Lewis Phonological Analysis, Second Edition (KLPA-2; Khan & Lewis, 2002)	• Phonological processes	2 to 21 years
Lindamood Auditory Conceptualization Test (LAC-3; Lindamood & Lindamood, 2004)	• Ability to perceive and conceptualize speech sounds using a visual medium	5-0 to 18-11 years
Test of Early Language Development: Third Edition (TELD-3; Hresko, Reid, & Hammill, 1999)	• Receptive language • Expressive language	2 to 7-11 years
Test of Language Development (Primary)–3rd Edition (TOLD-3; Hammill & Newcomer, 1997b)	• Expressive language	4-0 to 8-11 years
Test of Language Development (Intermediate)–3rd Edition (TOLD-3; Newcomer & Hammill, 1997a)	• Expressive language	8-0 to 12-11 years
Utah Test of Language Development (Mecham, 2003)	• Expressive language	3-0 to 9-11 years

TEST YOURSELF

1. Language skills are lateralized in the left hemisphere for approximately what percentage of all people?

(a) 65%
(b) 70%
(c) 80%
(d) 90%

2. What type of aphasia is characterized by slow, laborious, and nonfluent speech?

(a) Wernicke's aphasia
(b) Broca's aphasia
(c) Conduction aphasia
(d) Transcortical Sensory Aphasia

3. What type of aphasia is characterized by intact comprehension and spontaneous speech but difficulty with repeating words?

(a) Wernicke's aphasia
(b) Broca's aphasia
(c) Conduction aphasia
(d) Transcortical Sensory Aphasia

4. Prosody of speech is a right-hemispheric function. True or False?

5. What term is used to describe the inability to find the correct word or difficulty in naming objects?

(a) anomia
(b) amusia
(c) aphasia
(d) aprosodia

6. Which one of the following speech and language batteries is most likely to be administered by a speech and language pathologist?

(a) WJIII-ACH Oral Expression and Listening Comprehension Cluster subtests
(b) Clinical Evaluation of Language Fundamentals–Fourth Edition (CELF-4)
(c) NEPSY/NEPSY-II Language Domain subtests
(d) Kaufman Test of Educational Achievement–Second Edition (KTEA-II)

7. What term is used to describe difficulty with pronunciation due to weakness or poor coordination of the muscles of lips, tongue, jaw, and so on?

(a) dysarthria
(b) dysnomia
(c) aphasia
(d) circumlocution

Answers: 1. d; 2. b; 3. c; 4. true; 5. a; 6. b; 7. a

Nine

MEMORY AND LEARNING PROCESSES

In this chapter memory and learning functions will be defined, theories of memory and learning will be reviewed, the neuroanatomy of memory and learning will be described, and the common tests used to assess memory and learning within a school neuropsychological assessment model will be presented.

THEORIES OF MEMORY

Learning is defined as the process of acquiring new information, and *memory* is defined as the persistence of learning that can be assessed at a later time (Squire, 1987). Learning and memory are typically conceptualized into three hypothetical stages: encoding, storage, and retrieval. *Encoding* is the processing of incoming information to be stored. *Storage* is the result of acquisition and consolidation that creates and maintains a permanent memory trace. *Retrieval* is the conscious recall or recognition of previously learned and stored memories. When a student is suspected of having a memory problem, the school neuropsychologist will try to determine, among other things, if the memory problems are a function of encoding, storage, retrieval, or a combination of the three.

Atkinson and Shiffrin (1968) proposed a modal model of memory, consisting of sensory memory, short-term memory, and long-term memory. These categories of memory will be discussed in greater detail in the following sections.

Sensory Memory

Sensory memory has a high capacity for information, but has a very short life of just a few milliseconds. Visual sensory memory is referred to as *iconic memory* or an *iconic store,* and verbal sensory memory is referred to as *echoic memory*. Sensory memories are like background noise in our memory systems. If we do not attend to the sensory memory traces, they decay rapidly. A classic example of a sensory memory is the "cocktail party effect." If you are at a cocktail party talking to a friend, you are paying attention to that conversation. The background conversations are being processed in sensory memory but you are not attending to those conversations. Someone across the room suddenly mentions your name in the middle of his or her conversation and you shift your attention to that conversation to hear what that person is saying about you. We can extract information from sensory memory if we attend to it quickly. In this example our spoken name would be otherwise lost had we not attended to it. Sensory memory is an interesting basic part of memory, but it is not a construct that is measured directly by school neuropsychologists.

Short-Term Memory

> *Leticia is a third grader. She frequently does not seem to remember things right after information is presented. She frequently asks to have something repeated and she has trouble taking notes. Leticia is experiencing difficulties with her short-term memory.*

Unlike sensory memory that has a high capacity and short duration, *short-term memory* has a limited capacity and a long duration based on continual rehearsal. Short-term memory is associated with retention over seconds to minutes. An example would be a telephone number given to you by an operator. As long as you mentally rehearse the number verbally in your head, you can conceivably continue to hold that telephone number in short-term memory. However, as soon as you are the slightest bit distracted, the telephone number is lost to conscious memory. The capacity of short-term memory has been shown to be seven bits or chunks of information, plus or minus two (Miller, 1994).

Long-Term Memory Models

> *Adrienne is a fifth grader. She has trouble remembering to turn in her homework assignments even when they are completed. Adrienne can perform well on a daily quiz over a content area, but then she performs poorly on a more comprehensive exam. She has difficulty answering questions about factual information. Adrienne is evidencing signs of long-term memory deficits.*

Long-term memory is measured in days or years. Long-term memory represents near-permanent memory storage. Cognitive psychologists have conceptualized two distinct subdivisions of long-term memory: *declarative memory* and *nondeclarative memory*. Declarative memory refers to "knowledge that we have conscious access to, including personal and world knowledge" (Gazzaniga et al., 2002,

p. 314). Declarative memory can be further subdivided into *episodic memory*—our autobiographical memories—and *semantic memory*—our knowledge of basic facts. The major tests of memory, learning, and intelligence do measure semantic memory. Episodic or autobiographical memory is difficult to measure because it is personal and lacks objective verification. In severe cases of memory loss due to trauma or disease, episodic or autobiographical memory can be informally assessed using a clinical interview and verified by a third party (e.g., parents).

Nondeclarative memory refers to "knowledge that we have no conscious access to, such as motor and cognitive skills (procedural knowledge), perceptual priming, and simple learned behaviors that derive from conditioning, habituation, or sensitization" (Gazzaniga et al., 2002, p. 314). The only nondeclarative memory that may be included in a school neuropsychological assessment is procedural memory. Procedural memory involves the learning of a variety of motor skills, such as riding a bike, or cognitive skills, such as knowing to start reading from left to right. The disruption of procedural memories may be questioned in a clinical interview or directly observed by the school neuropsychologist.

Evidence For and Against the Modal Model of Memory

The *serial-order position effect* provides support for the distinction between short-term and long-term memory. The serial-order position effect is observed using a list-learning task. A distinct pattern for the number of correctly identified words emerges when a group of individuals is presented with a list of words and asked to recall those words. Some students are better at recalling words at the beginning of the list, a *primacy effect,* whereas other students perform best when recalling words at the end of the list, a *recency effect.* The primacy effect is thought to reflect long-term memory and the recency effect is thought to reflect short-term memory.

Atkinson and Shiffrin's (1968) proposed modal model of memory held widespread appeal for decades. However, experimental and theoretical evidence does not support the modal model of memory. The modal model of memory proposed that rehearsal was the key factor in transferring information from sensory memory to short-term memory and from short-term memory to long-term memory. Researchers have found that other factors besides rehearsal seem to influence long-term memory. Craik and Lockhart (1972) illustrated that the more meaningfully a stimulus item was processed the more it was consolidated and stored in long-term memory. This is called the *levels of processing model.* Gazzaniga and his colleagues (2002) reviewed several case studies of patients with brain damage. In these case studies, the patients were not able to form new short-term memories, yet they were able to form new long-term memories. These case studies suggested that short-term memory was not the absolute *gateway* to forming long-term memories.

Working Memory Models

Timothy is 12 years old and has a history of uneven academic progress. He has recently been having trouble with mathematics, reading, and writing. His teachers observe that he seems to lose track of what he is doing in the middle of math problems. When he tries to write he seems to lose track of what he was trying to communicate. Timothy seems to understand what he reads and he has good accuracy, but he has difficulty summarizing the overall content of a chapter or section in a book. Timothy is experiencing the symptoms that are consistent with a working memory deficit.

"The concept of working memory was developed to address the various shortcomings in the short-term memory concept as expressed in the modal model" (Gazzaniga et al., 2002, p. 311). *Working memory* is a limited capacity store for retaining information for a brief period while performing mental operations on that information. Information placed in working memory may come from sensory memory, short-term memory, or from long-term memory. The key component of a working memory task is the requirement for active manipulation of the information. Working memory has been shown to be a required cognitive process for components of reading, mathematics, and writing achievement in children (Evans, Floyd, McGrew, & LeForgee, 2002).

Baddeley and colleagues (Baddeley, 1995; Baddeley & Hitch, 1974) proposed a three-part working memory system that contains a *central executive* control system that regulates two subordinate subsystems: the *visuospatial sketchpad* and the *phonological loop* (see Figure 9.1).

The central executive system is a command and control center that presides over the interactions between the two subordinate systems and long-term memory (Gazzaniga et al., 2002). Norman and Shallice (1980) referred to the central executive system as the supervisory attentional system (SAS). The phonological loop is thought to be responsible for coding acoustic information in working memory. The visuospatial sketchpad is thought to be responsible for coding visual or visual-spatial codes in working memory.

There is neuroanatomical evidence for the working memory model of memory. Patients with left supramarginal gyrus (temporal-parietal gradient) lesions have deficits in phonological working memory. The rehearsal process of the phonological loop involves areas of the left premotor region. Therefore, the phono-

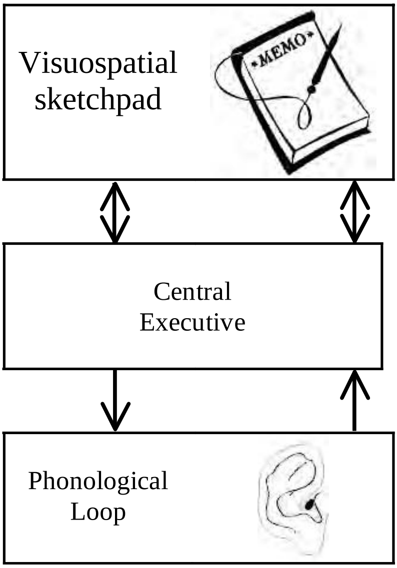


Figure 9.1 Baddeley and Hitch's (1995) working memory model

logical working memory system involves the lateral frontal, superior temporal, and inferior parietal regions of the brain (Gazzaniga et al., 2002).

Damage to the parietal-occipital region of either hemisphere will produce deficits in the visuospatial sketchpad, but damage to the right parietal-occipital region will produce even greater deficits (Gazzaniga et al., 2002). Children with lesions or damage to the right parietal-occipital region would have great difficulty performing a task like the WISC-IV Integrated Spatial Span test, in which the child has to touch blocks on a board following the same sequence as the examiner.

A CONCEPTUAL MODEL OF MEMORY AND LEARNING FOR SCHOOL NEUROPSYCHOLOGISTS

The constructs measured by the major tests of memory and learning are similar but not exactly alike. Rapid Reference 9.1 presents the classification of memory and learning within a conceptual school neuropsychological assessment model. Immediate memory is typically assessed using verbal or visual modalities. Likewise, long-term or delayed memory is typically assessed using verbal or visual modalities. Within the long-term memory area, it is also possible to assess for any differences between free-recall and recognition using either modality.

Verbal-visual associative memory and learning is another construct frequently

Rapid Reference 9.1

Classification of Tests of Memory and Learning

Classification	Definitions
• Verbal Immediate Memory	• The capacity to maintain verbal information in conscious awareness.
• Visual Immediate Memory	• The capacity to maintain visual information in conscious awareness.
• Verbal (Delayed) Long-Term Memory —Verbal Learning —Verbal Delayed Recall —Verbal Delayed Recognition	• Retention of verbal information for prolonged, perhaps indefinite periods of time.
• Visual (Delayed) Long-Term Memory —Visual Learning —Visual Delayed Recall —Visual Delayed Recognition	• Retention of visual information for prolonged, perhaps indefinite, periods of time.
• Verbal-Visual Associative Learning & Memory	• Learning and retention of associated verbal and visual stimuli for prolonged periods of time.
• Working Memory	• The ability to perform complex mental operations on material placed in immediate memory.
• Semantic Memory	• Knowledge of basic facts—often referred to as comprehension-knowledge.

assessed. Associative memory and learning tasks pair verbal and visual information (e.g., the WJIII-COG Visual-Auditory Learning subtest). The final two common memory and learning constructs that are frequently assessed are working memory (ability to perform complex mental operations on material placed in immediate memory) and semantic memory (knowledge of basic facts).

A conceptual model of memory and learning for school neuropsychologists is illustrated in Figure 9.2.

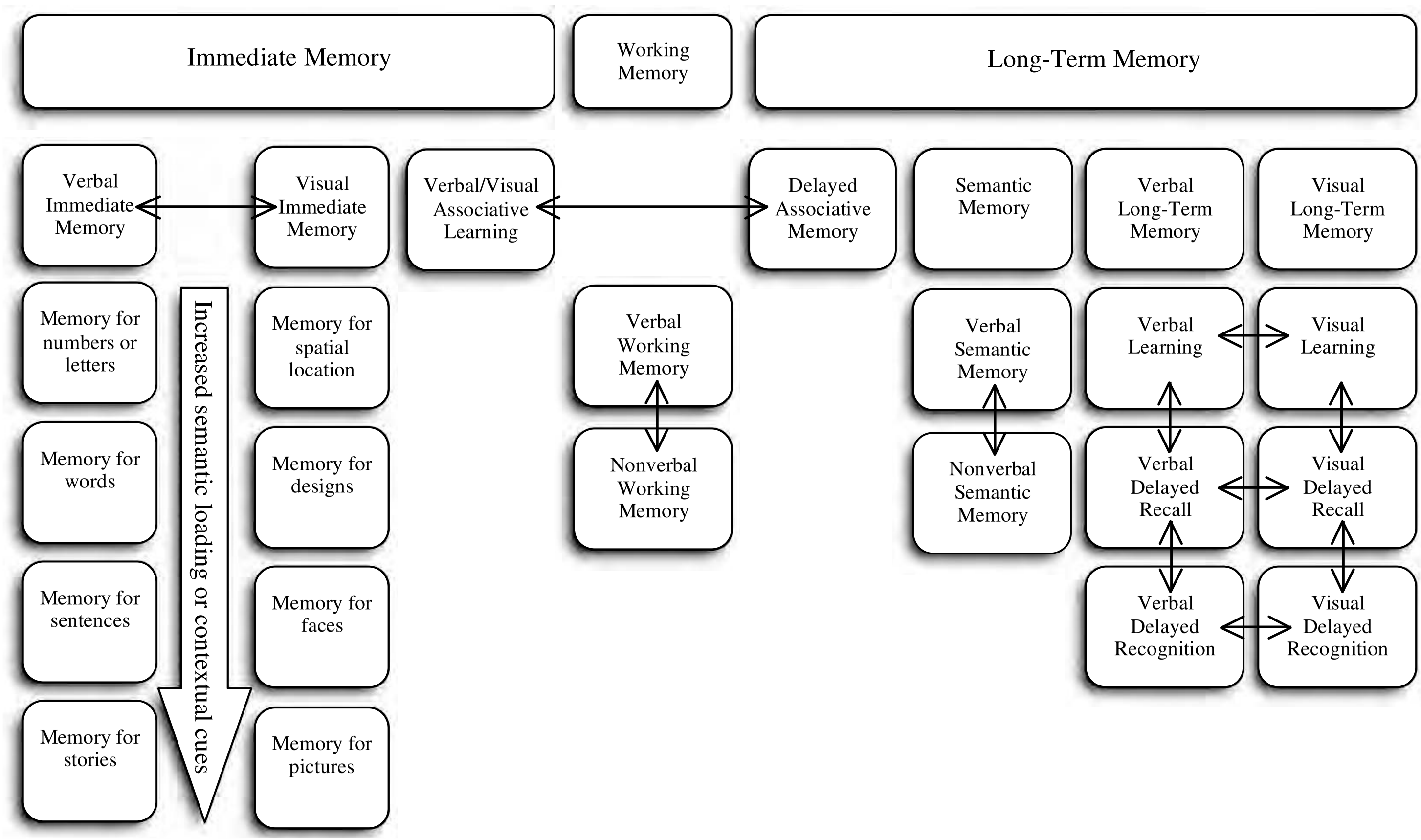


Figure 9.2 Conceptual model of memory and learning for school neuropsychology

The conceptual model first subdivides memory and learning into three divisions: immediate memory, working memory, and long-term memory. Immediate memory is further subdivided into verbal immediate memory, visual immediate memory, and verbal-visual associative learning. Performance comparisons can be made between verbal and visual immediate memory, as designated by the two-way arrow on Figure 9.2. Clearly, immediate memory is contingent upon attentional factors as well.

Within the verbal and visual immediate memory areas, these constructs are often measured with stimuli that range from simple to complex. For example, for verbal immediate memory, some tasks may measure immediate memory for numbers and letters, and then shift to memory for words, then sentences, and finally stories. Performance that increases or decreases, as a function of the changes in the semantic loading of the test, should be considered in the overall interpretation of verbal immediate memory and learning. Similar semantic loading changes in visual immediate memory tasks may be a part of a memory and learning test as well and should be interpreted as needed.

Verbal-visual associative learning requires pairing verbal and visual stimuli in active learning tasks. For younger students, the ability to name colors, pictures, numbers, and shapes all require pairing visual stimuli with a verbal label. These verbal-visual associative learning tasks may involve an immediate learning component and a delayed recall and recognition component. The immediate learning component falls under the immediate memory category and the delayed associative memory falls under the long-term memory category.

Working memory is one of the major memory areas assessed by most of the major tests of memory and learning. Working memory can be further subdivided into verbal working memory tasks and nonverbal or visual working memory tasks that mirror the phonological loop and visuospatial sketchpad of the working memory model, respectively. The phonological loop is very important in the reading comprehension process as well as with note-taking skills, while the visuospatial sketchpad is paramount during mental math endeavors (Feifer & Defina, 2005).

Long-term memory can be divided into four categories: delayed associative memory, semantic memory, verbal long-term memory and learning, and visual long-term memory. Delayed associative memory is the amount of verbal-visual associative stimuli remembered after a delay and can be compared to the performance on verbal-visual associative learning. Remember that semantic memory is our knowledge of basic facts. Some tests, such as the WJIII-COG, have a Comprehension-Knowledge Cluster that measures semantic memory. Semantic memory can be subdivided into verbal semantic memory and nonverbal/visual semantic memory.

Long-term memory can also be conceptualized into verbal long-term memory and visual long-term memory. Each of these long-term memory components may be further subdivided into indices of learning, measures of delayed free recall, and delayed recognition. Indices of learning are generally total scores of learning verbal or visual information over repeated trials. Delayed free recall is the amount of verbal or visual information remembered after a period of elapsed time (from minutes, to hours, to days). Delayed recognition is the amount of verbal or visual information remembered after a period of elapsed time and when provided with multiple-choice cues. Multiple performance comparisons may be made across these constructs (e.g., verbal versus visual learning, verbal versus visual delayed recall, verbal versus visual delayed recognition). Students with strong delayed recognition memories probably would perform best with multiple-choice types of examinations. Delayed free recall versus delayed recognition is also an interesting comparison. A deficit in recognition memory as compared to free recall is a better indicator of a memory disorder and poor recognition often suggests more severe impairment (Gazzaniga et al., 2002). Inclusion of a recognition trial, along with free recall, increases the sensitivity of a memory test.

NEUROANATOMY OF MEMORY AND LEARNING PROCESSES

Much of what we know today about the neuroanatomy of memory and learning comes from: the study of patients with memory impairments, comparative animal research, and functional imaging techniques. Converging evidence from these sources indicates that the *medial temporal lobe* (primarily the hippocampus and secondarily the amygdala) and the *midline diencephalon* (the dorsomedial nucleus of the thalamus) are essential brain structures for the learning and retention of new information. These structures permit the storage of information until consolidation is complete. Damage to the medial temporal lobe does not wipe out most declarative memories, but rather prevents new long-term memories from being formed. These anatomical sites are not the storage sites of memory but rather the brain regions that are essential for consolidation of new memories into long-term memory. The amygdala seems to play a role in emotional memory. *Flashbulb memories* of highly emotional memories (e.g., events from 9-11) would involve the amygdala and the hippocampus working in tandem to form new, emotionally charged long-term memories.

Damage to the temporal lobe in areas besides the hippocampus can produce severe retrograde amnesia (loss of previous memories) while the ability to form new memories remains intact. The prefrontal cortex is involved with the encoding and retrieval of information. Neuroimaging studies have revealed that episodic retrieval seems to activate the right prefrontal cortex while semantic retrieval activates the left prefrontal cortex (see Gazzaniga et al., 2002 for a review).

SUMMARY OF MEMORY AND LEARNING PROCESSES

Memory and learning form the foundation for what education is all about. A school neuropsychological evaluation must include assessment of both the subcomponents of memory and learning. There are many neuropsychological terms associated with memory and learning with which school neuropsychologists should become familiar (see Rapid Reference 9.2). The major tests of memory and learning for school-aged children will be reviewed in the next section.

Rapid Reference 9.2

Neuropsychological Terms Associated with Memory and Learning

- *Anterograde amnesia*—the inability to learn and recall new information.
- *Anterograde memory*—the ability to learn and recall new information.
- *Autobiographical memory*—an aspect of episodic or declarative memory related to the recollection of personal memories.
- *Central executive*—responsible for selection, initiation, and termination of processing routines (e.g., encoding, storage, retrieval).
- *Color amnesia*—loss of knowledge about color even with intact color vision and color perception.
- *Declarative (explicit) memory*—memories for experiences, facts, or events that can be consciously recalled.
- *Echoic memory*—sensory memory for auditory material that has a relatively large capacity but short duration.
- *Elaboration*—a memory process in which the products of initial encoding are enriched by further processing.
- *Episodic memory*—memory that is content-specific and often autobiographical.
- *Encoding*—process by which the cognitive system builds up a stimulus representation to place into memory.
- *Flashbulb memory*—a vivid memory of the circumstance surrounding shocking or emotionally charged news.

(*continued*)

- *Focal retrograde amnesia*—severe and lasting retrograde amnesia that occurs with relatively new learning ability preserved.
- *Forgetting (memory decay)*—the loss of information over time. Often calculated in neuropsychological assessment by subtracting delayed recall from immediate recall.
- *Free recall*—memory retrieval without the aide of external cues.
- *Iconic memory*—sensory memory for visual material that has a relatively large capacity but short duration.
- *Immediate memory*—the capacity to maintain information in conscious awareness.
- *Incidental learning*—learning that occurs without conscious effort.
- *Learning*—the process of acquiring new information.
- *Learning curve*—graph frequently used in memory tests to plot out the number of correctly recalled words over a number of trials.
- *Long-term memory*—retention of information for prolonged, perhaps indefinite, periods of time.
- *Memory span*—the amount of information that can be repeated immediately with complete accuracy. Memory span is assumed to be a measure of short-term memory capacity.
- *Metamemory*—knowledge about the nature and contents of one's own memory.
- *Mnemonic*—techniques for improving one's own memory.
- *Nondeclarative (implicit) memory*—a range of memory types in which performance is altered without conscious mediation (e.g., procedural memory, priming, classical conditioning).
- *Paired-associate learning*—a memory task that assesses the ability to learn the relationship between paired stimuli (e.g., ice–cream).
- *Phonological loop*—a temporary storage system for acoustic and speech-based information in working memory.
- *Practice effects*—improved performance on a second trial of the same test.
- *Primacy effect*—the tendency for words presented earlier in a list to be more easily recalled during a free-recall task.
- *Priming*—a form of nondeclarative memory in which prior exposure to a stimulus exerts an effect on subsequent stimulus detection or identification.
- *Proactive inhibition*—decreased learning of new information as a result of learning something in the past.
- *Procedural memory*—a type of nondeclarative memory for skills that are not verbalized or consciously analyzed (e.g., tying one's shoes).
- *Prospective memory*—memory for plans, appointments, and actions anticipated to occur in the future.
- *Recency effect*—the tendency to recall the last few words presented in a list-learning task during free recall.

- *Recognition*—memory that is assessed by presenting material shown earlier with new items not previous presented.
- *Retention*—the amount of information persisting over time.
- *Retroactive inhibition*—impairment in recall of previously learned materials due to newly learned material.
- *Retrograde amnesia*—the inability to recall information that was previously learned or stored.
- *Retrograde memory*—the ability to recall information that was previously learned or stored.
- *Semantic memory*—memory that is context-free, reflecting general knowledge of symbols, concepts, and the rules for manipulating them.
- *Sensory memory*—the first stage of memory processing in which a perceptual record is stored.
- *Serial learning*—any learning task in which items to be learned are presented over multiple trials.
- *Serial position effect*—the tendency to recall items presented at the beginning (primacy effect) and end (recency effect) of a list of words in a free-recall task.
- *Short-term memory*—retention of information over brief periods.
- *Topographical amnesia*—specific loss of memory for places.
- *Visuospatial sketch pad*—allows manipulation of visuo-spatial information in working memory.
- *Working memory*—a limited-capacity memory system that provides temporary storage to manipulate information for complex cognitive tasks such as learning and reasoning.

Sources: Ayd, 1995; Loring, 1999.

TESTS OF MEMORY AND LEARNING

The major tests of memory and learning can be divided into two categories: (1) stand-alone tests (e.g., Children's Memory Scale), or (2) memory and learning tests embedded within a broader test battery (e.g., WJIII-COG Long-term Retrieval Cluster and related subtests). Rapid Reference 9.3 presents the names of the stand-alone memory and learning tests and the names of the broader test batteries that contain tests/subtests of memory and learning. Rapid Reference 9.4 illustrates which areas the major tests of memory and learning are designed to measure. The school neuropsychologist should choose the stand-alone or embedded memory and learning test that best addresses the specific referral question(s).

Rapid Reference 9.3

Major Tests of Memory and Learning

Test	Age Range
Stand-Alone Tests of Memory and Learning	
• California Verbal Learning Test–Children's Version (CVLT-C)	5 to 16 years
• Children's Memory Scale (CMS)	5 to 16 years
• Test of Memory and Learning (TOMAL)	5 to 19-11 years
• Wide Range Assessment of Memory and Learning–Second Edition (WRAML2)	5 to 90 years
Broader Test Batteries that Contain Memory and Learning Tests/Subtests	
• Comprehensive Test of Phonological Processing (CTOPP): Phonological Memory Quotient (PAQ)	5 to 24 years
• Kaufman Assessment Battery for Children–Second Edition (KABC-II)	3 to 18 years
• NEPSY/NEPSY-II	3 to 12 years
• Stanford-Binet Intelligence Scales–5th ed. (SB-5)	2 to 85+ years
• Universal Nonverbal Intelligence Test (UNIT)	5 to 17 years
• Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV)	6 to 16-11 years
• WISC-IV Integrated	6 to 16-11 years
• Woodcock-Johnson III Tests of Cognitive Abilities	2 to 80+ years

Stand-Alone Tests of Memory and Learning

California Verbal Learning Test–Children's Version (CVLT-C)

The CVLT-C (Delis, Kramer, Kaplan, & Ober, 1994) is designed to measure verbal immediate and delayed memory and learning. The CVLT-C was standardized for children ages 5 to 16 and takes approximately 30 minutes to administer. On this test, the examiner reads one of two shopping lists to the child. The child

Rapid Reference 9.4

Classification Matrix for the Major Tests of Memory and Learning

Test	Ages	Verbal Immed.	Visual Immed.	Verbal LTM	Visual LTM	Verbal-Visual Associative	Working Memory	Semantic Memory
Stand-Alone Tests of Memory and Learning								
CVLT-C	5–16	✓		✓				
CMS	5–16	✓	✓	✓	✓		a	a
TOMAL	5–19-11	✓	✓	✓	✓	✓	a	
WRAML2	5–90	✓	✓	✓	✓	5–8 yrs. only	✓	
Select Memory Tests Contained within Broader Test Batteries								
KABC-II	3–18	✓	✓			✓	✓	✓
NEPSY	3–12	✓	✓	✓	✓	✓		
SB5	2–85+						✓	✓
UNIT	5–17	✓	✓					
WISC-IV	6–16-11						✓	✓
WISC-IV Integ.	6–16-11							✓
WJIII-COG	2–80+	✓	✓	✓		✓	✓	✓

[a] Not labeled by the test authors, but subtests reconceptualized to fit the school neuropsychology assessment model.

is instructed to recall as many items from the list as possible. The test is structured in such a way that the scores are generated for correct responses across trials, recall errors (perseverations or intrusions), short and long delayed free recall, short and long delayed cued recall, and semantic cluster indices (degree to which the child may favor a semantic strategy in recalling a list).

Children's Memory Scale (CMS)

The CMS "is a comprehensive learning and memory assessment instrument designed to evaluate learning and memory functioning in individuals ages 5 through 16 years" (Cohen, 1997b, p. 1). The memory and learning areas assessed by the CMS (Cohen, 1997a) are presented in Rapid Reference 9.5. The three core

Rapid Reference 9.5

Children's Memory Scale (CMS) Memory Areas Assessed

Verbal Immediate Memory

- *Stories*—recall meaningful and semantically related verbal material.
- *Word Pairs*—learn a list of word pairs over three trials.
- *Word Lists (supplemental)*—learn a list of unrelated words over four learning trials.

Visual Immediate Memory

- *Dot Locations*—learn the spatial location of an array of dots over three learning trials.
- *Faces*—remember and recognize a series of faces.
- *Family Pictures* (supplemental)—remember scenes of family members during various activities.

Verbal Delayed (Long-Term) Memory

- *Stories Delayed Recall*—retell the stories from memory after a delay and then answer some factual questions about the stories.
- *Stories Delayed Recognition*—the student is asked a series of questions about the details of the stories after a delay. The student is given options of answers that measure recognition memory.
- *Word Pairs Learning*—the total number of word pairs correctly identified over three trials.
- *Word Pairs Delayed Recall*—free recall of the word pairs previously presented.
- *Word Pairs Delayed Recognition*—the student is presented with a word pair and asked if that word pair appeared on the original list.
- *Word Lists Learning*—the total number of words correctly recalled across four trials.

- *Word Lists Delayed Recall*—the total number of words correctly recalled after a delay.
- *Word Lists Delayed Recognition*—the student is asked to indicate whether a stated word by the examiner occurred in the original list of words. Presented after a delay from the original list learning.

Visual Delayed (Long-Term) Memory

- *Dot Locations Long Delay*—the student is asked to recall the dot array after a delay.
- *Faces Delayed*—ability to recall faces after a delay.

Working Memory[a]

- *Numbers (Backward)*—ability to repeat verbally presented digits in reverse order.

Semantic Memory[a]

- *Sequences*—ability to mentally manipulate and sequence verbal information as quickly as possible.

Attention/Concentration[b]

- *Numbers Total Score & Forward Condition*—ability to repeat verbally presented digits in a forward sequence.
- *Sequences*—same as previous.

[a] Not labeled by the test authors, but subtests reconceptualized to fit the school neuropsychology assessment model.

[b] Covered in Chapter 6, Attention.

domains measured by the CMS are: (a) auditory/verbal memory and learning, (b) visual/nonverbal memory and learning, and (c) attention/concentration. The core battery can be administered in approximately 35 minutes, and a supplemental set of subtests will add approximately 15 minutes to the total administration time. In terms of the school neuropsychology conceptual model, the attention/concentration subtests are covered within Chapter 6, Attention.

Test of Memory and Learning (TOMAL)

The TOMAL (Reynolds & Bigler, 1994) is a comprehensive memory battery designed for children ages 5 through 19 years, 11 months. The TOMAL is composed of 10 subtests divided into a Verbal Memory Scale and a Nonverbal Memory Scale. The test generates a Composite Memory Scale. The TOMAL yields a Delayed Recall Index that is based on the delayed recall of both verbal and nonverbal information learned on the first four subtests. The test also generates supplemental indices for Sequential Recall, Free Recall, and Attention/Concentration. Four supplemental subtests (3 verbal and 1 nonverbal) are also available.

If the supplemental tests are administered, the TOMAL generates Learning and Associative Recall Indices. There is also a Supplemental Analysis Form that facilitates the plotting of learning curves. The TOMAL subtests along with a brief description are presented in Rapid Reference 9.6.

The TOMAL subtests classified by the various indices are presented in Rapid Reference 9.7. Working Memory is not an index recognized by the TOMAL

Rapid Reference 9.6

Test of Memory and Learning (TOMAL) Memory Areas Assessed

Verbal Memory Index

- *Memory for Stories*—recall a short story that was read by the examiner.
- *Word Selective Reminding*—the child learns a word list and repeats it only to be reminded of words left out.
- *Object Recall*—recall of the names associated with pictures across four trials.
- *Digits Forward*—a standard verbal recall of digits.
- *Paired Recall*—a verbal paired-associative learning task on which the child is asked to recall a list of paired words when the first word of each pair is provided by the examiner.
- *Letters Forward*—similar to the Digits Forward task except the digits are replaced with letters.
- *Digits Backward*—the child recalls the digits in reverse order.
- *Letters Backward*—the child recalls the letters in reverse order.

Nonverbal Memory Index

- *Facial Memory*—assesses recognition and identification of faces.
- *Visual Selective Reminding*—the nonverbal analog to the Word Selective Reminding test. The child points to specified dots on a card and is only reminded of the items recalled incorrectly.
- *Abstract Visual Memory*—assesses immediate recall for meaningless figures when order is not important.
- *Visual Sequential Memory*—requires recall of the sequence of a series of meaningless geometric designs.
- *Memory for Location*—assesses spatial memory. The child is presented with a set of dots on a page and then asked to recall where those dots were positioned after a short delay.
- *Manual Imitation*—reproduction of a set of ordered hand movements in the same sequence as presented by the examiner.

Rapid Reference 9.7

Test of Memory and Learning (TOMAL) Indices

	Verbal	Nonverbal	Sequential Recall	Free Recall	Associative Recall	Attention/ Concentration	Learning	Working Memory[a]
Memory for Stories	X				X			
Word Selective Reminding	X						X	
Object Recall	X			X			X	
Digits Forward	X		X			X		
Paired Recall	X				X		X	
Letters Forward	X		X			X		
Digits Backward	X					X		X
Letters Backward	X					X		X
Facial Memory		X		X				
Visual Selective Reminding		X					X	
Abstract Visual Memory		X		X				
Visual Sequential Memory		X	X					
Memory for Location		X		X				
Manual Imitation		X	X			X		

[a] Not labeled by the test authors, but subtests reconceptualized to fit the school neuropsychology assessment model.

test authors, but the Digits Backward and Letters Backward subtests do require working memory.

Wide Range Assessment of Memory and Learning–Second Edition (WRAML2)

The WRAML2 (Sheslow & Adams, 2003) is a comprehensive test of memory and learning designed for children ages 5 to 17 years. The WRAML2 consists of six core subtests that yield the Verbal Memory Index, the Visual Memory Index, and the Attention/Concentration Index. Those three indices combine to form a General Memory Index. The WRAML also includes indices for comparing recognition versus recall. There are two delayed verbal free-recall subtests: a Verbal Recognition Index, and a Visual Recognition Index. The WRAML also has a Working Memory Index that includes both verbal and visual working memory subtests. A description of the WRAML2 subtests and what they measure is presented in Rapid Reference 9.8.

Select Memory Tests Contained within Broader Test Batteries

Comprehensive Test of Phonological Processing (CTOPP): Phonological Memory Quotient Subtests

The CTOPP (Wagner, Torgensen, & Rashotte, 1999) contains a Phonological Memory Quotient (PMQ) that is composed of two subtests: Memory for Digits, and Nonword Repetition. Both of these subtests measure verbal immediate memory, which is an important corequisite for successful reading.

Kaufman Assessment Battery for Children–Second Edition (KABC-II)

The KABC-II (Kaufman & Kaufman, 2004) is a measure of cognitive ability designed for children ages 3 to 18. The KABC-II includes subtests that measure six components within the school neuropsychological assessment model of memory: verbal immediate memory, visual immediate memory, verbal-visual associative learning, verbal-visual associative memory, working memory, and semantic memory.

Verbal Immediate Memory

- *Number Recall*—the child repeats a series of numbers in the same sequence as the examiner.
- *Word Order*—the child touches a series of silhouettes of common objects in the same order as the examiner says the names of the objects.

(*Note:* These two subtests are also included under Attentional Capacity in Chapter 6, Attention.)

Rapid Reference 9.8

Wide Range Assessment of Memory and Learning–Second Edition (WRAML2) Memory Areas Assessed

WRAML2 Indices and the Subtests that Measure Those Indices

Verbal Memory Index

- *Story Memory*—recall a short story that was read by the examiner.
- *Verbal Learning*—a list-learning test over four trials.

Visual Memory Index

- *Design Memory*—assesses the child's ability to recall from visual memory any details of geometric forms that were briefly shown to him or her. The test does require a motor output.
- *Picture Memory*—child is asked to identify all of the elements that have been changed, moved, or added in a visual picture.

Attention/Concentration Index

- *Finger Windows*—This area is covered in Chapter 6 on Attention.
- *Number Letter*—This area is covered in Chapter 6 on Attention.

Verbal Recognition Index

- *Story Memory Recognition*—recognition of story details using multiple-choice answers.
- *Verbal Learning Recognition*—recognizing a particular word on the original verbal learning list.

Visual Recognition Index

- *Design Memory Recognition*—recognizing whether a particular shape was on the original test.
- *Picture Memory Recognition*—recognizing whether a particular shape was part of the original task.

Working Memory Index

- *Verbal Working Memory*—child listens to a list of words (some are animals and some are not) and is then asked to recall animal words first, then nonanimal words in any order.
- *Symbolic Working Memory*—examiner dictates a series of numbers or number-letter series and then asks the child to point out the numbers or number-letters in a prescribed order.

Optional WRAML2 Subtests

Delayed Recall Subtests

- *Story Memory Recall*—recall of the story elements after a 15-minute delay.
- *Verbal Learning Recall*—recall of the list of words previously learned after a delay (two intervening tests).
- *Sound Symbol Recall*—delayed recall of the paired-associate learning items (children ages 5–8).

Optional Subtests

- *Sentence Memory*—repetition of sentences.
- *Sound Symbol*—a paired-associate learning task for children ages 5–8.

Visual Immediate Memory

- *Face Recognition*—this subtest is only administered to children ages 3 to 5. The child looks closely at photographs of one or two faces that are exposed briefly and then selects the correct face(s) shown in a different pose from a group photograph.
- *Hand Movements*—the child copies the examiner's hand movement sequence.

Verbal-Visual Associative Learning

- *Atlantis*—the examiner teaches the child the nonsense names for pictures of Atlantis plants and animals. The child demonstrates learning by pointing to the correct picture from a stimulus array when it is named.
- *Rebus*—the examiner teaches the child the word or concept associated with each rebus (drawing) and then the child reads the sentences composed of the rebuses.

Verbal-Visual Associative Memory

- *Atlantis Delayed*—the child is asked to recall the paired associations after a 15 to 25 minute delay.
- *Rebus Delayed*—the child is asked to recall the paired associations learned 15 to 25 minutes earlier.

Working Memory

- *Word Order (with color interference)*—the child touches a series of silhouettes of common objects in the same sequential order as the examiner said the names of the objects. Prior to touching the sequence of words, the child must name colors (an interference factor).

Semantic Memory

- *Riddles*—the child points or names a concept that the examiner described.
- *Verbal Knowledge*—the child selects from an array of six pictures the one picture that describes the meaning of a vocabulary word or the answer to a general information question.
- *Expressive Vocabulary*—the child is prompted to name a pictured object.

NEPSY/NEPSY-II

The NEPSY (Korkman, Kirk, & Kemp, 1998) is a neuropsychological battery designed for children ages 3 to 12. The NEPSY-II (Korkman, Kirk, & Kemp, 2007) extends the age range to 3 to 16-11 years. Both versions of the test include Memory and Learning subtests designed to measure verbal immediate memory, visual immediate memory, verbal-visual associative learning, verbal-visual associative (delayed) memory, verbal long-term (delayed) memory, and visual long-term (delayed) memory.

Verbal Immediate Memory

- *Sentence Repetition*—assesses the ability to repeat sentences of increasing complexity and length. Sentence Repetition also measures attentional capacity (see Chapter 6, Attention).

Visual Immediate Memory

- *Memory for Designs*—This test is new to the NEPSY-II. It assesses spatial memory for novel visual material. The child is shown a grid with four to ten designs on a page, which is then removed from view. The child is then asked to select the designs from a set of cards and place them on a grid in the exact location as previously shown.
- *Memory for Faces: Total Score & Immediate Memory (Supplemental Score)*—measures the ability to recognize faces after a single exposure. The total score includes the number of correctly identified faces across the immediate and delayed recall conditions. The Memory for Faces: Immediate Memory supplemental score is a better indicator of immediate visual memory.

Verbal-Visual Associative Learning

- *Memory for Names: Total Score & Learning Trials (Supplemental Score)*—assesses the ability to learn the names of children associated with a picture over three learning trials. The total score includes the number of correctly identified names across the learning and delayed-recall conditions. The Learning Trials is a better indicator of immediate verbal-visual associative learning.

Verbal Long-Term (Delayed) Memory

- *List Learning*—measures several aspects of learning and memory including rate of learning, delayed recall, and the role of interference from prior and new learning.
- *Narrative Memory*—assesses the ability to retell a story under free- and cued-recall conditions. The test yields a total score that combines the number of correct answers across the free-recall and cued-recall conditions, with separate scores for free recall and cued recall.

Visual Long-Term (Delayed) Memory

- *Memory for Designs: Delayed Recall*—This test is new to the NEPSY-II. The child is asked to recall designs that were part of the immediate recall task.

- *Memory for Faces: Delayed Recall (Supplemental Score)*—this is a supplemental score for the number of correctly identified faces on the delayed portion of the Memory for Faces test.

Verbal-Visual Associative Learning

- *Memory for Names: Total Score & Learning Trials (Supplemental Score)*—assesses the ability to learn the names of children associated with a picture over three learning trials.

Stanford-Binet Intelligence Scales–5th Edition (SB5)

The SB5 (Roid, 2003) is a test of cognitive ability for examinees between the ages of 2 and 85+ years. The SB5 includes subtests that measure two components of memory within the school neuropsychological assessment model including working memory (verbal and nonverbal) and semantic memory (comprehension-knowledge).

Verbal Working Memory

- *Memory for Sentences (verbal)*—the child recalls sentences read by the examiner.
- *Last Word (verbal)*—the examiner reads a list of words then reads one word at a time in random order and asks the child to respond with *yes* or *no* as to whether the word was the last word in the sequence.

Nonverbal Working Memory

- *Delayed Response (nonverbal)*—this test is similar to the classic "shell game" in which an object is hidden under a shell or cup and the child must identify the location of the toy after a brief delay.
- *Block Span (nonverbal)*—the examiner taps out a sequence on blocks and then asks the child to tap out the same sequence in the same order or in a reverse order.

Semantic Memory (Comprehension-Knowledge)

- *Procedural Knowledge (nonverbal)*—used at younger age levels to measure a child's knowledge of basic human activities demonstrated in gestures.
- *Picture Absurdities (nonverbal)*—used at older ages. The child must study pictures showing people in odd or incongruous situations and point out the absurdity.
- *Vocabulary (verbal)*—lower levels begin with identification of body parts, identification of toy objects, and picture vocabulary. The upper levels of the test include increasingly difficult vocabulary words that the child is asked to define.

Universal Nonverbal Intelligence Test (UNIT)

The UNIT (Bracken & McCallum, 1998) is a nonverbal test of cognitive abilities designed for children ages 5 to 17 years. The UNIT includes subtests that measure one component of memory within the school neuropsychological assessment model, which is visual immediate memory.

Visual Immediate Memory

- *Symbolic Memory*—each item on the test shows the universal symbols for baby, girl, boy, woman, and man. The child is shown a picture with these symbols in a random order for 5 seconds, and is then asked to recreate the sequence using picture cards.
- *Spatial Memory*—the child views a random pattern of green, black, or green and black dots on a grid for 5 seconds, then the stimulus is removed. The child is asked to recreate the pattern just observed using chips placed on a grid.
- *Object Memory*—the child is presented with a random pictorial array of common objects for 5 seconds. The stimuli are removed and a second pictorial array is presented containing all of the objects that were present in the first picture and a few new objects. The child is asked to place chips on the pictures that were observed in the first pictorial array.

Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV)

The WISC-IV (Wechsler, 2003) is a measure of cognitive functioning for children ages 6 to 16 years-11 months. The WISC-IV includes subtests that measure two components of memory within the school neuropsychological assessment model including working memory (verbal and nonverbal) and semantic memory (comprehension-knowledge).

Working Memory

- *Digit Span*—the test consists of two parts: Digit Span Forward and Digit Span Backward. Digit Span Forward requires the child to repeat digits in the order that they were verbally presented by the examiner. Digit Span Backward requires the child to listen to a sequence of numbers verbally stated by the examiner, then recall them in reverse order. Because the total test score is the sum of correct responses across both the Forward and Backward conditions, the test measures both verbal immediate memory (Forward condition) and working memory (Backward condition). The test also requires attentional capacity since the digits increase in length as the test progresses.

- *Letter-Number Sequencing*—the examiner reads a sequence of numbers and letters to the child and the child is instructed to recall the numbers in ascending order first then the letters in alphabetical order second. This test measures verbal immediate memory, working memory, and attentional capacity.
- *Arithmetic*—this is a supplemental test on the WISC-IV designed to measure the child's ability to solve orally presented arithmetic problems within a specified time period. The child must hold the story problem information in his or her immediate memory and actively manipulate it to solve the problems.

Semantic Memory (Comprehension-Knowledge)

- *Comprehension*—requires the child to answer a series of questions based on his or her understanding of general principles and social situations.
- *Information*—requires the child to answer questions that address a wide range of general knowledge topics.
- *Vocabulary*—requires the child to name pictures or provide definitions of words.

WISC-IV Integrated

The WISC-IV Integrated (Wechsler, 2004) was introduced in Chapter 4, A Model for School Neuropsychological Assessment. The WISC-IV Integrated is a process-oriented battery of tests designed to test the limits of several of the WISC-IV subtests. The WISC-IV Integrated includes subtests that measure four components of memory within the school neuropsychological assessment model, including: verbal immediate memory, visual immediate memory, working memory (verbal and nonverbal), and semantic memory (comprehension-knowledge).

Verbal Immediate Memory

- *Digit Span: Forward*—the examiner reads a sequence of numbers and the child is asked to recall the numbers in the same order.
- *Letter Span: Forward*—a variation of the Digit Span subtest in which the child repeats non-rhyming and rhyming series of letters in the same order spoken by the examiner.

Visual Immediate Memory

- *Visual Digit Span: Forward*—a variation of the Digit Span subtest. The examiner shows the child a visual sequence of numbers, then asks the child to recall those numbers in the same order as they were presented.
- *Spatial Span: Forward*—a variation of the Digit Span subtest in which

the child repeats a sequence of tapped blocks in the same order that was shown by the examiner.

Working Memory

- *Arithmetic Process Approach*—an adaptation of the WISC-IV Arithmetic subtest in which the items are presented in different modalities to test the limits of the child's arithmetic skills.
- *Digit Span: Backward*—the examiner reads a sequence of numbers and the child is asked to recall the numbers in reverse order.
- *Letter-Number Sequencing Process Approach*—a variation of the Letter-Number Sequencing subtest from the WISC-IV. The examiner reads a sequence of letters and numbers, some of which contain an embedded word. The child is asked to recall the letters in alphabetical order and the numbers in ascending order.
- *Spatial Span: Backward*—the child watches the examiner tap a sequence on blocks then taps the sequence backward.

Semantic Memory (Comprehension-Knowledge)

- *Comprehension Multiple Choice*—a multiple-choice adaptation of the WISC-IV Comprehension subtest. The examiner reads each item that is also printed in a stimulus book, and the child chooses one of the answers.
- *Information Multiple Choice*—a multiple-choice adaptation of the WISC-IV Information subtest. The examiner reads each item that is also printed in a stimulus book, and the child chooses one of the answers.
- *Vocabulary Multiple Choice*—a multiple-choice adaptation of the WISC-IV Vocabulary subtest. Young children are shown a picture of an object and asked to name the object. Older children are read vocabulary words that are also printed in a stimulus book and asked to choose the best definition for the word.
- *Picture Vocabulary Multiple Choice*—a multiple-choice adaptation of the WISC-IV Vocabulary subtest. The examiner shows the child a group of four pictures and the child is asked to point to the picture that best depicts the vocabulary word read by the examiner.

Woodcock-Johnson III Tests of Cognitive Abilities (WJIII-COG)

The WJIII-COG (Woodcock, McGrew, & Mather, 2001a) is a comprehensive test of cognitive abilities for examinees between the ages of 2 to 80+ years. The WJIII-COG includes subtests that measure six components within the school neuropsychological assessment model of memory: verbal immediate memory, visual immediate memory, verbal-visual associative learning, verbal-visual associative delayed learning, working memory, and semantic memory.

Verbal Immediate Memory

- *Numbers Reversed*—the child is read a sequence of numbers and asked to recall them in reverse order. The test measures verbal short-term memory, working memory, and attentional capacity.
- *Memory for Words*—measures auditory short-term memory by asking the child to repeat lists of unrelated words in the correct sequence.

Visual Immediate Memory

- *Picture Recognition*—the child is shown a set of pictures, then after a brief delay, the child is asked to identify some pictures that were part of the original set. The original pictures are randomly embedded with distracter items. This test measures visual-spatial processing but also has a strong visual immediate memory requirement.

Verbal-Visual Associative Learning

- *Visual-Auditory Learning*—the WJIII-COG test loads on the long-term retrieval cluster. The test requires the child to learn visual-verbal associations and then recall them. The child is shown a pictorial representation and given a word to associate with it. The pictorial representations (rebuses) are combined to form sentences that the child is asked to read. Errors are corrected as the items are administered, which makes the test an active learning activity as well.

Verbal Long-Term (Delayed) Memory

- *Retrieval Fluency*—the child is given 1 minute to name as many examples as possible from a category given by the examiner (e.g., words that start with the letter *d*). This test measures the fluency of retrieval of long-term memory, which is an executive function as well.

Verbal-Visual Associative Delayed Memory

- *Visual-Auditory Learning: Delayed Recall*—after a delay of minutes, hours, or days, the child is asked to recall the names of the rebuses previously learned.

Working Memory

- *Numbers Reversed*—as previously mentioned, the Numbers Reversed subtest requires working memory, as well as verbal short-term memory and attentional capacity.
- *Auditory Working Memory*—the child listens to an audio recording of a

series of the names of both objects and digits. The child is instructed to repeat the name of the objects first in sequential order, followed by the numbers in sequential order. This test measures working memory and divided attention.

Semantic Memory (Comprehension-Knowledge)

- *Verbal Comprehension*—this test is made up of four parts: (1) Picture Vocabulary, (2) Synonyms, (3) Antonyms, and (4) Verbal Analogies. On the Picture Vocabulary subtest, the child is required to identify pictures of familiar and unfamiliar objects. On the Synonyms subtest, the examiner reads a word and the child is asked to provide the synonym. On the Antonyms subtest, the examiner reads a word and the child is asked to provide the antonym. On the Verbal Analogies subtest, the child hears three words of an analogy and then is asked to verbally fill in the missing word. Each of these tests measures a different aspect of semantic memory.
- *General Information*—contains two subtests: Where and What. In the Where subtest, the child is asked, "Where would you find [an object]?" In the What subtest, the child is asked, "What would you do with [an object]?" These subtests measure the child's depth of verbal knowledge.

Rapid Reference 9.9 integrates the major tests of memory and learning into the school neuropsychological conceptual model. The purpose of this table is to aid the school neuropsychologist in using a cross-battery approach to the assessment of memory and learning.

In this chapter the theories, terminology, neuroanatomy, and major tests associated with memory and learning functioning were reviewed. Memory and learning processes are essential elements in education and must be systematically evaluated by a school neuropsychologist. Memory and learning disorders are observed in many common developmental disorders. As an example in Chap-ter 16, the school neuropsychological conceptual assessment model will be used to review the presence of memory and/or learning deficits in autism-spectrum disorders.

Rapid Reference 9.9

Major Tests of Memory and Learning Classified within the School Neuropsychological Assessment Model

Test	Age Range
Verbal Immediate Memory	
California Verbal Learning Test: Children's Version (CVLT-C): List A Trial 1	5 to 16 years
Children's Memory Scale (CMS): Verbal Immediate Index Stories–Immediate Recall Word Pairs–Total Score CMS Supplemental: Word Pairs–Immediate Recall	5 to 16 years
KABC-II:	
Number Recall	3 to 18 years
Word Order (without color interference)	3 to 18 years
NEPSY:	
Sentence Repetition	3 to 12 years
Test of Memory and Learning (TOMAL) Verbal Memory Index: Memory for Stories Word Selective Reminding Object Recall Digits Forward Paired-Recall Verbal Supplemental: Letters Forward	5 to 19-11 years
WISC-IV Integrated: Digit Span: Forward Letter Span: Forward	6 to 16-11 years
WJIII-COG Short-Term Memory CHC Factor Numbers Reversed Memory for Words	2 to 80+ years

Test	**Age Range**
WRAML2 Verbal Memory Index: Story Memory Verbal Learning Sentence Memory	5 to 90 years
Tests of Visual Immediate Memory	
Children's Memory Scale (CMS): Visual Immediate Index Faces–Immediate Recall Dot Locations–Total Score CMS (Supplemental): Family Pictures–Immediate Recall Picture Locations–Total Score	5 to 16 years
KABC-II: Face Recognition Hand Movements	 3 to 5 years 3 to 18 years
NEPSY: Memory for Faces: Immediate Recall	5 to 12 years
TOMAL Nonverbal Memory Index: Facial Memory Visual Selective Reminding Abstract Visual Memory Visual Sequential Memory Memory for Location Nonverbal Supplemental Tests: Manual Imitation	5 to 19-11 years
UNIT: Spatial Memory (nonsymbolic) Symbolic Memory (symbolic) Object Memory (symbolic)	5 to 17 years
WISC-IV Integrated: Visual Digit Span: Forward Spatial Span: Forward	6 to 16-11 years

(continued)

Test	Age Range
WJIII-COG: Picture Recognition	2 to 80+ years
WRAML2: Design Memory Picture Memory	5 to 90 years
Tests of Verbal-Visual Associative Learning	
KABC-II: Atlantis Rebus	 3 to 18 years 4 to 18 years
NEPSY: Memory for Names: Total Score Memory for Names: Learning Trials	5 to 12 years
TOMAL: Memory for Stories Paired Recall	5 to 19-11 years
WJIII-COG: Visual-Auditory Learning	2 to 80+ years
WRAML2: Sound-Symbol	5 to 8 years
Tests of Verbal Long-Term (Delayed) Memory	
CVLT-C: List A Trial 5 List A Short-Delay Free Recall List A Long-Delay Free Recall List A Short-Delay Cued Recall List A Long-Delay Cued Recall	5 to 16 years
CMS Verbal Delayed Index: Stories 2–Delayed Recall Word Pairs 2–Learning Word Pairs 2–Long Delayed Recall	5 to 16 years

Test	Age Range
CMS: Verbal Delayed Recognition Index: Stories 2–Delayed Recognition Word Pairs 2–Delayed Recognition CMS Supplemental: Word Lists–Learning Word Lists–Delayed Recall Word Lists–Delayed Recognition	5 to 16 years
NEPSY: List Learning Narrative Memory	 7 to 12 years 3 to 12 years
TOMAL: Memory for Stories–Delayed Recall Word Selective Reminding–Delayed Recall	5 to 19-11 years
WJIII-COG: Retrieval Fluency	
WRAML2: Story Memory–Delayed Recall Story Memory–Retention Story Memory–Delayed Recognition Verbal Learning–Delayed Recall Verbal Learning–Recognition	5 to 90 years
Tests of Visual Long-Term (Delayed) Memory	
CMS: Visual Delayed Recall Index Faces 2–Delayed Dot Locations–Learning Dot Locations 2–Short Delayed Recall Dot Locations 2–Long Delayed Recall CMS (Supplemental): Family Pictures–Delayed Recall	5 to 16 years
NEPSY: Memory for Faces: Delayed Recall	5 to 12 years

(*continued*)

Test	**Age Range**
TOMAL: Facial Memory–Delayed Recall Visual Selective Reminding–Delayed Recall	5 to 19-11 years
WRAML2: Design Memory Recognition Picture Memory Recognition	5 to 90 years
Tests of Verbal-Visual Associative Delayed Memory	
KABC-II: Atlantis Delayed Rebus Delayed	 3 to 18 years 4 to 18 years
NEPSY: Memory for Names: Delayed Recall	5 to 12 years
WJIII-COG: Visual-Auditory Learning: Delayed	2 to 80+ years
WRAML2: Sound-Symbol Delayed Recall Sound-Symbol Retention	5 to 8 years
Tests of Working Memory	
Children's Memory Scale (CMS): Numbers (Backward)	5 to 16 years
KABC-II: Word Order (with color interference)	3 to 18 years
Stanford-Binet Intelligence Scales–5th Edition (SB5): Delayed Response (nonverbal) Block Span (nonverbal) Memory for Sentences (verbal) Last Word (verbal)	2 to 85+ years
TOMAL: Digits Backward Letters Backward	5 to 19-11 years

Test	Age Range
WISC-IV: Digit Span Letter-Number Sequencing Arithmetic	6 to 16-11 years
WISC-IV Integrated: Arithmetic Process Approach Digit Span: Backward Letter-Number Sequencing Process Approach Spatial Span: Backward	6 to 16-11 years
WJIII-COG Working Memory Cluster: Numbers Reversed Auditory Working Memory	2 to 80+ years
WRAML-2: Symbolic Working Memory Verbal Working Memory	5 to 90 years
Tests of Semantic Memory (Comprehension-Knowledge)	
CMS: Sequences	5 to 16 years
KABC-II: Riddles Verbal Knowledge Expressive Vocabulary	 3 to 18 years 7 to 18 years 3 to 18 years
SB5: Procedural Knowledge (nonverbal) Picture Absurdities (nonverbal) Vocabulary (verbal)	2 to 85+ years
WISC-IV: Comprehension Information Vocabulary	6 to 16-11 years

(*continued*)

Test	Age Range
WISC-IV Integrated: Comprehension Multiple Choice Information Multiple Choice Vocabulary Multiple Choice Picture Vocabulary Multiple Choice	6 to 16-11 years
WJIII-COG: Comprehension-Knowledge Cluster Verbal Comprehension General Information	2 to 80+ years

TEST YOURSELF

1. **What type of memory is verbal and has a very short life of just a few milliseconds?**
   (a) verbal long-term memory
   (b) echoic sensory memory
   (c) verbal short-term memory
   (d) iconic sensory memory
2. **Long-term memory can be conceptually divided into two distinct subdivisions. What are they called?**
   (a) episodic and semantic memory
   (b) echoic and iconic memory
   (c) declarative and nondeclarative memory
   (d) primacy and recency effect
3. **The serial-order position effect lends support to the distinction between short- and long-term memory.** True or False?
4. **Baddeley and colleagues proposed a three-part working memory system that contained a central executive system that regulated which two subordinate subsystems?**
   (a) visuospatial sketchpad and phonological loop
   (b) short-term and long-term memory
   (c) episodic and semantic memory
   (d) iconic and echoic memory

5. **What is the type of memory that is related to the recollection of personal memories?**
   (a) episodic memory
   (b) anterograde memory
   (c) nondeclarative memory
   (d) autobiographical memory
6. **What term is used to describe memory retrieval without the aide of external cues?**
   (a) recognition
   (b) free recall
   (c) learning
   (d) incidental learning
7. **What type of memory has a limited capacity and provides temporary storage to manipulate information for complex cognitive tasks such as learning and reasoning?**
   (a) long-term memory
   (b) short-term memory
   (c) working memory
   (d) sensory memory

Answers: 1. b; 2. c; 3. true; 4. a; 5. d; 6. b; 7. c

Ten

EXECUTIVE FUNCTIONS

Executive functions encompass many behaviors ranging from initiation responses, maintenance and cessation of actions, abstract and conceptual thinking, and the ability to plan and organize behavior toward a goal (Stirling, 2002). This chapter will review: (a) the terms associated with executive functions; (b) the neuroanatomy of executive functions; (c) the major behavioral tests associated with executive functions; and (d) the behavioral rating scales designed to measure executive functions.

DEFINITIONS

There are many terms that researchers and practitioners use to describe executive functioning (see Rapid Reference 10.1). Deficits in some or all of these executive functions have been associated with more than one neurodevelopmental disorder, including: Attention-Deficit/Hyperactivity Disorder, Tourette Syndrome, Obsessive-Compulsive Disorder, and Schizophrenia. The relationships between these executive dysfunction disorders are not yet clearly understood and make differential diagnosis difficult.

NEUROANATOMY OF EXECUTIVE FUNCTIONS

Historically, executive functions have been viewed to be synonymous with frontal lobe involvement. While the frontal and prefrontal lobes do play major roles in executive functioning, there are excitatory and inhibitory pathways that start in subcortical regions of the brain (e.g., the basal ganglia and thalamus) and project to the frontal cortex and vice versa. Alexander, DeLong, and Strick (1986) introduced the idea that there is a parallel but segregated set of frontal-subcortical (FSC) circuits that influence both movement and behavior.

A five-circuit scheme has been generally accepted in the literature (Lichter & Cummings, 2001); and more recently a seven-circuit scheme has been

Rapid Reference 10.1

Terms Associated with Executive Functions

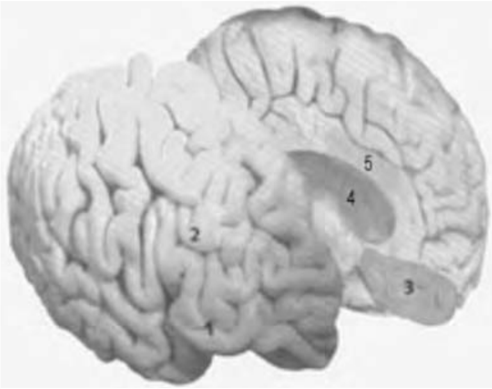
- Abstract reasoning
- Anticipation
- Attentional control
- Behavioral initiation/productivity
- Behavioral regulation
- Common sense
- Concept formation
- Creativity
- Estimation
- Fluency (verbal and nonverbal)
- Goal setting
- Hypothesis generating
- Inhibition of impulsiveness
- Mental flexibility
- Organization
- Planning problem solving
- Rule learning
- Self-control
- Self-monitoring
- Set formation and maintenance
- Set shifting
- Working memory

Source: Adapted from (Baron, 2004, p. 134).

suggested (Middleton & Strick, 2001). These FSC circuits can be divided into seven general categories: skeletomotor, oculomotor, dorsolateral prefrontal, lateral orbitofrontal, ventromedial orbitofrontal, anterior cingulate, and inferior-temporal/posterior parietal. The lateral and ventromedial orbitofrontal circuits will be discussed together in this section.

Two of the circuits appear to be related to the control of movement: the skeletomotor circuit (body movements) and the oculomotor circuit (eye movements). The skeletomotor circuit is related to premotor, supplementary motor, and primary motor output functions of the brain. Hale and Fiorello (2004) suggested that the evaluation of a student's handwriting would be an appropriate ecological validity check of integrity of the skeletomotor circuit. The oculomotor circuit is related to the frontal eye fields and helps regulate visual scanning. Hale and Fiorello (2004) suggested that oculomotor functioning could be measured by the student's performance on word tracking and visual scanning. The function of the inferior-temporal/posterior parietal circuit has not been clearly articulated in the literature but may be related to the working memory functions of the frontal lobes.

The three remaining FSC circuits all appear to be associated with executive functions and are of most interest to school neuropsychologists. The locations of the major frontal-subcortical circuits that help regulate behavior are illustrated in Figure 10.1.



1. Orbitofrontal (lateral)
2. Dorsolateral prefrontal
3. Orbitofrontal (ventromedial)
4. Limbic System
5. Anterior Cingulate

Figure 10.1 The locations of the major frontal-subcortical circuits that help regulate behavior relative to the location of the limbic system.

Dorsolateral Prefrontal Circuit

Tonika is having trouble at school and at home. Her symptoms are varied but always seem to come down to a few difficulties. Tonika has poor organizational skills. She is always losing her school papers and she never knows when assignments are due in class. Tonika seems to have trouble remembering things as well. When working on an assignment at school she performs well, but when presented with the same assignment later she cannot remember what she is supposed to do. Tonika also has problems focusing her attention for prolonged periods of time. Tonika is experiencing many of the symptoms associated with damage or dysfunction in the dorsolateral prefrontal regions of her brain.

The major functions attributable to all seven FSC circuits are presented in Rapid Reference 10.2.

The dorsolateral prefrontal circuit serves as the principle "executor of the brain." As shown in Rapid Reference 10.3, the dorsolateral prefrontal circuit regulates multiple executive functions, ranging from planning and maintaining organizational strategies, implementing efficient memory search strategies, sustaining the instructional demands of a task, having the cognitive flexibility to shift sets, and regulating complex motor programming output. Therefore, the dorsolateral prefrontal cortex primarily regulates more cognitive executive functioning skills, which are critical to the execution of a goal-directed academic task in school. The neuropsychological deficits associated with damage to the dorsolateral prefrontal circuit are presented in Rapid Reference 10.3.

Rapid Reference 10.2

The Major Functions of the Frontal-Subcortical Circuits

Frontal-Subcortical Circuits	Major Functions
Skeletomotor circuit	Regulates large and fine muscle movements.
Oculomotor circuit	Regulates eye movements.
Dorsolateral prefrontal circuit	The "Executor of the Brain." Regulates: • anticipation • goal selection • planning • monitoring • use of feedback in task performance • focusing and sustaining attention • generating hypotheses • maintaining or shifting sets • verbal and design fluency • visual-spatial search strategies • constructional strategies on learning and copying tasks • motor programming disturbances
Orbitofrontal circuit	• Integration of emotional information into contextually appropriate behavioral responses. • Integration of emotional functions with the internal states of the child.
Anterior Cingulate circuit	• Motivational mechanisms (e.g., apathy) • Behavioral initiation responses • Creativity and concept formation • Allocation of attentional resources
Inferior/temporal posterior parietal circuit	• Working memory

Rapid Reference 10.3

Neurocognitive Deficits Associated with Damage or Dysfunction in the Dorosolateral Prefrontal Circuit

- decreased verbal fluency
- decreased design fluency
- abnormal motor programming
- impaired set shifting
- reduced learning and memory retrieval
- disruptions in working memory
- poor organizational skills
- poor constructional strategies in copying
- poor problem solving, goal selection, planning, monitoring, and use of feedback in task performance
- difficulty focusing attention and sustaining attention
- difficulty generating hypotheses

Orbitofrontal Circuit

In the history of neuropsychology, the classic case study of Phineas Gage illustrates the functions of the orbitofrontal circuit. Phineas Gage was a railroad worker in the 1800s when, as a result of an accident, an iron rod blew through his left eye socket and out the top of his head. Phineas Gage survived the accident but he had marked personality changes as a result of the destruction of the orbitofrontal region of his brain. Before the accident, Phineas was described as a capable foreman with a well-balanced mind. After the accident, Phineas showed no empathy for anyone else; he was quick to make plans but slow to follow through on those plans; and he was often crude, socially inappropriate, impatient, and obstinate.

A summary of the neurocognitive deficits associated with damage or dysfunction to the orbitofrontal circuit is presented in Rapid Reference 10.4. "The orbitofrontal circuit mediates empathic, civil, and socially appropriate behaviors; personality change is the hallmark of orbitofrontal dysfunction" (Chow & Cummings, 1999, p. 6). The orbitofrontal circuit regulates our abilities to inhibit, evaluate, and act on social and emotional decision making. The orbitofrontal circuit is also involved in cognitive and affective functions such as assessing emotional significance of events, anticipating rewards and punishments, adjusting behaviors to adapt to changes in rule contingencies, and inhibiting inappropriate behaviors. Damage to the orbitofrontal circuit seems to disconnect the frontal monitoring systems from the emotional responses of the limbic system, resulting in behavioral disinhibition (Lichter & Cummings, 2001). Obsessive-compulsive symptoms also seem to be associated with damage to the orbitofrontal circuit (Lichter & Cummings, 2001).

Rapid Reference 10.4

Neurocognitive Deficits Associated with Damage or Dysfunction in the Orbitofrontal Circuit

- impulsivity
- antisocial behavior
- inappropriate feelings under normal circumstances (e.g., inappropriate laughter or crying)
- irritability
- tactlessness
- undue familiarity
- reduced empathy

There also seems to be some specific hemispheric deficits associated with orbitofrontal damage. Right orbitofrontal damage seems to produce greater disinhibition and loss of socially appropriate behaviors than damage to the left orbitofrontal region (Miller, Chang, Mena, Boone, & Lesser, 1993). Left orbitofrontal damage seems to produce some disinhibition, poor judgment, and irresponsibility toward responsibilities at home and at school (Meyers, Berman, & Scheibel, 1992). Students who consistently blurt out answers in class or continually say inappropriate comments in social situations, or lash out at classmates when they walk by, may have some damage or dysfunction associated with the orbitofrontal regions of the brain.

Anterior Cingulate Circuit

Jose is 16 years old. Over the past year or so, he has become increasingly apathetic and lethargic. He shows no motivation at school or at home. Jose only speaks when he is spoken to. He seems to be content sitting in a chair picking at his fingers and hands. Jose's symptoms are consistent with damage or dysfunction to the anterior cingulate portion of his brain.

A summary of the neurocognitive deficits associated with damage or dysfunction to the anterior cingulate circuit is presented in Rapid Reference 10.5. The anterior cingulate circuit regulates motivational mechanisms. Apathy is the common behavioral manifestation associated with damage to the anterior cingulate region of the brain. A condition called Akinetic mutism is often present when there is bilateral damage to the anterior cingulate. "Akinetic mutism represents a wakeful state of profound apathy, with indifference to pain, thirst, or hunger; absence of motor or psychic initiative, manifested by lack of spontaneous movement; absent verbalization; and failure to respond to questions or commands" (Lichter & Cummings, 2001, p. 13). Similar to the orbitofrontal circuit, obsessive-compulsive symptoms seem to be associated with damage to the anterior cingulate circuit (Lichter & Cummings, 2001).

Rapid Reference 10.5

Neurocognitive Deficits Associated with Damage or Dysfunction in the Anterior Cingulate Circuit

- apathy
- limited spontaneous speech
- indifference to pain, thirst, or hunger (in severe cases)
- obsessive-compulsive characteristics
- poor response inhibition (impulsive)
- poor creativity or generation of new concepts
- poor allocation of attentional resources

On neuropsychological measures, the most pronounced deficit associated with damage to the anterior cingulate is the failure of response inhibition. For example, in the NEPSY Tower test, when the child is told that a particular item could be solved in six moves but the examiner wants him or her to solve it in seven moves, this would be very difficult for a child with damage to the anterior cingulate. Children with damage to the anterior cingulate may also show deficits in creative thought processes and generating new concepts (Miller & Cummings, 1999). Finally, the anterior cingulate has been hypothesized to operate as an executive attention system (Posner, 1994; Posner & Raichle, 1994). The anterior cingulate allocates attentional resources to other parts of the brain to ensure that a particular task is handled most efficiently. In brain imaging studies using PET scans, blood flow increases in the anterior cingulate when tasks become difficult (e.g., incongruent Stroop trial compared to congruent Stroop trial or on divided attention tasks; see Gazzaniga, Ivry, & Mangrum, 2002 for review).

Rapid Reference 10.6 lists some common neuropsychological terms used to describe impairments in executive functioning.

TESTS OF EXECUTIVE FUNCTIONS

Rapid Reference 10.7 presents a list of common tests for measuring deficits in executive functioning. Behavioral samples of executive functioning come from four sources:

1. *Comprehensive test batteries designed to measure executive functioning* (e.g., Delis-Kaplan Executive Function System [D-KEFS; Delis, Kaplan, & Kramer, 2001]);

Rapid Reference 10.6

Neuropsychological Terms Associated with Impairments in Executive Functioning

- *Abulia*—lack of initiation or drive.
- *Anterior cingulate syndrome*—symptoms consist of reduced spontaneous activity (increased apathy, do not speak spontaneously, eat and drink only if fed, show little to no emotion, and may be incontinent).
- *Echopraxia*—pathological copying of another person's speech. Associated with frontal lobe disorders.
- *Emotional lability*—abnormal variability in emotional expression characterized by repetitive and abrupt shifts in affect. Often seen after damage to the orbitofrontal regions of the frontal lobes.
- *Initiation deficit*—the failure to act, or behavior requiring extensive cueing, despite a demonstrated ability to perform the desired behavior. Child may be able to describe the intended action but not be able to initiate the action. Characteristic of damage to the anterior cingulate region of the frontal lobes.
- *Dorsolateral frontal syndrome*—symptoms consist of difficulty with generating hypotheses, cognitive flexibility, shifting of cognitive sets, reduced verbal or design fluency, poor organizational strategies for learning, constructional strategies for copying complex designs, and motor programming deficits.
- *Orbitofrontal syndrome*—characterized by prominent personality changes including: emotional lability, impulsivity, irritability, becoming more outspoken and less worried, and occasionally showing imitation and utilization behaviors.
- *Perseveration*—a tendency to repeat the same response over and over, even when it is shown to be inappropriate. Perseveration may involve motor acts, speech, or ideas.
- *Utilization behavior*—the tendency to grasp and use objects within reach regardless of whether they are related to the current task. An example would be a child feeling compelled to start hammering when handed a hammer. This behavior is thought to arise from an enslavement to the environment and is associated with bilateral frontal lobe damage.

Sources: Ayd, 1995; Loring, 1999.

2. *Comprehensive test batteries designed to measure all major neuropsychological processes including executive functions* (e.g., NEPSY; Korkman, Kirk, & Kemp, 1998);
3. *Tests of cognitive functions* (e.g., Woodcock-Johnson III Tests of Cognitive Ability [WJIII-COG; Woodcock, McGrew, & Mather, 2001a]); and
4. *Stand-alone tests that were designed to measure executive functions* (e.g., Wisconsin Card Sorting Test [Heaton, 1981]).

Rapid Reference 10.7

Common Neuropsychological Tests for Measuring Executive Functioning

Test	Age Range
Measures of Concept Generation	
D-KEFS: Card Sorting Test	8 to 89 years
Measures of Inhibition	
Go-No-Go Tasks	See text
NEPSY:	
Auditory Attention and Response Set	5 to 12 years
Knock and Tap	5 to 12 years
Statue	3 to 12 years
Visual Attention	3 to 12 years
Stroop Color-Word Test	See text
WJIII-COG: Pair Cancellations	2 to 80+ years
Measures of Motor Programming	
Dean-Woodcock Sensory-Motor Battery: Fingertip Tapping	4 to 80+ years
NEPSY:	
Fingertip Tapping	5 to 12 years
Manual Motor Sequences	3 to 12 years
Measures of Planning, Reasoning, and Problem Solving	
Category Tests	See text
Tower Tests	See text
Trail-Making Tests	See text
D-KEFS:	
20 Questions	8 to 89 years
Tower	8 to 89 years
Proverbs	16 to 89 years
Word Context	8 to 89 years
KABC-II:	
Conceptual Thinking	3 to 6 years
Pattern Reasoning	5 to 6 years
Rover	6 to 18 years
Story Completion	6 years
Triangles	3 to 18 years
NEPSY/NEPSY-II:	
Block Construction	3 to 12/3 to 16 years
Tower (NEPSY only)	5 to 12 years
Route Finding	5 to 12 years

Test	Age Range
Porteus Maze Test	3 years to adult
SB-5 Fluid Reasoning tests:	2 to 85+ years
Nonverbal Fluid Reasoning:	
Object Series	
Matrices	
Verbal Fluid Reasoning:	2 to 85+ years
Early Reasoning	
Verbal Absurdities	
Verbal Analogies	
UNIT Reasoning tests:	5 to 17 years
Analogic Reasoning (Symbolic)	
Cube Design (Nonsymbolic)	
Mazes (Nonsymbolic)	
WJIII-COG:	2 to 80+ years
Executive Processes Cluster tests	
Concept Formation	
Planning	
Pair Cancellation	
Fluid Reasoning tests	
Concept Formation	
Analysis-Synthesis	
WISC-IV:	6 to 16-11 years
Block Design	
Matrix Reasoning	
Picture Completion	
Picture Concepts	
WISC-IV Integrated: Elithorn Mazes	6 to 16-11 years
Measures of Set Shifting	
Category Tests	See text
Cognitive Assessment System: Expressive Attention	5 to 17 years
D-KEFS:	8 to 89 years
Color-Word Interference Test (Condition 4)	
Design Fluency (Condition 3)	
Trail-Making (Condition 4)	
Verbal Fluency (Condition 3)	
NEPSY: Auditory Attention and Response Set (Part B)	5 to 12 years
Stroop Tests	See text
Trail-Making Tests	See text
Wisconsin Card Sorting Test	6.5 to 89 years
Measures of Retrieval Fluency	
Non-verbal:	
D-KEFS: Design Fluency (Conditions 1 & 2)	8 to 89 years

(continued)

Test	Age Range
NEPSY: Design Fluency	5 to 12 years
Ruff Figural Fluency Test	16 to 70 years
Verbal:	
D-KEFS: Verbal Fluency (Conditions 1 & 2)	8 to 89 years
NEPSY: Verbal Fluency test	3 to 12 years
WJIII-COG: Retrieval Fluency	2 to 80+ years
Measures of Selective/Focused Attention	
These tests are reviewed in Chapter 5, Attentional Processes.	See text
Measures of Sustained Attention	
These tests are reviewed in Chapter 5, Attentional Processes.	See text
Measures of the Use of Feedback in Task Performance	
Category Tests	See text
Wisconsin Card Sorting Test	6.5 to 89 years
D-KEFS: Twenty Questions	8 to 89 years
WJIII-COG:	2 to 80+ years
Analysis-Synthesis	
Concept Formation	
Visual-Auditory Learning	
Measures of Working Memory	
These tests are reviewed in Chapter 9, Memory and Learning.	See text

It is important to note that traditional intelligence tests do not measure executive functioning skills. In fact, the examiner often provides a *surrogate* executive functioning role during the evaluation by telling the child what to do when, allocating enough time to complete each task, reinforcing sustained effort, and assisting the child to refocus his or her attention when distracted. Still, there are certain components within intelligence test batteries that attempt to tease out various aspects of executive functioning skills (e.g., measures of planning, reasoning, concept generation).

Measures of Concept Formation

The D-KEFS: Card Sort Test is a complex task that measures multiple cognitive processes, including: verbal and nonverbal concept formation, conceptual reasoning, initiation fluency, cognitive flexibility, and ability to maintain cognitive set (Delis, Kaplan, & Kramer, 2001). The D-KEFS: Card Sort Test includes three conditions (free sort, free sort description, and recognition) with two card sets. In the Free Sort Condition, the child is asked to sort cards into two sets of three cards each so that all the cards in the set match the sorting principle. In the Free Sort Description Condition, the child must explain how he or she sorted the cards after the free sort condition. In the Recognition Sort Condition, the child must describe the principle used by the examiner to sort the cards into groups. The test allows for the differentiation of the ability to form basic conceptual sorts nonverbally and the ability to verbally describe those sorts. The test is not too difficult to administer, but the scoring and interpretation poses a challenge. The scoring generates a variety of qualitative measures that includes: indicators of perseveration or failure to maintain cognitive sets, tendency to produce verbal or perceptual sort descriptions, and error pattern analyses.

Measures of Inhibition

Disinhibition is a hallmark clinical feature of several frontal lobe disorders including ADHD. Behaviorally, the ability to not respond to distracter stimuli while focusing on target stimuli is, in part, measuring inhibition. Levin, Song, Ewing-Cobbs, and Robertson (2001) found that efficiency of inhibition is negatively impacted by orbitofrontal, inferior frontal, and gyrus rectus lesions. Examples of neuropsychological tests that measure inhibition are reviewed in the following section.

Go/No-Go Tests

Go/no-go tasks assess the ability to inhibit one's response after a particular response set has been established (Loring, 1999). Luria (1980) popularized the use of reciprocal motor movement tasks, that is a go/no-go type of task. An example of a go/no-go task would be if the examiner instructs the child to raise his or her right hand every time the examiner knocks once, and to raise his or her left hand every time the examiner knocks twice. Once the response pattern is learned, the examiner changes the rules and asks the child to do nothing when two knocks are heard, but continue to raise the right hand when one knock is heard. In this example of a go/no-go task, the ability to inhibit raising the left hand when the examiner knocks twice is the core measure of the task. Neuroimaging studies have shown that the frontal regions of the brain, particularly the orbitofrontal region, help regulate go/no-go performance, or inhibitory control (Casey et al., 1997; Fuster, 1989; Kawashima, Satoh, Itoh, Yanagisawa, & Fukuda, 1996).

The Knock and Tap subtest on the NEPSY (Korkman, Kirk, & Kemp, 1998) is an example of a go/no-go task. On the first part of this test, the examiner demonstrates a knock on a table with a clenched fist or a tap on the table with an open palm. The child is instructed to perform the opposite action: knock with fist (examiner)–tap with palm (child), and vice versa. The rule for the first part of the test is: when the examiner knocks, the child taps. On the second part of the test, the child is instructed to hold his or her fist on the table stationary when the examiner knocks, and to knock his or her hand on the table when the examiner places his or her fist on the table in a stationary position. The rule for the second part of the test is: when the examiner taps, the child does nothing. This test "assesses self-regulation and the ability to inhibit immediate impulses evoked by visual stimuli that conflict with verbal direction" (Korkman, Kirk, & Kemp, 1998, p. 246). In addition, working memory and maintaining cognitive set is needed to attain optimum performance as well.

Another example of a go/no-go type of test is the TEA-CH: Walk Don't Run test (Manly, Robertson, Anderson, & Nimmo-Smith, 1999). This test was reviewed in Chapter 5, Attentional Processes.

Motor Impersistence Tasks

The Statue subtest on the NEPSY (Korman, Kirk, & Kemp, 1998) is a motor impersistence test. On this test, the child is asked to stand still with eyes closed for 75 seconds. The examiner makes several distracting auditory noises to see if the child will be distracted. This test "assesses the child's ability to sustain a position (motor persistence) over a 75-second period and to inhibit the impulse to respond to auditory distracters" (Korkman, Kirk, & Kemp, 1998, p. 246).

Tests with Auditory or Visual Distracters

Several neuropsychological tests measure inhibition by including auditory or visual distracters as part of the task (e.g., Stroop Color-Word Test, WJIII-COG: Pair Cancellations test). For example, on the Auditory Attention and Response Set subtest from the NEPSY/NEPSY-II, the child is asked to focus his or her attention on a target word (red) while ignoring all of the other words. Inhibiting a response to the other distracter words is an important neurocognitive requirement of the task. The number of commission errors that the child makes on the task quantifies inhibition. The Visual Attention subtest from the NEPSY/NEPSY-II also records commission errors based on visual distracters.

Measures of Motor Programming

The frontal lobes play an important role in regulating motor behaviors. The motor areas in the frontal lobes include: the primary motor strip and the secondary motor areas (help regulate body movements and eye movements). The secondary motor area is divided into the premotor area (on the lateral side of the brain) and the supplemental motor area (on the medial [middle] side of the brain). The premotor cortex is activated when learning new motor sequences while the supplemental motor area is activated when the brain is engaged in previously learned motor routines (Jenkins, Brooks, Nixon, Frackowiak, & Passingham, 1994). Neuropsychological tests such as fingertip tapping tests (Dean & Woodcock, 2003b; Korkman, Kirk, & Kemp, 1998) or manual imitation tests (e.g., NEPSY: Manual Motor Sequences: Korkman, Kirk, & Kemp, 1998) seem to measure premotor cortex functions.

Measures of Planning, Reasoning, and Cognitive Flexibility

Measures of planning, reasoning, and problem solving have long been associated with executive functions. Most of the tests previously mentioned in this section require planning and reasoning skills, such as the tower tests, trail-making tests, and the set-shifting tests. This section will review some additional measures that have tried to isolate the planning, reasoning, and problem-solving skills.

Category Tests

Category tests have been described as measures of concept generation, mental shifting, rule learning, and problem solving (Baron, 2004). The commonly held belief that the Category Test is a direct measure of frontal lobe functioning has produced mixed results in the literature (Anderson, Damasio, Jones, & Tranel, 1991; Chase-Carmichael, Ris, Weber, & Schefft, 1999; Heaton, Chelune, Talley, Kay, & Curtiss, 1993; Levin, et al., 1997). The Reitan-Indiana Neuropsychological Test Battery (Reitan & Wolfson, 1985) has a Category Test based on 80 items and is for use with children ages 5 to 8. The Halstead-Reitan Neuropsychological Test Battery for Older Children (Reitan & Davidson, 1974; Reitan & Wolfson, 1992) has a Category Test based on 168 items and is for use with children ages 9 to 15. For both of these versions of the test, the test items are presented in slides using a carousel projector and a projection box with a built-in buzzer and bell. The task requires the child to look at a slide and categorize that slide into one of four categories based on some property of the stimulus. For example, for older children the slide may be the number 1, so the child would press the lever marked 1. The younger children's version uses color categories instead on numbers. If the child's response was correct, a bell sounded. If the child's response was incorrect, a buzzer sounded. By having the auditory feedback after each trial indicating whether this was a correct or incorrect response, this task became an active learning task as well.

Some practitioners are still using the original apparatus for the Category Test, yet there are alternatives that produce near-equivalent results and yield additional qualitative data for clinical interpretation. Portable versions of the Category Test have been developed including: the Booklet Category Test (DeFilippis & McCampbell, 1979; DeFilippis, McCampbell, & Rogers, 1979), and the Children's Category Test (Boll, 1993). Mercer, Harrell, Miller, and Rockers (1997) reported that there was no significant difference between the traditional Halstead-Reitan version of the Category Test and the Booklet Category Test, and a computerized version of the Category Test (Miller, 1993) in a sample of normal adults and adults with traumatic brain injuries. See Baron (2004) for a detailed review of the versions of the Category Tests.

The Wisconsin Card Sorting Test (WCST; Heaton, 1981) was originally developed as a measure of cognitive flexibility. The WCST is generally recognized to measure concept generation, response inhibition, ability to maintain a cognitive set, ability to shift cognitive sets, attribute identification, abstract reasoning, hypothesis testing, problem-solving, indicators of perseverative response styles, and sustained attention (Baron, 2004). Chelune and Baer (1986) were the first to provide normative data for children using the WCST (see Baron, 2004 for those norms). Similar to the Category Test, there are alternative booklet forms that are available (e.g., Wisconsin Card Sorting Test–64 [WCST-64]; Kongs, Thompson, Iverson, & Heaton, 2000) and computerized versions for both the WCST and the WCST-64 (Heaton, 1999; 2000). See Baron (2004) for an extensive review of the WCST literature related to children and for a set of WCST norms for children and adolescents.

Tower Tests

There are multiple versions of the Tower Test that all purport to measure executive functions ranging from working memory, planning, behavioral inhibition, and rule application (Baron, 2004). The Tower Test versions are reviewed in Baron (2004) and include: Tower of Hanoi test (Simon, 1975), Tower of London (Shallice, 1982), Tower of London–Drexel University (Culbertson & Zillmer, 2000), NEPSY Tower (Korkman, Kirk, & Kemp, 1998), and the D-KEFS Tower Test (Delis, Kaplan, & Kramer, 2001).

The Tower of Hanoi test "requires the child to place five disks of different sizes onto one of three equally sized posts from a prearranged configuration" (Baron, 2004, p. 155). The child must follow a prescriptive set of rules such as a larger disk cannot be placed on top of a smaller disk, only one disk can be moved at a time, and so on. The other Tower tests require the child to move balls on pegs to match a picture showing the final solution. On some versions of the test, the child is told how many moves to make to complete the task and other versions do not set a minimum number of moves. Scoring varies widely across the versions of the Tower tests. Baron (2004) reviewed the studies that used these Tower tests with different populations of children and the results indicated that the tests might not be interchangeable due to subtle differences in the respective neurocognitive demands.

The D-KEFS Tower test version does add some process-oriented scores to the task. The examiner keeps track of how long the child takes to produce the first move, and calculates the time-per-move ratio, move accuracy ratio, total number of rule violations, and rule violations per item ratio. These additional process-oriented measures give the examiner additional insight into the child's ability to maintain his or her cognitive sets, the child's reflective or impulsive response style, and the child's level of processing speed.

Trail-Making Tests

The Trail Making Test (TMT) has its roots in the 1940s but became widely known when it was incorporated into the Halstead-Reitan Neuropsychological Test Batteries (Reitan, 1955; Reitan & Davidson, 1974; Reitan & Wolfson, 1985; Reitan & Wolfson, 1992; Reitan & Wolfson, 1993). The Halstead-Reitan Trail-Making Test (HR-TMT) has two parts: (a) number sequencing and (b) number-letter sequencing (e.g., 1-A-2-B-3-C . . .). The TMT is widely used by practitioners because it is sensitive to overall brain dysfunction; however, it does not reliably localize brain dysfunction. The TMT test is thought to measure alternating and sustained visual attention, sequencing, psychomotor speed, cognitive flexibility, and inhibition-disinhibition. Several versions of the TMT have been developed for children including the Children's Color Trails Test for ages 8 to 16 (Llorente, Williams, Satz, & D'Elia, 1996); the Planned Connections subtest on the Das-Naglieri Cognitive Assessment System (Naglieri & Das,1997); the Comprehensive Trail-Making Test for ages 11 to 74 (Reynolds, 2002); and the D-KEFS Trail-Making test (Delis, Kaplan, & Kramer, 2001).

One of the limitations of traditional versions of the TMT mentioned previously is that poor performance may be attributable to a variety of neurocognitive factors, including: slow processing speed, poor psychomotor speed, poor fine motor coordination, poor visual scanning, or impairment in number or letter sequencing (Baron, 2004). The D-KEFS version of the Trail Making Test (D-KEFS-TMT; Delis, Kaplan, & Kramer, 2001) sought to address some of these interpretative limitations by having five conditions.

Condition 1–Visual Scanning—the child is asked to find all of the number 3s on the page as quickly as possible.

Condition 2–Number Sequencing—the child is asked to connect the circles with the numbers in them in sequential order (e.g., 1, 2, 3, 4 . . .). This condition is similar to the HR:TMT–Part A.

Condition 3–Letter Sequencing—the child is asked to connect the circles with the letters in them in sequential order (e.g., A, B, C, D . . .).

Condition 4–Number-Letter Sequencing—is the traditional number-letter sequencing similar to HR:TMT–Part B.

Condition 5–Motor Speed—the child is asked to trace over the dotted lines that already connect the dots as quickly as possible.

On the D-KEFS-TMT, when a child performs poorly on the Number-Letter Sequencing trial (Condition 4), the child's performance may be explained by one or more underlying impairments measured by conditions 1, 2, 3, or 5. For example, poor performance on the Number-Letter Sequencing trial could be due to poor motor speed and that shows up on Condition 5. The D-KEFS-TMT scoring generates contrast scores that indicate how much of the Conditions 1, 2, 3, 2+3, and 5 contribute to the overall performance on Condition 4. The scoring also generates optional error scores such as omission and commission errors for Condition 1—Visual Scanning; sequencing errors, set-loss errors, and time-discontinue errors for Conditions 2, 3, and 4; and time-discontinue errors for Condition 5—Motor Speed.

Other Measures of Planning, Reasoning, and Problem Solving

Visual-spatial planning and reasoning may be measured by tests that require the child to find efficient routes through mazes (e.g., KABC-II: Pattern Reasoning, Rover, Story Completion tests: Kaufman & Kaufman, 2004; NEPSY Route Finding tests: Korkman, Kirk, & Kemp, 1998; Porteus Maze Test: Krikorian & Bartok, 1998; WISC-IV Integrated Elithorn Mazes: Wechsler, 2004a). Note that these measures involve additional processes beyond planning and reasoning such as motor output as visual-spatial analysis. Visual perceptual reasoning may also be assessed by the KABC-II: Conceptual Thinking and Triangles tests, the NEPSY Block Construction test, and several WISC-IV subtests including: Block Design, Picture Completion, Picture Concepts, and Matrix Reasoning (Wechsler, 2003).

The D-KEFS (Delis, Kaplan, & Kramer, 2001) has several tests that measure verbal reasoning and problem-solving skills. The D-KEFS: Word Context test requires intact verbal reasoning abilities to assess higher-order executive functions, including: receptive and expressive language, deductive reasoning, hypothesis testing, ability to integrate multiple bits of information, and mental flexibility. The child is presented with a verbal statement followed by a verbal question such as "Most people *chinga* once a day. What might *chinga* mean?" The child takes a guess at the right answer and then keeps getting more statements that give better clues to what the word *chinga* might mean.

The D-KEFS: Twenty Questions test requires the child to ask the fewest number of yes/no questions possible in order to identify an unknown target object selected by the examiner from a visual array of objects. This test measures the child's problem-solving skills by evaluating the efficiency of eliminating the most objects with a question (e.g., is it an animal?). Several optional measures help the clinician to interpret the results, including: the number of spatial questions (e.g., is it in the top row?), number of repeated questions (sign of perseveration or memory problem), and number of set-loss errors (failure to maintain cognitive set or failure to comprehend instructions). The test measures multiple processes, including: ability to categorize objects into subgroups based on salient features, abstract reasoning, use verbal feedback to alter problem-solving behavior, perseveration, stimulus-bound behavior, attention problems, and memory problems (Delis, Kaplan, & Kramer, 2001).

The D-KEFS: Proverbs test is only administered to adolescents (16 and older) and adults. The test requires intact language skills and involves two conditions (free inquiry and recognition trial). The test is a measure of abstract reasoning. On the free inquiry condition, a proverb (e.g., *a rolling stone gathers no moss*) is read by the examiner and the student is asked to interpret it. In the recognition trial, the same proverbs are presented again in written format with four interpretative statements. The student is asked to choose the one interpretative statement that best describes the meaning of the proverb. The D-KEFS: Proverbs test and the Similarities test from the WISC-IV (Wechsler, 2003) both require inductive, verbal reasoning skills (Delis, Kaplan, & Kramer, 2001). The two tests differ in that the Similarities test requires reasoned associations between two words, while the D-KEFS: Proverbs test requires associated reasoning across multiple words.

The KABC-II (Kaufman & Kaufman, 2004) also contains two subtests that are designed to measure inductive reasoning: Pattern Reasoning and Story Completion. On the Pattern Reasoning subtest, the child is shown a series of either abstract or meaningful stimuli that form a logical, linear pattern; however, one stimuli is missing in the pattern. The child is asked to complete the pattern by selecting the correct stimuli from a set of four to six options. On the Story Completion subtest, the examiner shows the child a row of pictures that tells a story, but some of the pictures are missing. The child is handed a set of possible pictures and asked to choose the one that best completes the story.

The Stanford-Binet Intelligence Scale, Fifth Edition (SB5; Roid, 2003) contains nonverbal and verbal fluid reasoning tasks. The nonverbal fluid reasoning tasks range from an easier object-series task to a more difficult matrices task. The Object Series subtest measures the child's ability to identify shapes and to use color, size, and shape concepts to identify sequences and patterns. The Matrices test requires the child to use inductive reasoning to solve visual analogy problems. The verbal fluid reasoning tasks starts with an early reasoning task in which the child must identify cause and effect relationships or interactions going on between objects in visual pictures. The next level of difficulty for the verbal fluid reasoning tasks is the Verbal Absurdities test in which the child must identify the nature of the verbal absurdity. The most difficult portion of the verbal fluid reasoning tasks is the verbal analogies section in which the child must solve a series of verbal analogies.

The Universal Nonverbal Intelligence Test (Bracken & McCallum, 1998) contains both symbolic and nonsymbolic nonverbal reasoning tasks. The Analogic Reasoning test is a symbolic nonverbal matrix analogies test in which the child completes the analogies by pointing to one of four responses. Cube Design is a nonsymbolic, nonverbal reasoning task in which the child is asked to construct a block design while viewing the stimulus design. Mazes is also a nonsymbolic, nonverbal reasoning task. On the Mazes test, the child uses paper and pencil to navigate and exit mazes.

The WJIII COG (Woodcock, McGrew, & Mather, 2001a) includes several measures of executive functioning. The Executive Processes Cluster was designed to measure processes such as cognitive flexibility, planning, and response inhibition (Schrank & Flanagan, 2003). The Executive Processes Cluster is composed of the Concept Formation (concept shifting), Planning (planning), and Pair Cancellations (sustained attention) tests.

Set-Shifting Tests

The Stroop Color Word Test (SCWT) measures several cognitive processes, including: focused/selective attention, the ability to shift one's cognitive set, and the ability to inhibit automatic responses. The SCWT is based on the so-called "Stroop Effect" (Stroop, 1935), in which an individual often has difficulty when asked to name the color of the ink that a color word (e.g., blue) is written in. Typically the time required to read color words is less than the time required to read the color of the printed word.

There are multiple versions of the Stroop Test (see Baron, 2004 for a review). One modified Stroop version is the NEPSY Auditory Attention and Response

Set test (Part B) in which the child listens to a tape recording of an examiner naming words one at a time. The child is instructed to place a yellow chip into a box each time he or she hears the word *red,* and conversely put a red chip in a box when he or she hears the word *yellow.* This task requires multiple cognitive processes including the ability to shift one's cognitive set. Another modified Stroop version is the Expressive Attention subtest within the Das-Naglieri Cognitive Assessment System (Naglieri & Das, 1997). The Contingency Naming Test (CNS; Taylor, 1988) is a modified Stroop version that does not require reading skills. Normative data for the CNS are published in Baron (2004). A traditional Stroop Color and Word Test (Golden & Freshwater, 2002) is commercially available and has supplemental norms for children ages 5 to 14.

Baron (2004) noted that the construct validity of the Stroop is confounded because of the neurocognitive demands inherent in the task. For example, the task requires naming ability, basic reading skills, color discrimination skills, selective visual attention, response inhibition, response shifting, and sustained attention (Baron, 2004). The D-KEFS: Color-Word Interference Test (Delis, Kaplan, & Kramer, 2001) attempted to parcel out the influences of these multiple task demands to help the clinician interpret the Stroop results more precisely.

The D-KEFS: Color-Word Interference Test (Delis, Kaplan, & Kramer, 2001) has the traditional part of the test (Condition 3) that requires the student to name the color of the printed word rather than name the color word (e.g., red). This test also incorporates three other conditions. In Condition 1, the student is asked to identify a page of color patches and the time is recorded. In Condition 2, the student is asked to read a page of color words printed in black ink and the time is recorded. Condition 3 is the traditional Stroop Effect trial. The addition of Conditions 1 and 2 allow the examiner to determine if poor performance on Condition 3 may be caused by poor color naming, poor reading skills, or a combination or both. In Condition 4, the student starts out by reading the color of the printed word, but is then periodically asked to switch to naming the color word. The added set-shifting trial is a useful measure of response inhibition. The D-KEFS incorporated set shifting into several of the tests including: Trail-Making (Condition 4), Verbal Fluency (Condition 3), and Design Fluency (Condition 3).

Measures of Retrieval Fluency

Nonverbal Retrieval Fluency

Baron (2004) noted that the design fluency tasks are similar to the verbal fluency tasks in that they require executive functions of initiation, shifting attention, self-regulation, and self-monitoring. One of the major differences between the design fluency and the verbal fluency tasks is that the verbal fluency task requires the generation of stored words, whereas the designs generated do not come from memory. Examples of design fluency tests include the D-KEFS Design Fluency test (D-KEFS:DF; Delis, Kaplan, & Kramer, 2001); the NEPSY Design Fluency test (Korkman, Kirk, & Kemp, 1998); and the Ruff Figural Fluency Test (RFFT; Ruff, 1988).

The D-KEFS:DF has three conditions. On Condition 1, the child is shown sets of domino dots with five dots within each frame. The child is instructed to create a pattern connecting the filled dots with a different design in each frame, using only four straight lines to connect the dots, and making sure that each line touches at least one other line at a dot. This condition measures nonverbal productivity and creativity, and visual-perceptual speed (Delis, Kaplan, & Kramer, 2001). Condition 2 is similar to Condition 1, but on this task the child connects the empty dots following the same rules. In Condition 2, each frame contains filled and empty dots and the child is instructed to ignore the filled dots. This task assesses aspects of nonverbal productivity and creativity, visual-perceptual speed, and the ability to ignore extraneous stimuli (Delis, Kaplan, & Kramer, 2001). Finally, in Condition 3, the child is shown a series of frames that each contains filled and empty dots. The child is asked to alternate or shift connecting the filled dots to the empty dots following the same rules. Condition 3 adds a measure of cognitive flexibility or set shifting to the neurocognitive demands of the prior conditions (Delis, Kaplan, & Kramer, 2001).

The scoring includes the tallying of the total correct patterns produced in each condition and across conditions. The scoring also produces a combined score for design fluency across the filled and empty dot conditions and a contrast score comparing the switching condition (Condition 3) with the nonswitching conditions. The scoring also generates optional error scores such as the total number of set designs, total number of repeated designs, the total number of attempted designs, and the total percent design accuracy.

It is suggested that the D-KEFS:VF and D-KEFS:DF tests be administered together to compare the verbal versus the nonverbal problem-solving skills, ability to maintain cognitive sets, and the ability to inhibit and shift sets.

Verbal Retrieval Fluency

Verbal fluency measures have been integrated into neuropsychological and cognitive test batteries (e.g., Multilingual Aphasia Examination: Controlled Oral Word Association Test: Benton, Hamsher, & Sivan, 1994; NEPSY Verbal Fluency test: Korkman, Kirk, & Kemp, 1998; WJIII COG: Retrieval Fluency test: Woodcock, McGrew, & Mather, 2001a). Generally these tests include a measure of letter fluency that requires a student to generate a list of words that all start with the same letter, and semantic fluency that requires a student to generate a list of words that all belong to the same semantic category (e.g., fruit). Verbal fluency tests measure speeded lexical production and the degree of automatic lexical access or retrieval.

One of the limitations of the NEPSY and WJIII COG versions of verbal fluency tests is not keeping track of the child's responses based on the time limits. For example, a child that took 20 seconds to produce the first word, but then achieved an overall average score is qualitatively different from a child that achieved the same overall score but produced all of the responses in the first 15 seconds. The D-KEFS Verbal Fluency test (D-KEFS:VF; Delis, Kaplan, & Kramer, 2001) addressed that interpretative issue by tracking the number of words generated in 15-second increments. This feature of the test is particularly useful as a diagnostic indicator of slow processing speed or poor initiation behaviors. The D-KEFS:VF test has three conditions: (1) Letter Fluency, (2) Category (semantic) Fluency, and (3) Category Switching Fluency. The third condition is novel, in that it requires the child to recall and name words that start with a particular letter, then upon command switch to naming words that belong to a particular semantic category. The third condition of the D-KEFS:VF test requires cognitive flexibility and set shifting, two neurocognitive processes associated with frontal lobe executive functioning. The scoring also generates optional error scores such as set loss errors and repetition errors that can help interpret poor performance on the test.

Overall, the D-KEFS:VF test measures speeded lexical production and the degree of automatic lexical access. Baron (2004) noted that performance on verbal fluency tasks are not independent of intelligence or vocabulary and that the tasks do involve components of working memory, the ability to self-monitor, initiate, shift cognitive sets, and inhibit rule violations.

Measures of Selective/Focused and Sustained Attention

The tests that measure selective/focused attention and sustained attention were reviewed in Chapter 6. These tests are also included here in the Executive Functions Chapter because of their relationship to frontal lobe functioning. Damage or dysfunction in the prefrontal regions of the brain have been associated with attentional dysfunction (see Chapter 6 for a review).

Measures that Use Feedback During Task Performance

Being able to modify one's performance based on feedback during learning has some regulatory components that are controlled by the frontal lobes. The tests that measure the use of feedback during task performance generally fall under the category of active learning. Tests such as the Category Test and the WCST are active-learning tasks. The child must learn to modify his or her cognitive sets based on the feedback of the examiner during the task performance. Other tests that require the use of feedback during the performance of a test include: the D-KEFS: Twenty Questions, WJIII-COG: Analysis-Synthesis, Concept Formation, and Visual-Auditory Learning tests. These tests are covered in other parts of the book. The D-KEFS tests were reviewed earlier in this chapter while the WJIII-COG tests are reviewed in Chapter 12.

Measures of Working Memory

The tests that measure working memory are reviewed in Chapter 9, Memory and Learning. The measures of working memory are also listed here in the executive functions section in recognition of the important role of the prefrontal cortex in working memory. Jonides and colleagues (2000) found that there were functional changes in the prefrontal cortex in adult subjects with poor working memory. Neuroimaging studies have shown that the prefrontal cortex is activated during verbal working memory (Awh et al., 1996) and nonverbal working memory (Jonides et al., 1993).

Summary of Behavioral Measure of Executive Functions

The proceeding section of this chapter has reviewed the common behavioral tests for measuring executive functioning. The tests of executive functions were categorized into measures of concept generation, inhibition, motor programming, planning, reasoning, set shifting, retrieval fluency, selective/focused and sustained attention, use of feedback in task performance, and working memory. The next section of this chapter will review an indirect method of gathering information about a child's executive functioning, through behavioral rating scales.

Questionnaires for Executive Functions

The Behavior Rating Inventory of Executive Function (BRIEF) Scale is an indirect method of gathering information about a child's executive functioning (see Rapid Reference 10.8). The BRIEF tests use a questionnaire format that

Rapid Reference 10.8

The Behavior Rating Inventory of Executive Function

	BRIEF		BRIEF-P			BRIEF-SR	
	5–18 years		2–5-11 years			11–18 years	
Raters	**Parent or Teacher**		**Parent, teacher, or day care provider**			**Adolescent Self Report**	
Behavioral Regulation Scale	•	•				•	•
Flexibility Scale			•				
Inhibitory Self-Control				•			
Inhibit	•			•	•	•	
Shift	•		•		•	•	
Emotional Control	•		•	•	•	•	
Metacognition Scale	•	•				•	•
Emergent Metacognition Scale			•				
Initiate	•						
Working Memory	•		•		•	•	
Plan/Organize	•		•		•	•	
Organization of Materials	•						
Monitor	•					•	
Task Completion						•	
Global Executive Composite		•			•		•
Validity Scales							
Negativity Scale	•		•			•	
Inconsistency Scale	•		•			•	

is completed by parents, teachers, day care providers, or the adolescent, based on the version of the test. The BRIEF instrument is published in several versions including: the BRIEF (Gioia, Isquith, Guy, & Kenworthy, 2000) designed for children ages 5 to 18 years; the BRIEF-Preschool Version (Gioia, Espy, & Isquith, 2003) designed for preschool aged children 2 to 5–11 years; and the BRIEF–Self-Report Version (Gioia, Espy, & Isquith, 2004) designed for adolescents ages 11 to 18 years.

The BRIEF version of the test has two empirically validated factor scales: the Behavioral Regulation Index and the Metacognition Index. Rapid Reference 10.8 shows the BRIEF factor scales and the subtests that load on them for each of the versions of the test. The Behavioral Regulation Index "represents a child's ability to shift cognitive set and modulate emotions and behavior via appropriate inhibitory control" (Gioia, Isquith, Guy, & Kenworthy, 2000, p. 20). The Behavioral Regulation Index is a factor score for both the BRIEF and BRIEF-SR versions. For the Preschool Version of the test, the Behavioral Regulation Index spilt into two factors labeled the Flexibility Scale and the Inhibitory Self-Control Scale.

The Metacognition Index "represents the child's ability to initiate, plan, organize, and sustain future-oriented problem-solving in working memory" (Gioia, Isquith, Guy, & Kenworthy, 2000, p. 20). The Metacognition Index is a factor score for both the BRIEF and BRIEF-SP versions of the test, although subtests used to derive each of the indices differed between versions. The BRIEF-P had a slightly different factor structure that was labeled the Emerging Metacognition Scale.

Each version of the BRIEF has two validity scales: negativity and inconsistency. "The Negativity scale measures the extent to which the respondent answers selected BRIEF items in an unusually negative manner relative to the clinical samples" (Gioia, Isquith, Guy, & Kenworthy, 2000, p. 14). The BRIEF Scales are a welcome addition to the school neuropsychologist's list of assessment resources. The BRIEF should be viewed as a screener for executive functions in children and youth and not as a replacement for direct measures. An external rater's assessment of a child's executive functioning may or may not be equivalent to actual behavioral samples of the child's executive functioning.

In this chapter, the terminology, neuroanatomy, major behavioral tests, and rating scales associated with executive functioning were reviewed. Executive functions play a major role in regulating purposeful behavior and should be systematically assessed by a school neuropsychologist. Executive dysfunctions are observed in many common developmental disorders. As an example in Chapter 16, the school neuropsychological conceptual assessment model will be used to review the presence of executive functioning deficits in autism-spectrum disorders.

TEST YOURSELF

1. **All of the following terms are associated with executive functions except which one?**
   (a) Tactile perception
   (b) Self-monitoring
   (c) Planning
   (d) Abstract reasoning
2. **Which one of the following frontal-subcortical circuits is not involved with the regulation of behavior?**
   (a) Dorsolateral prefrontal circuit
   (b) Oculomotor circuit
   (c) Orbitofrontal circuit
   (d) Anterior cingulate circuit
3. **Which of the frontal-subcortical circuits helps regulate socially appropriate behaviors under normal circumstances?**
   (a) Oculomotor circuit
   (b) Anterior cingulate circuit
   (c) Dorsolateral circuit
   (d) Orbitofrontal circuit
4. **Damage to this frontal-subcortical circuit can cause decreased retrieval fluency, poor organizational skills, poor planning, impaired set shifting, and so on. What frontal-subcortical circuit seems to be impaired?**
   (a) Orbitofrontal circuit
   (b) Anterior cingulate circuit
   (c) Dorsolateral circuit
   (d) Oculomotor circuit
5. **Phineas Gage was a railroad worker who sustained a head injury to his orbitofrontal region of the brain.** True or False?
6. **A tendency to repeat the same response over and over again, even when shown it to be inappropriate, is referred to as:**
   (a) initiation deficit
   (b) perseveration
   (c) utilization behavior
   (d) echopraxia
7. **The Wisconsin Card Sorting Test is typically associated with measuring retrieval fluency.** True or False?

(continued)

8. Which of the following tests measures a child's executive functioning using a rating scale completed by either the parent or teacher?

(a) D-FEKS
(b) WCST
(c) BRIEF
(d) Stroop Color-Word Test

Answers: 1. a; 2. b; 3. d; 4. c; 5. true; 6. b; 7. false; 8. c

Eleven

SPEED AND EFFICIENCY OF COGNITIVE PROCESSING

Several terms have been used to describe speed of information processing including: processing speed, cognitive efficiency, and cognitive fluency. Speed of information processing constructs are not as clearly defined and agreed upon by researchers as the other cognitive processes that have already been discussed in previous chapters. This chapter will review the definitions of the speed of information processing constructs, present the theoretical neuroanatomical bases for the constructs, and review the common tests used to assess these constructs.

DEFINITIONS

Processing Speed Definition

Juan's teachers are always prompting him to get his work turned in on time. Juan is generally accurate in his seatwork but it takes him longer than his classmates to complete assignments. Juan also has trouble with the rate of his reading. He often takes so long to read a passage that by the time he gets to the end, he has forgotten what he has read. Juan is experiencing problems with processing speed and cognitive fluency.

Processing Speed measures have been explicitly included in two of the mainstream tests of intelligence since the late 1980s (Wechsler Intelligence Scale for Children–Third Edition [WISC-III]: Wechsler, 1991; Woodcock-Johnson Revised Tests of Cognitive Ability [WJ-R COG]: Woodcock & Johnson, 1989). The processing speed construct has remained in the updated versions of each test as well (WISC-IV: Wechsler, 2003; WJIII-COG: Woodcock, McGrew, & Mather, 2001a).

Following the Cattell-Horn-Carrol (CHC) model, a processing speed measure (*Gs*) is defined as a test that "measures the speed with which an individual performs simple cognitive tasks" (Schrank & Flanagan, 2003, pp. 28–29). The tasks used to measure processing speed typically are timed on a fixed interval and require little in the way of complex thinking or cognitive processing. Processing Speed may be best conceptualized as a broad construct with several specific or narrow abilities based on item content contained within (Carroll, 1993). Another way of stating this is that not all processing speed tests measure the same construct (Feldmann, Kelly, & Diehl, 2004; Floyd, Evans, & McGrew, 2003), which has lead to some interpretation confusion for practitioners. Motor speed (a.k.a., psychomotor skill, graphomotor speed, or paper-and-pencil skill) and number facility (skill in dealing with numbers ranging from number recognition and counting, to simple mathematical computations) have been hypothesized to be contributors to an individual's performance on processing speed measures (Feldmann et al., 2004; Floyd et al., 2003).

Feldman and colleagues (2004) examined the relationship between five measures of processing speed: (1) WISC-III Coding, (2) WISC-III Symbol Search, (3) WJR Visual Matching, (4) WJR Cross Out, and (5) Differential Ability Scale's (Elliott, 1990) Speed of Information Processing. Feldmann and colleagues found that Motor Speed accounted for small (7–17 percent) but significant amounts of variance on all five processing speed tests. Number Facility was found to account for 14 percent of the variance for the WJR Visual Matching and the DAS Speed of Information Processing tests and 8 percent of the variance for the WISC-III Symbol Search subtest.

As children develop, they process information more rapidly (Kail & Miller, 2006). Processing speed deficits have been found in clinical populations of children, including ADHD (e.g., Fuggetta, 2006); youth diagnosed as having Bipolar Disorder (Doyle et al., 2005); children exposed prenatally to alcohol (e.g., Burden, Jacobson, & Jacobson, 2005); and children with reading disabilities (Willcutt, Pennington, Olson, Chhabildas, & Hulslander, 2005).

Cognitive Efficiency Definition

Cognitive efficiency is one of the three broad cognitive abilities reported on the WJIII-COG (Woodcock, McGrew, & Mather, 2001a). Currently, cognitive efficiency only appears as a stand-alone construct on the WJIII-COG and is based on logical but not empirical classification of CHC abilities (Woodcock, McGrew, & Mather, 2001b). *Cognitive Efficiency* is a compilation of two different automatic cognitive processes: processing speed and short-term memory (Schrank, Flanagan, Woodcock, & Mascolo, 2002); see Figure 11.1. Tasks that require cognitive efficiency are needed for complex cognitive functioning. Fry and Hale (1996) found that cognitive efficiency was a good predictor for most areas of

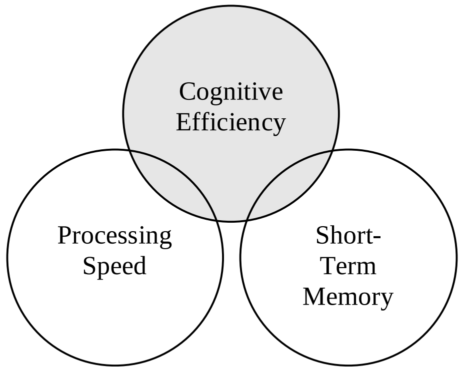


Figure 11.1. The theoretical construct of cognitive efficiency is composed of two automatic cognitive processes: processing speed and short-term memory

early learning, particularly reading fluency. Cognitive efficiency scores from the WJIII-COG must be interpreted taking into consideration the contributions of the processing speed measures (measuring both Motor Speed and Number Facility components) as well as performance on the (auditory) short-term memory measures (measuring auditory short-term memory, working memory, and attentional capacity). The school neuropsychologist should interpret the cognitive efficiency construct cautiously until further research has been conducted.

Cognitive Fluency Definition

When the WJIII-COG was restandardized in 2001, the authors developed several clinical cluster scores that reflected advances in reading research as well as new theories in the fields of cognitive psychology and neuropsychology (Schrank & Flanagan, 2003). Cognitive fluency was one of those new clinical clusters included on the WJIII-COG. *Cognitive Fluency* measures the ability to perform simple and complex cognitive tasks quickly and fluently. The *fluency* aspect refers to automaticity, or the ability to develop or use skills so quickly that they become routine and do not require much effort (Schrank & Flanagan, 2003).

Measures of fluency within the language domain generally refer to the speed of lexical access or rapid automatic naming (RAN). RAN has been shown to be a significant predictor of early reading skills (Torgensen, Wagner, Rashotte, Burgess, & Hecht, 1997). The Woodcock-Johnson III Tests of Achievement (Woodcock, McGrew, & Mather, 2001c) included an Academic Fluency clus-

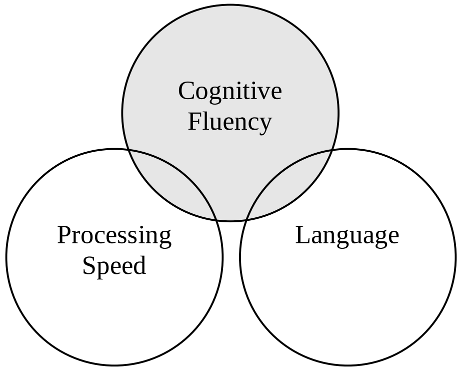


Figure 11.2. The cognitive fluency construct draws from processing speed and the automaticity of language

ter composed of Reading Fluency, Writing Fluency, and Math Fluency. More research is needed to determine the relationship between the cognitive fluency and academic fluency measures on the WJIII tests. However, with the increased emphasis of utilizing curriculum-based measurement as a primary tool to assess reading fluency, school neuropsychologists should be cognizant that processing speed is an important cognitive construct to measure.

In order to interpret cognitive fluency, Carroll's (1993) distinction between factors that represent *level* and those that represent *rate* must be understood. A test of levels becomes increasingly more difficult as the examinee progresses through the test and is thought to reflect ability on the construct being measured. Tests of rate focus on speed of a performance. The tests are constructed in such a manner that most examinees could easily complete the task items correctly if granted enough time to complete the task. As shown in Figure 11.2, cognitive fluency has a conceptual overlap with processing speed and the speed or automaticity of language. Cognitive fluency appears to place greater emphasis on completion speed for complex tasks than do general processing speed measures (Schrank & Flanagan, 2003).

NEUROANATOMY OF SPEED OF INFORMATION PROCESSING

The neuroanatomical bases of processing speed, cognitive efficiency, or cognitive fluency are not fully understood. The neuroanatomy of speed of information processing must have a close relationship with the brain's myelination (Kail, 2000). Myelination is the formation of the myelin sheath around a nerve fiber. Myelin makes up the white matter within the brain. A myelinated pathway within the brain will produce more efficient and faster processing.

Clinical syndromes in children and adults, which adversely affect speed of processing, give us some insight into the brain mechanisms that help regulate efficiency and speed within the brain. Children with head injuries that caused axonal shearing (tearing of the myelin sheath over the axons) show deficits in processing speed and reading fluency (Barnes, Dennis, & Wilkinson, 1999). Adults with demyelinating diseases like Multiple Sclerosis (MS) also demonstrate impairments in processing speed (e.g., Kail, 1997).

Most processing speed tests for younger children involve rapid and automatic naming of colors, numbers, familiar pictures, and letters. This type of visual-verbal learning is often mediated by the ventral stream, a neural pathway connecting the visual centers of the brain in the occipital lobe with the verbal centers of the brain in the temporal lobe. Tests requiring students to rapidly look at a visual stimulus and attach a verbal label are, in essence, measuring the integrity of the ventral stream.

TESTS OF SPEED AND EFFICIENCY OF COGNITIVE PROCESSING

Rapid Reference 11.1 presents a list of common tests of speed and efficiency of cognitive processes for school-aged children. The tests are categorized based on measures of processing speed, measures of cognitive efficiency, and measures of cognitive fluency.

Measures of Processing Speed

Anytime a test requires the examiner to record completion time, processing speed is indirectly being measured. The list of processing speed tests described in the following include subtests from the D-KEFS and NEPSY that record completion time, and the more formalized processing speed index/cluster subtests from the WISC-IV and WJIII-COG, respectively.

Delis-Kaplan Executive Function System (D-KEFS)

The D-KEFS (Delis, Kaplan, & Kramer, 2001) contains several tests in which completion time or time per moves is calculated:

Card Sorting Test: Time-Per-Sort Ratio—The average time that a time used to generate the attempted sorts across both card sets in Condition 1. Slow completion

Rapid Reference 11.1

Tests of Speed and Efficiency of Cognitive Processing

Test	Age Range
Measures of Processing Speed	
D-KEFS: Card Sorting Test: Time-Per-Sort Ratio Color-Word Naming Test: Completion Times Tower: First Move Time & Time-Per-Move Ratio Trail-Making Test: Completion Times Time Discontinue Errors	8 to 89 years
NEPSY:	
Speeded Naming: Completion Time	5 to 12 years
Visual Attention: Completion Time	3 to 12 years
Visuomotor Precision: Completion Time	3 to 12 years
WISC-IV Processing Speed Index: Coding Symbol Search Cancellation	6 to 16-11 years
WJIII-COG: Processing Speed Cluster: Visual Matching Decision Speed Cross Out[a]	2 to 89 years
Measures of Cognitive Efficiency	
WJIII-COG: Cognitive Efficiency Performance Index: Processing Speed Cluster Visual Matching Decision Speed Short-Term Memory Cluster Numbers Reversed Memory for Words	2 to 89 years

Test	Age Range
Measures of Cognitive Fluency	
WJIII-COG: Cognitive Fluency Cluster: Retrieval Fluency Rapid Picture Naming Decision Speed	2 to 89 years

[a] Cross Out is part of the *Woodcock-Johnson III Diagnostic Supplement* (Woodcock, McGrew, Mather, & Schrank, 2003).

times can reflect problems with initiation behaviors or slow processing speed in general.

Color-Word Naming Test: Completion Times—The D-KEFS Color-Word Test has five conditions and completion time is recorded for each condition. Slow processing speed is one of several possible reasons for slow completion time.

Tower: First Move Time and Time-Per-Move Ratio—A low first move time score generally indicates activation problems. Low scores for the time-per-move ratio indicate slow initiation or generalized processing speed weakness.

Trail-Making Test:

- *Completion Times*—There are five conditions on the D-KEFS TMT and completion time is recorded for each condition. The reasons for slow completion times vary based on the conditions, but slow processing speed can be a causal factor to consider. The examiner must look at the student's performance across multiple samples of behavior in order to determine the cause(s) of poor TMT performance.
- *Time Discontinue Errors*—Are scored when the student failed to connect one or more items because the time limit for the trial was reached. A high score could indicate slow processing speed or possibly an obsessive-compulsive response style.

NEPSY (Korkman, Kirk, & Kemp, 1998)

Speeded Naming: Completion Time—Speeded Naming is a test of oral expressive fluency. The student is asked to name the size, color, and shape of objects on a page as quickly as possible. The overall score is based on the number of errors as well as completion time. There is a supplemental score for just the completion time element of the test. A processing speed deficit is one possible reason for slower than normal completion time of this test.

Visual Attention: Completion Time—On the Visual Attention test, the student is asked to locate a target within a visual array and mark it with a pencil. Completion time is one of the scores calculated on the two parts of the test. Slow completion time may be related to speed of cognitive processing deficits.

Visuomotor Precision: Completion Time—This test is designed to assess fine motor speed and accuracy of eye-hand coordination. Completion times on two separate trials are two supplemental scores available for interpretation. Again, slow completion time may be indicative of processing speed weaknesses.

WISC-IV Processing Speed Index (Wechsler, 2004a)

These tests are timed and load on the Processing Speed Index:

Coding—The child copies symbols that are paired with geometric shapes or numbers.

Symbol Search—The child scans a visual array of objects and indicates whether the target symbol(s) match(es) any of the symbols in the search group.

Cancellation—The child scans a random or structured array of pictures and marks target pictures within a designated time period.

WJIII-COG: Processing Speed Cluster (Woodcock, McGrew, & Mather, 2001a)

Visual Matching—The child is asked to rapidly locate and circle identical numbers within a visual array of numbers. This task does involve a motor response (circling numbers with a pencil). Within the CHC Model the test loads on Perceptual Speed (Narrow Ability).

Decision Speed—The child is asked to locate and circle two pictures from a visual array that have a similar concept (e.g., two cars). This task does involve a motor response (circling objects with a pencil). Within the CHC model the test loads on Perceptual Speed (Narrow Ability) and Semantic Processing Speed (Narrow Ability).

Cross Out—This test is part of the *Woodcock-Johnson III Diagnostic Supplement* (Woodcock, McGrew, Mather, & Schrank, 2003). The child is asked to put a mark through five objects on a line that match a target object on the left side of the paper. The five correct response objects are randomly embedded within other objects on the line. The test is timed and loads on Processing Speed.

Measures of Cognitive Efficiency

As previously noted in this chapter, cognitive efficiency is a stand-alone construct only on the WJIII-COG and is based on logical not empirical classifications of CHC abilities. *Cognitive Efficiency* is a compilation of two different automatic cognitive processes: processing speed and short-term memory.

WJIII-COG Cognitive Efficiency Performance Cluster (Woodcock, McGrew, & Mather, 2001a)

Processing Speed Cluster—Contains the Visual Matching and Decision Speed subtests previously described.

Short-Term Memory Cluster

- *Numbers Reversed*—The child listens to a series of numbers and is then asked to recall them in reverse order. This subtest requires multiple cognitive processes including short-term memory, working memory, attentional capacity, and cognitive efficiency.
- *Memory for Words*—The child listens to a series of words and then repeats them verbatim. This subtest also requires multiple cognitive processes including short-term memory, attentional capacity, and cognitive efficiency.

Measures of Cognitive Fluency

Cognitive fluency was one of those new clinical clusters included on the WJIII-COG and was designed to measure speed in completing complex cognitive tasks.

WJIII-COG Cognitive Fluency Clinical Cluster (Woodcock, McGrew, & Mather, 2001a)

Retrieval Fluency—The child is asked to recall as many words that start with a particular letter, or fall within a particular category (e.g., cars) as quickly as possible. The test measures speed of retrieval of stored information.

Rapid Picture Naming—The child is asked to name pictures on a page as quickly as possible. The test measures speed of lexical (vocabulary) access.

Decision Speed—See previous processing speed tests from the WJIII-COG for a description.

In this chapter, the terminology, neuroanatomy, and major tests associated with speed and efficiency of cognitive processing were reviewed. Speed and efficiency of cognitive processing is an important component of a school neuropsychological evaluation. Children with neurodevelopmental disorders (e.g., ADHD) or acquired neurological disorders (e.g., traumatic brain injury) often have slow processing speed. Of the three constructs reviewed in this chapter, processing speed is the most clearly defined; however, it does not appear to be interchangeable across assessment batteries. The constructs of cognitive efficiency and cognitive fluency need further research and refinement. Deficits in speed and efficiency are observed in many common developmental disorders. As an example in Chapter 16, the school neuropsychological conceptual assessment model will be used to review the presence of speed and efficiency of cognitive processing deficits in autism-spectrum disorders.

TEST YOURSELF

1. All of the following are examples of constructs that could be classified as speed and efficiency of cognitive processing, except one. Which one?

(a) Processing Speed
(b) Cognitive Fluency
(c) Comprehension-Knowledge
(d) Cognitive Efficiency

2. Which of the two major tests of cognitive processing include a processing speed component?

(a) the WISC-IV and WJIII-COG
(b) the WISC-IV and KABC-II
(c) the KABC-II and SBV
(d) the WJIII-COG and KABC-II

3. The WISC-IV Processing Speed Index test scores are interchangeable with the WJII-COG Processing Speed Cluster test scores. True or False?

4. Feldmann and colleagues (2004) found that what two factors accounted for a moderate amount of variance in processing speed measures?

(a) short-term memory and motor speed
(b) motor speed and number facility
(c) short-term memory and attention
(d) number facility and attention

5. On the WJIII-COG, Cognitive Efficiency is a compilation of which two CHC factor scores?

(a) Long-term Retrieval and Short-Term Memory
(b) Fluid Reasoning and Processing Speed
(c) Fluid Reasoning and Comprehension-Knowledge
(d) Processing speed and Short-Term Memory

6. Any test that records completion time could reflect the efficiency of processing speed. True or False?

7. The three speed and efficiency of cognitive processing constructs that were reviewed in this chapter are all equally refined. True or False?

Answers: 1. c; 2. a; 3. false; 4. b; 5. d; 6. true; 7. false

Twelve

GENERAL INTELLECTUAL ABILITY AND ACADEMIC ACHIEVEMENT

Chapters 5 through 11 presented information about essential cognitive processes required for success in school and in life, ranging from baseline sensory-motor and attentional processes to higher-order executive functions. General intellectual ability or *g* is not a construct that will be emphasized in this chapter. As the reader has most likely observed, the subtests from the major tests of cognitive functioning have already been reported in each of the respective areas (e.g., language processes, visual-spatial processes).

Academic achievement is often the "measuring stick" that is used by school personnel to determine a child's progress in school. Academic achievement is closely related to a child's profile of cognitive strengths and weaknesses. A school neuropsychologist must include measures of academic achievement in an assessment battery, but the interpretation must move beyond looking at standard scores alone.

This chapter will review: (a) the pros and cons of providing a single measure of general intelligence in a school neuropsychological report; (b) the similarities and differences between the major tests of intelligence; (c) a glossary of neuropsychological terms used for academic disorders; (d) the neuropsychology of reading disorders; (e) the neuropsychology of written language disorders; (f) the neuropsychology of mathematics; and (g) a listing of the common achievement tests subdivided by academic area.

GENERAL INTELLECTUAL FUNCTIONING

The overemphasis on global IQ scores has been a disservice to the profession of school psychology. Too many school psychologist practitioners across the country have purely become psychometrists, cranking out as many as 100 or more IQ tests each academic year for the purposes of special education qualification. The qualitative understanding of a child's individual strengths and weaknesses applied to the child's learning potential has been largely deemphasized at the expense of obtaining an overall IQ score. Fortunately, recent federal legislation such as NCLB and IDEA reauthorization are deemphasizing the use of traditional methods of identifying children with learning disabilities (e.g, not using the IQ-achievement discrepancies) and reemphasizing early intervention and research-based techniques and practices.

If intelligence tests are inappropriate, why keep administering them? In recent years, authors of cognitive abilities tests and their publishers have done an excellent job of developing and publishing tests of cognitive abilities that are theoretically based and psychometrically sound. Tests of cognitive ability, if interpreted correctly, do provide a wealth of information about a child's cognitive strengths and weaknesses and how the child approaches cognitive tasks of varying complexity. School psychologists and school neuropsychologists have the unique training to interpret tests of cognitive abilities from a cognitive perspective and use those results to craft educationally relevant interventions.

In the conceptual school neuropsychological assessment model presented in this book, it is recommended that general intelligence not be covered in the report until after the basic cognitive process are reported and interpreted, if they are covered at all. In traditional psychoeducational reports, an IQ score is one of the first scores reported. This is a good way to lose the reader of the report (e.g., the parent or teacher) because they can make a quick value judgment based on that single IQ score and may not attend to the rest of the details of the report.

As previously mentioned in the introduction of this chapter, the reader has probably noted that the subtests of the major tests of cognitive processing have already been integrated into the various sections (e.g., Language Processes, Visual-Spatial Processes). This is the approach that is recommended for a school neuropsychological evaluation. The question that arises for each evaluation is what test of cognitive functioning should be chosen to fully answer the referral question(s). Rapid Reference 12.1 presents the major tests of cognitive abilities and compares them based on the Cattell-Horn-Carroll (CHC) model of intelligence. (Note: the Differential Ability Scales [Elliott, in press] was not included in this table because it was not yet published at the time this book was written.)

The Woodcock-Johnson Tests of Cognitive Abilities (Woodcock, McGrew, & Mather, 2001a) has the broadest representation of the CHC factors of the major tests of cognitive processing. The WISC-IV (Wechsler, 2004a) was designed to measure four global factors: verbal comprehension, perceptual reasoning, working memory, and processing speed. The WISC-IV Technical Manual provides strong support for the four-factor model of the WISC-IV. Keith, Fine, Taub, Reynolds, and Kranzler (2004) conducted a confirmatory factor analysis of the WISC-IV using the CHC model (see Flanagan & Kaufman, 2004 for a review)

Rapid Reference 12.1

Comparison of the Major Tests of Cognitive Ability and What They Measure

Woodcock-Johnson III Tests of Cognitive Abilities CHC Factors							
Gf Fluid Reasoning	*Gc* Comprehension Knowledge	*Gv* Visual-Spatial Thinking	*Glr* Long-Term Retrieval	*Ga* Auditory Process	*Gsm* Short-Term Memory	*Gs* Processing Speed	*Gq* Quantitative Reasoning
Wechsler Intelligence Scale for Children–Fourth Edition Factors Scores							
Perceptual Reasoning (MR, PC) & Working Memory (Arth)	Verbal Comprehension Perceptual Reasoning (PCM)	Perceptual Reasoning (BD, MR, PCM) & Process Speed (SS)			Working Memory (DS, LN)	Processing Speed	
Kaufman Assessment Battery for Children–Second Edition Factor Scores							
Planning	Knowledge	Simultaneous	Learning		Sequential		
Stanford-Binet–Fifth Edition Factor Scores							
Fluid Reasoning	Knowledge	Visual Spatial Thinking	Working Memory				Quantitative Reasoning
Cognitive Assessment System Factor Scores							
Simultaneous		Simultaneous			Successive	Planning & Attention	

and found support for a five-factor model. Rapid Reference 12.1 shows where the WISC-IV subtests align with a CHC interpretative model.

The Kaufman Assessment Battery for Children–Second Edition (Kaufman & Kaufman, 2004) can be interpreted using a CHC interpretative model or a Lurian processing model. Rapid Reference 12.1 shows how the KABC-II aligns with a CHC interpretative model. The Stanford-Binet Intelligence Scale–Fifth Edition (SB5: Roid, 2003) was constructed based on five factors of the CHC model of intelligence. The five SB5 factors are fluid reasoning, knowledge, quantitative reasoning, visual-spatial reasoning, and working memory. The SB5 also includes a verbal and nonverbal component for each of the five factors.

Finally, the Cognitive Assessment System (CAS: Naglieri, & Das, 1997) was originally based on Lurian theory and found to have four factors: planning, attention, simultaneous, and successive. Keith, Kranzler, and Flanagan (2001) conducted a confirmatory factor analysis of the CAS using the CHC model (see Flanagan & Ortiz, 2001 for a review) and found that the factor structure of the CAS changed dramatically using the CHC perspective. The CAS Planning and Attention measures seemed to relate more to the CHC Processing Speed (*Gs*) factor, the CAS Successive measures related to the CHC Short-Term Memory (*Gsm*) factor, and the Simultaneous measures related to both the CHC Fluid Reasoning (*Gf*) and Visual-Spatial Thinking (*Gv*) factors.

A comprehensive review of all tests of intelligence is beyond the scope of this book. The books by Flanagan and Harrison (2005) or by Sattler (2001) will provide such reviews. It is important for a school neuropsychologist to understand the factor structure of the cognitive abilities tests that are chosen to answer the referral question(s) and how to report the scores within a school neuropsychological assessment model.

ACADEMIC FUNCTIONING

Mazzocco (2001) reported that approximately 6 percent of children in school have either a reading or math disorder. The incidence rate for writing disorders may be as high as 17 percent in a school-age population (Hooper et al., 1994). With so many children experiencing academic difficulties, the school neuropsychologist must be able to correctly identify the disabilities associated with these disorders and make appropriate prescriptive educational recommendations. Proper identification of children with reading, writing, and mathematics disorders requires the school neuropsychologist to understand the neuropsychological terms associated with academic impairments (see Rapid Reference 12.2), and

Rapid Reference 12.2

Neuropsychological Terms Associated with Academic Impairments

Acalculia—inability to perform mathematic computations.

Agraphia—an acquired difficulty in writing or spelling.

- *Central agraphia*—a spelling disorder in both written and oral spelling that is related to linguistic disturbance and not to the motor or sensory systems that support spelling.

Alexia—inability to read.

- *Acquired alexia*—loss of reading ability due to some form of brain trauma.
- *Alexia with agraphia*—inability to read and write.
- *Pure alexia*—sometimes referred to as word blindness or alexia without agraphia.

Dyscalculia—difficulty with mathematics.

Dysgraphia—difficulty with written language.

Dyslexia—difficulty with reading.

- *Developmental dyslexia*—a reading disorder present from birth and not acquired.
- *Dysphonetic dyslexia*—difficulty with reading because of poor phonological skills, having an overreliance on visual cues.
- *Surface dyslexia*—poor reading because of difficulty recognizing symbols of language, having an overreliance on auditory cues.
- *Mixed dyslexia*—poor reading because of an overreliance on semantic cues. Auditory and visual processing of reading is impaired.
- *Deep dyslexia*—reliance on visual and semantic cues. Reading abstract words is difficult because of impaired phonological processing. Semantic errors are the hallmark of this disorder (e.g., *food* for *dinner*).

the characteristics of the subtypes associated with each of the academic areas. Proper identification of the neuropsychological subtypes of reading, writing, and mathematics cannot be determined by administering an individual achievement test alone. A school neuropsychologist must do error analyses, miscue analyses, and evaluate qualitative behaviors in order to fully understand the type of academic problems a child may be experiencing. The next few sections of this chapter will review the subtypes associated with reading, writing, and mathematics. The chapter will end with a listing of the most common achievement tests used by practitioners.

READING DISORDERS

Reading and Aphasia

Reading disorders are often related to the language disorders as described in Chapter 8. Rapid Reference 12.3 describes reading strengths and weaknesses related to the subtypes of aphasia.

Neuroanatomical Circuitry of Reading

Shaywitz (2003) reviewed several major studies that used functional brain imaging techniques (e.g., fMRI) to study reading in efficient and inefficient readers. The studies revealed two slower and more inefficient pathways used by the dyslexic readers and one quicker pathway used by skilled readers. When a child reads a word, the visual image of the word is projected to the primary visual cortex of the *right occipital lobe*. Information about the visual features of the word (e.g., the lines and curves that make up the letters) is processed within the occipital lobe. Next, the brain needs to transform the letters into sounds of language, and

Rapid Reference 12.3

Reading Strengths and Weaknesses Related to Types of Aphasia

Type of Aphasia	Associated Reading Strengths/Weaknesses
Broca's (Expressive) Aphasia	• Good reading comprehension. • Poor oral reading. • Agrammatical speech equates to agrammatical writing. • Failure to understand grammar when listening equates to failure to do so while reading.
Conduction Aphasia	• Poor reading skills. • Often make semantic paraphasia errors (saying synonyms for some of the words read) when reading aloud.
Transcortical Sensory Aphasia	• Reading aloud is adequate. • Poor reading comprehension.

ultimately attach meaning to those sounds. The visual feature information of the word processed within the occipital lobe is passed onto one of two different brain pathways: an upper pathway, called the dorsal stream, emanates from the left *parieto-temporal region* and a lower pathway called the ventral stream is located at the junction of the occipital and temporal lobes, the *occipito-temporal area*.

The parieto-temporal system is essential for phonetic decoding in reading: initially analyzing a word, pulling it apart by phonemes, and linking the letters to sounds. Specific brain regions that are activated in the parieto-temporal region include the *angular gyrus* and the *supramarginal gyrus.* Children learning to read initially use the parieto-temporal system almost exclusively.

As children become more skilled at reading, the occipito-temporal pathway becomes more active. The *insular cortex* also has been implicated with automatically recognizing words in print and, along with the occipito-temporal pathway, plays a key role in reading fluency. The occipito-temporal pathway uses a whole-word approach to reading. Words are automatically recognized by sight in the occipito-temporal system and do not need to be deconstructed phonetically as in the parieto-temporal system. When the occipito-temporal region of the brain is activated, an exact neural form of the word is retrieved along with the word's spelling, pronunciation, and meaning. Therefore, the occipito-temporal region allows reading to become more fluent and automatic because words are recalled quickly by sight rather than relying on sounding out words every time they are read. Figure 12.1 illustrates a model of reading then speaking a word based on either the parieto-temporal or the occipito-temporal pathways in the brain.

There is a third pathway in the brain for reading that lies in the frontal region associated with Broca's area. This pathway also helps with the phonemic decoding of words and, like the parieto-temporal pathway, is not as efficient as the occipito-temporal pathway. The inferior frontal gyrus around Broca's area appears to be the end point for the brain's inner articulation system. In summary, three pathways for processing reading have been identified, with two relying on phonemic decoding and one relying on a whole-word processing approach.

Good readers show a consistent pattern of activation in the back of the brain with less activation in the front pathways; whereas, inefficient readers or children with dyslexia have shown the opposite pattern (Shaywitz, 2003). Children with dyslexia show two distinct patterns. First, dyslexics can activate all three brain pathways required for reading individually, but they have trouble activating them simultaneously (Feifer & DeFina, 2000). Second, dyslexics often show an over-activation in Broca's area while reading. Using the frontal system as a guide, a dyslexic reader can form sound structures of words and can subvocalize the words as they are being read. These compensatory strategies can aid a dyslexic reader to

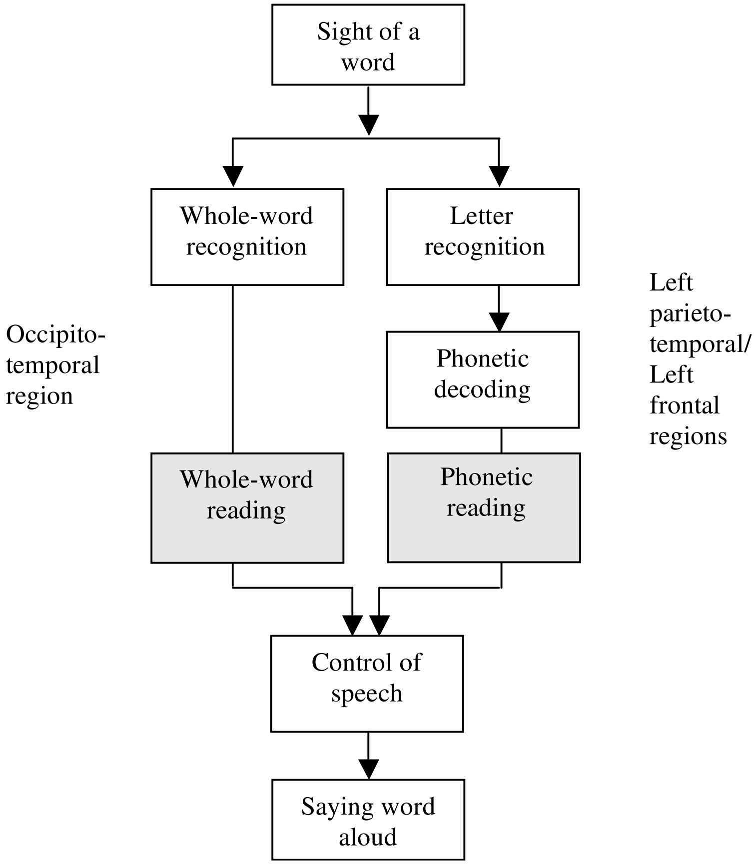


Figure 12.1 A model of reading a word aloud following a whole-word or phonetic approach

Source: Adapted from Carlson (2007).

sound out words, but the fluency and automaticity that is regulated by the posterior systems remains elusive. In an exciting line of research, Shaywitz (2003) reported several fMRI studies that showed how early intervention and effective reading instruction helps develop the posterior, automatic reading system of the brain.

In summary, there appears to be compelling evidence that skilled readers activate the quicker, more rapid, and automatic pathways to decipher words in print (McCandliss & Noble, 2003; Owen, Borowsky, & Sarty, 2004; Shaywitz, 2003). This pathway is primarily situated in the posterior portions of the brain, along the interface of the occipital and temporal lobes, in a brain region called the fusiform gyrus. Conversely, dyslexics do not activate these self-same pathways, but instead rely on different pathways, forged in part by compensatory mechanisms, which are slower and less efficient, to assist with word recognition skills (Shaywitz & Shaywitz, 2005). These slower pathways, which overrely on breaking down each word into its phonological core, are referred to as the dorsal stream. The quicker, automatic pathway, which processes words at the lexical level, is sometimes referred to as the ventral stream. This pathway may have further assistance from yet another brain region, the insular cortex, when automatically processing unusual spellings of words, which tend to be common in the English language (Owen et al., 2004).

Subtypes of Reading Disorders

There are several classification schemas for naming the subtypes of reading disorders. For the purposes of a school neuropsychological assessment model, the following reading subtypes will be discussed: pure alexia, phonological dyslexia, surface dyslexia, spelling or word-form dyslexia, direct dyslexia, and semantic dyslexia. An overview of these reading disorder subtypes is presented in Rapid Reference 12.4.

Pure alexia, also referred to as word blindness or alexia without agraphia, is a perceptual disorder that prevents a child from reading. Pure alexia is caused by lesions in the visual pathways that prevent visual information from reaching the extrastriate cortex within the occipital lobe (Carlson, 2007). Children with pure alexia cannot read, but they can recognize words that are spelled aloud to them, if the word was previously learned. Children with pure alexia cannot use either the whole-word or phonetic approaches to read because they are not getting the initial visual information to process. However, if a child has previously learned to read and write and has acquired pure alexia due to some type of brain damage, the child will be able to write some, even in the absence of reading.

Phonological dyslexia, also referred to as dysphonetic dyslexia, is "a reading disorder in which a person can read familiar words but has difficulty reading unfamiliar words or pronounceable non-words" (Carlson, 2007, p. 508). A model that illustrates the phonological dyslexia impairment is shown in Figure 12.2. Phonological reading is required when a reader is presented with a nonsense word or a new word that is not yet learned. Children with phonological dyslexia over-rely on memorizing whole words as they are visualized in space because they cannot phonetically sound out the word.

Surface dyslexia, also referred to as dyseidetic dyslexia, is "a reading disorder in which a person can read words phonetically but has difficulty reading irregularly spelled words by the whole-word method" (Carlson, 2007, p. 508). The term

Rapid Reference 12.4

Subtypes of Reading Disorders

Reading Disorder Subtype	Symptoms
Pure Alexia	• A perceptual disorder in which the child has difficulty with visual input. • Also referred to as word blindness or alexia without agraphia. • Limited writing capability, if writing skills were present prior to an acquired pure alexia.
Phonological dyslexia	• Good whole-word reading. • Poor phonetic reading. • Overreliance on memorizing a whole word as seen in space rather than phonetic decoding.
Surface dyslexia	• Good phonetic reading. • Poor whole-word reading.
Spelling/word-form/mixed dyslexia	• Poor whole-word reading. • Poor phonetic reading. • Can read words letter by letter.
Direct dyslexia	• Good phonetic reading. • Good whole-word reading. • Poor reading comprehension.
Semantic dyslexia	• Rely on visual and semantic cues in reading. • Make semantic errors in reading (e.g., *food* for *dinner*). • May have trouble reading function words (e.g., *of, an, not*)

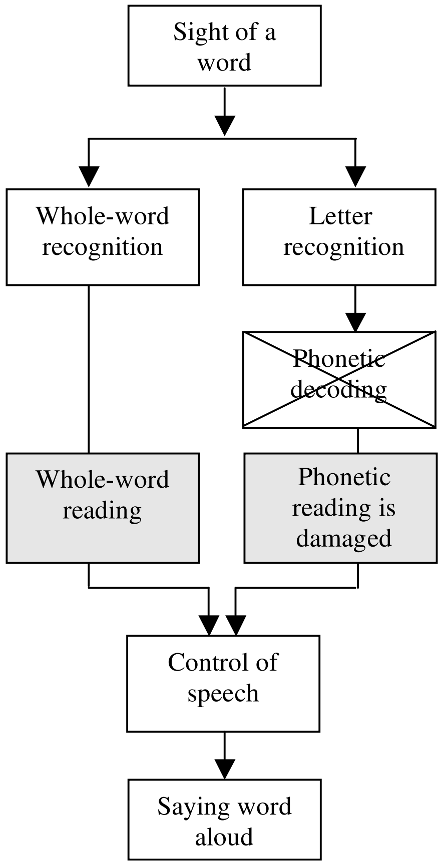


Figure 12.2 A reading model showing *phonological dyslexia*. Phonetic reading is damaged while whole-word reading remains intact.

Source: Adapted from Carlson (2007).

surface is used because children with this type of disorder make errors based only on what the word looks like on the *surface* rather than related to the word meanings. Surface dyslexia is usually caused by a lesion within the left temporal lobe (Patterson & Ralph, 1999). Children with surface dyslexia have difficulty memorizing a whole word, which makes them overrely on phonetically sounding out almost every word. Overrelying on phonetic decoding slows down reading fluency and can adversely affect reading comprehension. Children with surface dyslexia often can read words that have regular spelling (e.g., bat, fist, chin), but they have difficulty with reading words with irregular spelling (e.g., pint, yacht). A model of surface dyslexia impairment is illustrated in Figure 12.3.

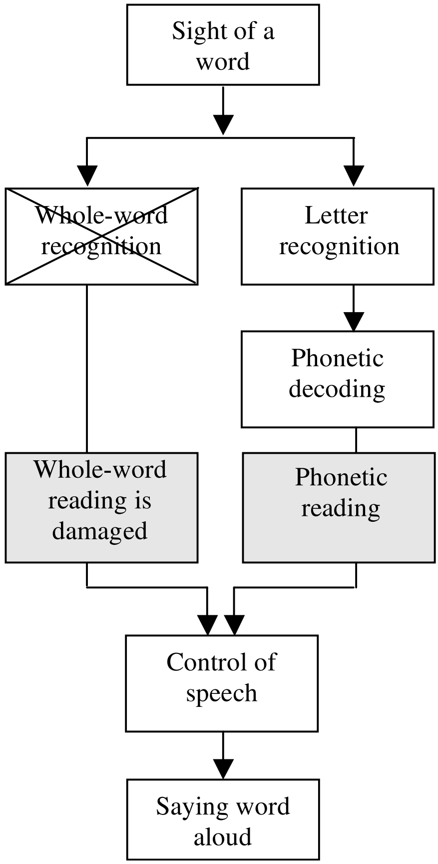


Figure 12.3 A reading model showing *surface dyslexia*. Whole-word reading is damaged while phonemic reading remains intact.

Source: Adapted from Carlson (2007).

Spelling or *word-form dyslexia,* also known as mixed dyslexia, is a reading disorder in which the ability to read a word using a whole-word or phonetic approach is disrupted but the visual pathways remain intact. Although a child with spelling dyslexia cannot recognize words as a whole or sound them out phonetically, individual letters can be recognized. The child reads words by reading the letters individually (e.g., c-a-t, for *cat*). A model of spelling dyslexia impairment is illustrated in Figure 12.4.

Direct dyslexia is "a language disorder caused by brain damage in which the person can read words aloud without understanding them" (Carlson, 2007, p. 511). In Chapter Eight, a type of aphasia—transcortical sensory aphasia—was

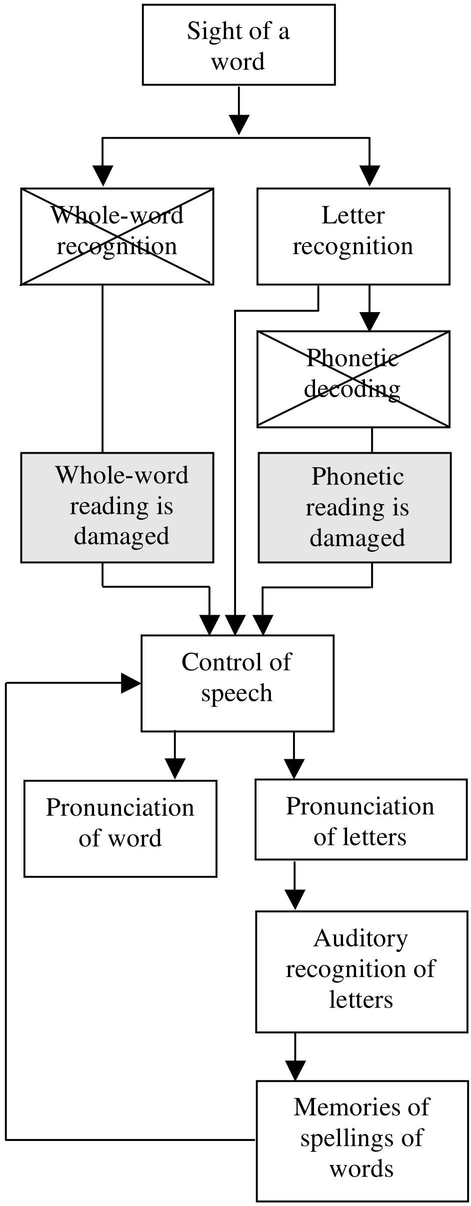


Figure 12.4 A reading model showing *spelling* or *word-finding dyslexia*. Whole-word and phonetic reading are damaged. The child must pronounce the letters, recognize the words, and then say them.

Source: Adapted from Carlson (2007).

DON'T FORGET

Dyslexia Subtype →	Relies on
Phonological Dyslexia	Visual cues
Surface Dyslexia	Auditory cues
Spelling Dyslexia	Individual letters
Direct Dyslexia	All cues
Semantic Dyslexia	Visual & semantic cues

described, in which a child can repeat what others say to him or her, but can neither comprehend the meaning of what he or she hears nor produce meaningful speech on his or her own. Direct dyslexia is similar to transcortical sensory aphasia; however, in direct dyslexia the words are written in text and not spoken (Carlson, 2007).

Semantic dyslexia, also known as deep dyslexia, is a reading disorder in which the hallmark feature is making semantic errors (e.g., *food* for *dinner*) during reading (Feifer & Defina, 2000). Children with semantic dyslexia rely heavily on visual and semantic cues during reading, while minimizing phonetic decoding. Reading abstract words is difficult because of the impaired phonetic decoding and difficulty conjuring up a visual image of the word.

It is important for a school neuropsychologist to identify the reading disorder subtype that a poor reader is experiencing because the ultimate effectiveness of any intervention(s) will be dependent upon matching the reading subtype with the proper intervention. See Feifer and Defina's (2000) book, *The Neuropsychology of Reading Disorders,* for subtype-based reading interventions.

WRITTEN LANGUAGE DISORDERS

Subtypes of Written Language Disorders

There are three types of writing disorders: One involves an inability to spell words; the other two involve difficulties with motor control. Rapid Reference 12.5 presents the common subtypes of written language disorders classified as aphasic dysgraphia disorders (language-based), apraxic dysgraphia (non-language based), or mechanical dysgraphia.

Aphasic Dysgraphias

Phonological Dysgraphia is "a writing disorder in which the person cannot sound out words and write them phonetically" (Carlson, 2007, p. 513). Children with

Rapid Reference 12.5

Subtypes of Written Language Disorders

Writing Disorder Subtype	Symptoms
Aphasic Dysgraphia (Language-based disorder)	
Phonological Dysgraphia	• Spelling of unfamiliar words, nonwords, and phonetically irregular words is impaired. • Good skills in copying words, writing from dictation, and spelling relatively familiar words.
Surface (Orthographic) Dysgraphia	• Can spell regularly spelled words. • Has difficulty spelling irregularly spelled words. • Poor lexical representations of words. • Poor knowledge of the idiosyncratic properties of words.
Mixed Dysgraphia	• Inability to recall letter formations. • Inconsistent spelling skills. • Phonological and orthographic errors. • Cannot sequence letters accurately in words.
Semantic/Syntactic (Direct) Dysgraphia	• Can write dictated words. • Cannot understand written words. • Lack of understanding of the implicit rules of grammar.
Apraxic Dysgraphia (Nonlanguage based)	
Ideomotor Dysgraphia	• Failure to carry out a motor act or gesture in response to a verbal command. • Intact comprehension and motor skills but they do not work together.
Ideational Dyspraxia	• Poor sequential motor processing. • Slow writing output. • Can copy. • Mild difficulty with dictation. • Cannot write well spontaneously.

(*continued*)

Writing Disorder Subtype	**Symptoms**
Constructional Dyspraxia	• Visuospatial difficulty. • Cannot copy.
Mechanical Dysgraphia	
Motor Dysgraphia	• No cognitive dysfunction related to writing. • Poor penmanship. • Writing deficits caused by mechanical problems with hands only (e.g., stiffness, tremors, poor fine motor skills).

Source: Adapted from Feifer and DeFina (2002).

phonological dysgraphia have difficulty with spelling unfamiliar words, nonwords, or phonetically irregular words because their phonetic decoding skills are impaired. They can write relatively familiar words by visually imagining them. Children with phonological dysgraphia can also copy words and write from dictation (Feifer & DeFina, 2002).

Surface (Orthographic) Dysgraphia is "a writing disorder in which the person can spell regularly spelled words but not irregularly spelled ones" (Carlson, 2007, p. 513). Children with surface (orthographic) dysgraphia can only sound out words because they cannot visually remember the whole word. As a result, children with this writing disorder can spell regular words and they can write pronounceable nonsense words. They do however have difficulties spelling irregular words (*half* becomes *haff, said* becomes *sed*).

Mixed Dysgraphia is a writing disorder characterized by the inability to sequence letters accurately in words, the inability to recall letter formations properly, and inconsistent spelling skills (Feifer & Defina, 2002). Children with this writing disorder can copy written text and they can form letters correctly. However, children with mixed dysgraphia make phonological errors in spelling and orthographic errors based on faulty sequential arrangement of letters (e.g., *advantage* is misspelled as *advangate*).

Semantic/Syntactic (Direct) Dysgraphia is characterized by a lack of understanding of the implicit rules of grammar that help guide how words and phrases are combined (Feifer & DeFina, 2002). In the reading disorders section of this chapter, direct dyslexia was characterized as being able to read aloud but not understand what is read. Semantic/Syntactic or Direct Dysgraphia is similar in that children with this disorder can write words that are dictated to them but they cannot understand those words (Carlson, 2007).

Apraxic Dysgraphias

The term *apraxia* refers to a variety of motor skill deficits in which the child has very little control over skilled motor movement. By definition, the motor difficulties are not a result of paralysis, paresis, or lack of comprehension. Writing problems can be caused by poor motor control that adversely affects the movements of the pen or pencil when forming letters and words.

Ideomotor Dyspraxia is the failure to carry out a motor act or gesture in response to a verbal command. A child with ideomotor dyspraxia will have intact comprehension and the necessary motor skills to perform a motor response, but the connection between the understanding of a verbal command and the motor act is impaired. Ideomotor apraxia is generally associated with left inferior parietal lobe or left supplementary motor cortex area lesions, or a lesion of the corpus callosum.

Ideational Dysgraphia is an inability to perform a series of gestures due to a loss of plan of action (ideation) for movement. Children with ideational dysgraphia have trouble with planning a written assignment and organizing their thoughts in a sequential manner. Children with this writing disorder can perform motor acts in isolation and on command but cannot string a series of motor acts together. Therefore, a child might be able to construct the letter *b* in isolation, though he or she may have difficulty writing the same letter within the context of the word *ball*. For children with this disorder, writing is slow and laborious and characterized by frequent erasures, or self-corrections (Feifer & DeFina, 2002).

Constructional Dyspraxia is "an inability to produce and/or modulate written language production due to deficits with the spatial constraints of letter and word production" (Feifer & DeFina, 2002, p. 79). Most written-language processes involve left hemispheric functioning, but the visual-spatial aspect of writing (e.g., staying within the lines, maintaining a horizontal plane in a sentence, starting at the top of the page and writing from left to right) is a right hemispheric function. Poor handwriting skills are often related to the failure to obey spatial constraints coupled with a lack of consistency.

Mechanical Dysgraphia

Motor dysgraphia does not have any cognitive (language or nonlanguage) based impairment that can be linked to a writing impairment. Rather the writing problems stem from a difficulty with motor output. Motor dysgraphia can cause the child to hold a pen or pencil incorrectly and to apply the wrong type of pressure to the writing instrument. Motor dysgraphia is usually associated with mechanical problems of the hands (e.g., stiffness, tremors, poor fine motor skills). An occupational therapist can serve as an excellent resource for assessments and interventions for children with motor dysgraphia (see Chapter 5, Sensorimotor Functions, for a list of assessments).

Neuroanatomical Circuitry of Writing

Benson and Geschwind (1985) suggested that phonological dysgraphia is caused by damage to the superior temporal lobe, whereas surface (orthographic) dysgraphia is caused by damage to the inferior parietal lobe. More recent functional imaging studies and postmortem studies of patients with known brain lesions have found that the posterior inferior temporal cortex is involved with both phonological dysgraphia and surface (orthographic) dysgraphia (Carlson, 2007). Specifically, the anterior portion of the supramarginal gyrus seems to be impaired or dysfunctional in individuals with phonological dysgraphia.

Mixed dysgraphia seems to involve dysfunction within the left inferior parietal lobe. Also, because of the planning and sequential organization needed for proper letter sequencing, there may be some prefrontal cortex impairment in children with mixed dysgraphia. The motor aspects of writing involve the dorsal parietal lobe, the premotor cortex, and the primary motor cortex (Carlson, 2007).

MATHEMATICS DISORDERS

Subtypes of Mathematics Disorders

Acalculia is the neuropsychological term that means an acquired disturbance of computational ability associated with impairment in both the ability to read and write numbers (Loring, 1999). *Dyscalculia,* not the same as acalculia, is defined as a specific neurological disorder affecting a person's ability to understand and/or manipulate numbers. Acalculia/Dyscalculia are very rare and are generally seen in children with head injuries or other neuropsychological insults. Hale and Fiorello (2004) pointed out that the likelihood of finding a *pure* dyscalculia in children is rare. However, there are some basic subtypes of math disorders that are generally agreed upon. Mazzocco (2001) suggests three subtypes of math disorders: semantic-memory, procedural, and visual-spatial subtypes. Feifer and DeFina (2005) include the same three math disorder subtypes as suggested by Mazzocco (2001), but they add a verbal dyscalculia subtype. Highlights of these subtypes of math disorders are presented in Rapid Reference 12.6.

Rapid Reference 12.6

Subtypes of Mathematics Disorders

Math Disorder Subtype	Symptoms
Verbal Dyscalculia	Deficits in: • Counting • Rapid number identification • Retrieval of stored facts • Addition and multiplication facts • Possible coexisting reading/writing difficulties. Strengths in: • Number qualities • Comparisons between numbers • Understanding basic concepts • Visual-spatial skills
Procedural Dyscalculia	Deficits in: • Writing numbers from dictation • Reading numbers aloud • Math computational skills • Syntactical rules of problem solving • Deficits with division and regrouping procedures in subtraction Strengths in: • Retrieval of overlearned facts • Comparisons between numbers • Magnitude comparisons
Semantic-Memory Dyscalculia	Deficits in: • Magnitude representations • Transcoding math operations • Higher-level math proofs • Conceptual understanding of math • Estimation skills Strengths in: • Reading and writing numbers • Computational procedures • Retrieval of overlearned facts
Visual-Spatial Dyscalculia	Deficits in: • Aligning a column of numbers • Visual perception of numbers • Spatial attributes (e.g., size, location) • Magnitude comparisons Strengths in: • Retrieval of stored facts • Reading numbers • Math algorithms • Verbal strategies

Source: Adapted from Feifer and DeFina (2005).

Verbal Dyscalculia "represents a disorder of the verbal representations of numbers, and the inability to use language-based procedures to assist in arithmetic fact retrieval skills" (Feifer & DeFina, 2005, p. 39). Children with verbal dyscalculia have difficulties with counting and rapid number identification, and difficulties retrieving or recalling previously learned math facts. Verbal dyscalculia often coexists with reading and spelling difficulties because of the generalized language processing deficits (von Aster, 2000). Children with verbal dyscalculia are still able to appreciate numeric qualities, understand mathematical concepts, or make comparisons between numbers (Feifer & DeFina, 2005).

Procedural Dyscalculia "often involves poor strategy or algorithm use" (Hale & Fiorello, 2004, p. 212). Gerry (1993) reported that individuals with procedural dyscalculia have slow computational processing speed and they make frequent calculation errors. Von Aster (2000) reported that children with this type of math disorder often have trouble reading numbers aloud, and may perform poorly on writing numbers from dictation. Procedural dyscalculia seems to draw heavily on manipulating information in working memory. Hale and Fiorello (2004) suggest that procedural dyscalculia probably involves executive functioning deficits such as limited flexibility, sequencing errors, and difficulty maintaining information in working memory. See Hale and Fiorello (2004) for a discussion of the related disorders that often coexist with procedural dyscalculia (e.g., ADHD-Inattentive Type).

Semantic-Memory Dyscalculia "is characterized by poor number-symbol association and math fact automaticity" (Hale & Fiorello, 2004, p. 212). Children with semantic-memory dyscalculia often have coexisting reading and language disorders and have difficulty learning or retrieving basic math facts from memory. Unlike the working memory deficits associated with procedural dyscalculia, phonological and/or semantic memory seems to be associated with semantic-memory dyscalculia.

Visual-Spatial Dyscalculia is characterized by poor column alignment, difficulties with place values, and not paying attention to the mathematical operational signs (e.g., adding all problems, including subtraction problems; Hale & Fiorello, 2004). Visual-spatial dyscalculia is often associated with Rourke's (1994) classification of nonverbal learning disabilities. The constellation of symptoms associated with visual-spatial dyscalculia includes: poor visual-spatial, organizational, psychomotor, tactile-perceptual, and concept-formation skills. In other words, these children have trouble thinking in pictures, which is often required for more abstract types of mathematical problem solving such as geometry. However, children with visual-spatial dyscalculia have good rote, automatic, and verbal skills. Hale and Fiorello (2004) suggest there might be two separate

Rapid Reference 12.7

Similarities of the Neuroanatomy of Reading and Mathematics

Brain Region	Reading Function	Math Function
Inferior Frontal Gyrus	Breaks down larger words into smaller phonological units.	Breaks down larger numbers into smaller, more accessible units.
Angular Gyrus	Visual-spatial appreciation of fixed symbols including words (left hemisphere).	Visual-spatial recognition of mathematical facts and symbols.
Occipital-Temporal Regions	Automatic recognition of letters and words (fluency).	Automatic recognition of numbers and digits (fluency).

Source: Adapted from Feifer & DeFina, 2005.

visual-spatial dyscalculia subtypes: one involving the right frontal area that disrupts problem-solving skills and novel concept formation, and a right posterior area deficit that causes visual-spatial problems of poor alignment and attention to detail.

Neuroanatomical Circuitry of Mathematics

Disruptions in mathematics can be associated with multiple brain regions and multiple cognitive processes. Many of the same areas associated with reading disorders can cause difficulties with mathematics (see Rapid Reference 12.7). Verbal dyscalculia appears to be associated with damage to the left perisylvian area, damage to bilateral occipital-temporal lobes for procedural dyscalculia, damage to bilateral inferior parietal lobes for semantic-memory dyscalculia, and damage to prefrontal and/or bilateral occipital-parietal lobes (the fusiform gyrus) for visual-spatial dyscalculia (Feifer & DeFina, 2005).

TESTS OF ACADEMIC ACHIEVEMENT

Rapid Reference 12.8 lists the major achievement tests subdivided by the following academic areas: reading accuracy, reading comprehension, reading fluency, mathematical calculations, mathematical reasoning, mathematical fluency, writ-

Rapid Reference 12.8

Major Achievement Tests

Test	Functions Assessed	Age Range
Tests of Reading Accuracy		
KTEA-II (Kaufman & Kaufman, 2005):		
Letter and Word Identification	• Letter and word decoding.	4-6 to 25-11 years
Nonsense Word Decoding	• Decoding of words with no meanings.	Grade 1 to age 25-11
WIAT-II:		
Word Reading	• Accuracy of word recognition.	2 to 95+ years
Pseudoword Decoding	• Accuracy of word recognition.	
WJIII-ACH:		
Letter-Word Identification	• Reading decoding.	2 to 95+ years
Word Attack	• Phonological and orthographic coding.	
Tests of Reading Comprehension		
KTEA-II:		
Reading Comprehension	Reading comprehension.	Grade 1 to age 25-11
WIAT-II:		
Reading Comprehension	Literal and inferential comprehension.	4-6 to 25 years (Comprehensive) 4-6 to 90+ years (Brief)
WJIII-ACH:		
Passage Comprehension	• Reading comprehension of contextual information.	2 to 95+ years
Reading Vocabulary	• Reading vocabulary and comprehension.	

Test	Functions Assessed	Age Range
Tests of Reading Fluency		
CTOPP Rapid Naming Composite:	Rapid automatic naming (fluency).	
Rapid Color Naming and Rapid Object Naming		5-0 to 6-0 years
Rapid Digit Naming and Rapid Letter Naming		7-0 to 24-11 years
KTEA-II:		
Word Reading Fluency	• Speed of reading words.	Grade 3 to age 25-11
Decoding Fluency	• Speed of reading of nonsense words.	Grade 3 to age 25-11
Associational Fluency	• Speed of reading words that belong to a semantic category or start with the same phonetic sound.	4-6 to 25-11 years
Naming Facility (RAN)	• Speed of naming objects, colors, and letters.	4-6 to 25-11 years
Process Assessment of the Learner (PAL)	Orthographic and phonological coordination (fluency).	Grades K to 6
Rapid Automatized Naming and Rapid Alternating Stimulus Tests (RAN/RAS)	Rapid Naming Facility.	5 years to Adult
WJIII-ACH:		
Reading Fluency	Reading speed.	2 to 95+ years
Tests of Mathematical Calculations		
KTEA-II:		
Math Computation	Basic math computations.	Grade K to age 25-11

(*continued*)

Test	Functions Assessed	Age Range
WIAT-II: Numerical Operations	Number writing; calculation using basic operations; calculation of fractions, decimals, & algebra.	4-6 to 25 years (Comprehensive) 4-6 to 90+ years (Brief)
WJIII-ACH: Calculation	Mathematical computations.	2 to 95+ years
Tests of Mathematical Reasoning		
KTEA-II: Math Concepts and Applications	Math reasoning (e.g., number & operation concepts, rational number, measurement, shape and space, data investigations, higher-math concepts).	4-6 to 25-11 years
WIAT-II: Math Reasoning	Quantitative concepts; problem solving; money, time, and measurement; geometry; reading and interpreting charts and graphs; statistics.	4-6 to 25 years (Comprehensive) 4-6 to 90+ years (Brief)
WJIII-ACH: Applied Problems Quantitative Concepts	• Analyze and solve practical math problems, mathematical reasoning. • Quantitative reasoning and math knowledge.	2 to 95+ years
Tests of Mathematical Fluency		
WJIII-ACH: Applied Problems	Number facility and math achievement.	2 to 95+ years
Tests of Written Language		
KTEA-II: Written Expression	Writing sentences; adding punctuation and capitalization; filling in missing words; completing sentences; combining sentences; writing an essay (grade 1 and higher).	4-6 to 25-11 years

Test	Functions Assessed	Age Range
Spelling	Writes words from dictation. Words are orthographically regular and irregular words of increasing complexity.	Grade 1 to age 25-11
WIAT-II:		
Written Expression	• Descriptive writing.	4-6 to 25 years (Comprehensive)
	• Narrative writing.	4-6 to 90+ years (Brief)
Spelling	• Alphabet principle. • Written spelling of regular and irregular words from dictation, and homonyms.	
WJIII-ACH:		
Writing Samples	• Quality of meaningful written expression and ability to convey ideas.	2 to 95+ years
Editing	• Identify and correct errors in spelling, usage, punctuation, and capitalization.	
Punctuation and Capitalization	• Knowledge of punctuation and capitalization rules.	
Spelling	• Spell dictated words.	
Spelling of Sounds	• Phonological/orthographic coding.	
Writing Evaluation Scale (WES)	• Writing skills by informal, analytic evaluation of longer, more complex passages.	
Tests of Writing Fluency		
WJIII-ACH:		
Writing Fluency	Automaticity with syntactic components of written expression.	2 to 95+ years

ten language, and writing fluency. The listening comprehension and oral expression areas were previously covered in Chapter Eight, Language Processes. For a more comprehensive review of achievement tests see Smith (2001) or Flanagan, Ortiz, Alfonso, & Mascolo (2002). The KTEA-II is reviewed by Lichtenberger and Smith (2005) and the WJII-Ach is reviewed by Mather, Wendling, & Woodcock (2001).

Measuring and reporting a *g*-factor of intelligence is not emphasized in a school neuropsychological evaluation. Rather, the cognitive processes that are measured by tests of intelligence or cognitive ability measures need to be reported within a conceptual model as presented in this book. This chapter has presented a list of the major tests of cognitive ability and how they relate to each other using a CHC model of intelligence as a common focus.

The neuropsychological aspects of reading, writing, and mathematics were presented along with the major achievement tests designed to measure those academic areas. Achievement deficits are observed in many common developmental disorders. As an example in Chapter 16, the school neuropsychological conceptual assessment model will be used to review the presence of achievement deficits in autism-spectrum disorders.

TEST YOURSELF

1. **A school neuropsychological evaluation should emphasize a global measure of intelligence (*g*).** True or false?
2. **What subtype of a reading disorder is characterized by overreliance on memorizing a whole word as seen in space rather than phonetic decoding?**
   (a) pure alexia
   (b) phonological dyslexia
   (c) surface dyslexia
   (d) direct dyslexia
3. **What subtype of a reading disorder is characterized by an overreliance on visual and semantic cues and frequent semantic errors during reading?**
   (a) semantic dyslexia
   (b) direct dyslexia
   (c) surface dyslexia
   (d) phonological dyslexia

4. **The WJIII-COG is the only major test of intelligence of cognitive abilities that includes an auditory processing factor.** True or False?
5. **What subtype of written-language disorder is characterized by an inability or difficulty with sequencing letters accurately in words?**
   (a) phonological dysgraphia
   (b) surface dysgraphia
   (c) mixed dysgrahia
   (d) direct dysgraphia
6. **What type of written-language disorder does not involve a cognitive component but results in poor penmanship?**
   (a) phonological dysgraphia
   (b) surface dysgraphia
   (c) mixed dysgrahia
   (d) motor dysgraphia
7. **What type of mathematics disorder results in difficulties with poor alignment of number columns?**
   (a) visual-spatial dyscalculia
   (b) semantic-memory dyscalculia
   (c) procedural dyscalculia
   (d) verbal dyscalculia

Answers: 1. false; 2. b; 3. a; 4. true; 5. c; 6. d; 7. a

Thirteen

MODEL FOR SCHOOL NEUROPSYCHOLOGY REPORT WRITING

In Chapter 4 a model for school neuropsychological assessment was presented and Chapters 5 through 12 defined and operationalized each of the subcomponents of the conceptual model. This chapter will illustrate how that assessment model can be integrated into a school neuropsychological report. Some principles of neuropsychological assessment and report writing will be presented first in this chapter. Second, the essential elements of a comprehensive neuropsychological report will be reviewed (e.g., identifying information, reason for referral, background information). Please note that not all children will require a comprehensive school neuropsychological assessment. The actual neuropsychological domains measured in a particular evaluation will vary based on the referral question(s) and the history of the child. However, in this chapter, the components of the entire model will be illustrated for instructional purposes. In the next chapter, Chapter 14, an actual case study that uses this school neuropsychological model is presented.

BASIC PRINCIPLES OF SCHOOL NEUROPSYCHOLOGICAL ASSESSMENT AND REPORT WRITING

Why Are School Neuropsychological Evaluations Lengthy?

DON'T FORGET

The ultimate goal of a good neuropsychological evaluation should be to identify the student's neurocognitive strengths and weaknesses and link that information to prescriptive interventions that will maximize the student's learning potential.

Psychoeducational or psychological reports are not as comprehensive as neuropsychological reports. Rapid Reference 13.1 presents the common components of psychoeducational, psychological, and neuropsychological assessments. Psychoeducational assessment typically includes measures of cognitive

Rapid Reference 13.1

Typical Components Across Psychoeducational, Psychological, and Neuropsychological Assessments

	Psycho-educational	Psychological	Neuro-psychological
Record Review	X	X	X
Developmental History	X	X	X
Clinical Interviews	O	X	X
Intellectual	X	X	O
Academic Functioning	X	X	X
Personality Assessment	—	X	O
Psychopathology	—	X	O
Adaptive Behavior	O	O	O
Visual-Motor Skills	O	—	X
Sensory-Motor Skills	—	—	X
Attentional Processes	O	—	X
Visual-Spatial	X	X	X
Verbal Processes	X	X	X
Memory/Learning	O	—	X
Executive Processes	O	—	X
Rate of Processing	O	—	X

Note: X = typically used; O = optional; — = not typically used.

and academic functioning at a minimum, and perhaps a measure of visual-motor integration. Psychoeducational assessments conducted by an assessment specialist (e.g., school psychologist, educational diagnostician) generally provide data to determine eligibility for IDEA disabilities (e.g., Mental Retardation and specific learning disability classifications). Since the primary goals of both a psychological and psychoeducational report are to assist schools with eligibility decisions, these types of assessments often yield limited information for making prescriptive interventions. Psychological assessment within the schools typically includes measures of personality and psychopathology (e.g., depression, anxiety, conduct, hyperactivity/inattention scales). Psychological evaluations conducted in the schools are usually completed to determine eligibility for the IDEA Emotional Disturbance classification. Neuropsychological evaluations are more comprehensive and may include assessments of sensory-motor functions, attention, memory and learning, and executive functions. The inclusion of these more specific cognitive processing domains in a comprehensive neuropsychological assessment, by default, requires a longer written report.

Armengol, Kaplan, and Moes (2001) suggested that there are three factors that may dictate the length of the neuropsychological report: (1) the nature of the exam, (2) efficiency, and (3) expectations or purpose. If the test battery includes only a neuropsychological screener as compared to a comprehensive assessment, the length of the report will vary. Armengol and colleagues (2001) suggested that some busy clinicians may not have the luxury of writing long reports due to lack of time. The expectations and purpose of the evaluation will help determine the length of the report as well. The report may be lengthy if the evaluation is to determine both eligibility for special education services and provide evidence for prescriptive interventions.

An important principle to remember is that a long report does not necessarily make it better. A list of dos and don'ts for neuropsychological report writing is presented in Rapid Reference 13.2. The rationale for these best practices and poor practices will be discussed in the remainder of this chapter. Keep in mind that the ultimate goal of a good neuropsychological evaluation should be to identify the student's neurocognitive strengths and weaknesses and link that information to prescriptive interventions that will maximize the student's learning potential.

Linear Versus Integrative Report Writing Styles

School psychologists often write psychoeducational and psychological reports in a linear manner. The background information and observations of the child are reported; the results of Test 1, Test 2, . . . Test X; then the examiner writes a summary section and makes recommendations based on the results of the evaluation. The reader of a linear report must wait until the end of the report to see how all of these data relate to each other to help explain the student's current academic or behavioral difficulties.

Rapid Reference 13.2

Tips for School Neuropsychological Report Writing

Neuropsychological Report "Dos"	Neuropsychological Report "Don'ts"
• Administer a battery of tests comprehensive enough to answer the referral question(s). • Discuss the validity of the assessment and any interpretation cautions as needed. • Interpret the various assessment results throughout the report to support the final diagnostic conclusions. • Avoid medical and educational jargon. • Provide data to support the diagnostic conclusions and related recommendations within the report. • Organize the report into sections to aid the reader. • Use tables, charts, and figures to illustrate multiple data. • Integrate the presenting concerns from the referral source(s) with the current assessment results. • List the tests administered to aid in a reevaluation. • Discuss the student's strengths first—then the weaknesses—in the summary section of the report. • Interpret the results within the student's developmental, social-emotional, cultural, and environmental backgrounds. • Answer the referral question(s). • Link the diagnostic conclusions with evidenced-based, prescriptive interventions. • Always provide educational recommendations for the home and school, and, where applicable, the child and outside agency personnel. • Hierarchically arrange the recommendations from the most important first to the least important last.	• Ignore the referral question. • Over test the student, only for the sake of testing. • Ignore the assessment validity section of the report. • Write a report in a pure linear fashion with the results of test 1, 2, … X. • Write a report that reads like a summary section with no supporting evidence for the conclusions. At a minimum include a data sheet at the end of the report. • Provide much assessment data but not put it in the context of the student's developmental, social-emotional, cultural, and environmental backgrounds. • Introduce new information in the summary section of the report. • Overemphasize the presence of brain lesions or dysfunctions. • Include a DSM diagnosis only and assume that will qualify a student for special education services. • Conclude the report with a diagnosis only. • Provide a long list of recommendations that are not organized by home or school, or by neurocognitive areas. • Describe the tests but not the child.

It is recommended that school neuropsychological evaluations not be written in a purely linear fashion. This is due, in part, to the fact that many of the neurocognitive processes measured are not factorially pure. A particular test may require a student to use sustained attentional skills as well as verbal memory processes. The intertwined and cognitively complex neurocognitive tasks that comprise many of the current tests require a more integrative approach to report writing.

A truly integrated report requires more effort, critical thinking skills, and problem solving on the part of the report writer. It is recommended, at a minimum, that the report writer relate the elements of the assessment together as the report is being written. For example, after the background information is presented and it is reported that the child has a history of attention problems, confirm or not confirm that positive history of attention problems based on the classroom observations. In many ways, the examiner is like a *cognitive detective,* and constantly searches for clues in the test results to build a case that best explains academic or behavioral difficulty in the classroom. Likewise, if a student performs poorly on a test that measures attentional processing, the examiner should relate that back to the background information and behavioral observations. Continue to "weave a tapestry" of the supporting evidence of your diagnostic conclusions. Reports that suddenly suggest a diagnosis of ADHD, for example, in the summary section yet provide no supportive evidence throughout the report for that diagnosis are not credible.

Avoiding the Use of Jargon

The report writer has a responsibility to try to communicate complex information in a meaningful way to parents and educators. Several key reminders are important. First, try to avoid professional jargon in the report. Parents and often educators will not understand the medical jargon that is often associated with school neuropsychological cases. When reporting medical jargon from an outside evaluation that is part of the student's relevant background information, it is appropriate to quote the medical terminology, diagnosis, or procedure. However, it is then imperative that the school neuropsychologist defines, in lay terms, that medical jargon. For example, a

CAUTION

Avoid using medical and educational jargon in a report. A teacher might find the statement that "Johnny suffered a subarachnoid hemorrhage" interesting but might not know what to do with the information to better educate Johnny.

student's medical records might indicate, "he suffered a subarachnoid hemorrhage as a result of the head injury." A good practice is to report the medical finding and then put in parentheses a definition. Using the previous example, the report could read: "he suffered a subarachnoid hemorrhage . . . (bleeding under the outer membrane of the brain) . . . as a result of the head injury." Jargon is not limited to medical terminology. Educators have a whole set of acronyms that we use when communicating with each other. Parents will not readily understand a statement in a report such as: "Johnny was initially referred for a CIA by his parents. The IEP team will consider the LRE for placement including possible placements within the LEAP, SBU, Resource, Content Mastery, or continuing regular classroom placement. EYP will also be considered in order to maximize his AYP." School neuropsychologists should minimize or avoid the use of educational and medical jargon. If complex language is used, define it in the report so the reader will be able to better understand what is being communicated.

Including or Not Including Data in a Report

The issue of including data in neuropsychological reports has been debated in the field (see Armengol, Kaplan, & Moes, 2001; Freides, 1993, 1995; Matarazzo, 1995; Naugle & McSweeney, 1996). Some neuropsychologist practitioners write reports that read like summary sections. In these reports there is no data to support their diagnostic conclusions or recommendations. It is almost as if the practitioner is saying "trust me, my conclusions do not need to be justified because I am the expert." These types of reports are generally of little use to a school district that is trying to integrate those test results with its own test results to help the student. By excluding data from a report it makes it nearly impossible for another knowledgeable practitioner to come to the same diagnostic conclusions, or to compare test results for a reevaluation. At a minimum, get in the practice of including a data sheet at the end of the report as an attachment. That way other practitioners can review the data on their own. Also, there is a legal consideration. Unfortunately, we live in a litigious age. If a school neuropsychologist provides testimony in court about his or her written report, the data used to reach the diagnostic conclusions will be paramount. Finally, there is a pragmatic reason why data should be included in a report. School psychologists often have heavy caseloads and the cases have a tendency to "run together" after a while. When sitting in an Individual Education Program (IEP) meeting reviewing the report with the student's parents and educators, the data helps reframe the rationale for your diagnostic conclusions and recommendations.

"A Picture Is Worth a Thousand Words"

Consistent with the idea that school neuropsychologists need to avoid the use of jargon in their report writing, they should also seek methods that clearly communicate complex data to the report reader as quickly and efficiently as possible. Visual charting of data and the use of figures to convey trends in data can be very useful.

Charts that present data that share a common construct, but come from different test batteries, can be a useful method (see example in Figure 13.1). Graphs can also be useful in presenting data that can illustrate strengths and weaknesses clearly. A parent or educator can clearly see what range the student's performance or clinical cluster scores fall into on the example of the graph presented in Figure 13.2.

Sustained Attention				
Test: Subtest	**Standard Score**	**Scaled Score**	**Percentile Rank (%)**	**Classification**
WJIII- Cog: Pair Cancellations	105	—	63	At Expected Level
NEPSY: Auditory Attention and Response Set: Part A score	—	5	3–10	Below Expected Level
NEPSY: Auditory Attention and Response Set: Part B score	—	11	26–75	At Expected Level

Figure 13.1 An example of charting data

COMPONENTS OF A SCHOOL NEUROPSYCHOLOGICAL REPORT

What to Title the Report?

Report titles are often linked to the credentials of the examiner. If the examiner has competency in school neuropsychology, the report could be titled "School Neuropsychological Evaluation." Other titles could be used based on the examiner's qualifications, including: "Neurocognitive Evaluation," or the traditional "Psychoeducational Evaluation." Report titles may be regulated by practice acts within a particular state. Practitioners are urged to know the limits of the practice acts within their states.

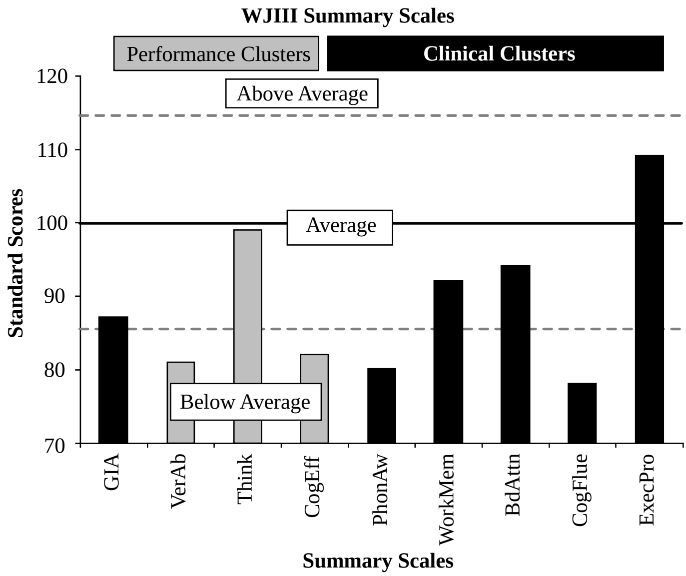


Figure 13.2 Example of a report graph

Organizing the Report

Rapid Reference 13.3 presents a suggested list of major report headers for a school neuropsychological report. The rationale for each of these report sections will be presented in the remainder of this chapter.

Identifying Information

Typically, psychoeducational and school neuropsychological reports contain the following identifying information on the front page of the report:

- student's name
- student's date of birth and age
- student's school name and grade placement
- parent's/guardian's names
- primary language spoken at home
- examiner's name
- dates of testing
- date of report

This identifying information is important to establish the child whom this report is about, when in the child's life the evaluation was conducted, and who conducted the evaluation.

Rapid Reference 13.3

Suggested Overall Organization of the School Neuropsychology Report

- identifying information
- reason for referral
- background information
- current assessment instruments and procedures
- assessment validity
- evaluation results
- summary
- diagnostic impressions
- intervention strategies and recommendations

Reason for Referral

One of the most important sections of a school neuropsychogical report is the reason(s) for referral. It is important to clarify the reasons for referral and the expected outcomes from all parties involved. In this section of the report, identify the person(s) making the referral (e.g., teacher, parent, guidance counselor, private practitioner). It is crucial to document the referral source, because this is the principle audience for the written report. List the questions to be answered by the current evaluation. A referral question such as "What is causing a child to have reading problems and what interventions would work best for this particular child?" is much better than a referral question that states: "Is the child learning disabled in reading?" It is imperative that the referral questions are answered by the end of the evaluation and are clearly stated in the report.

Background Information

Background information may be generally obtained from three sources: (1) a review of the child's educational records, (2) a clinical interview with the parent(s)/guardian(s), and (3) an interview with the child's current teacher(s). A child's cumulative record or educational file is often a "treasure trove" of information that is essential to understanding the history and extent of the presenting problem(s). Fletcher-Janzen (2005) suggested that the child's educational records should be reviewed specifically for information related to absences from school, history of chronic illnesses, evidence of events that could have induced psychological trauma, evidence of events that could reflect neurotoxin exposure, and any assessments and/or diagnoses that the child might have received in the past.

A thorough clinical interview of the child's parent(s)/guardian(s) is crucial to fully understanding a child. Potential explanations or insights into the causal factors of the child's current presenting problems may often be found in the child's background information. The time spent in reviewing the child's educational records and interviewing the child's parent(s)/guardian(s) and teacher(s) is as important as assessing the child directly.

It is good practice to divide this section of the report into subsections. When a reader of the report wants to retrieve a detail from the report related to the birth history, it is easier to find that information if this section is subdivided by background information topics.

The following subsections are recommended, with some example questions:

- *Family History*
  —With whom does the child live?
  —How many brothers and sisters does the child have?
  —Is the child adopted or living with a step-parent or other relative?
  —What is the principle language spoken at home?
  —What cultural factors in this child's life play a role in the child's achievement and behavior at school, in the home, and in the community?
  —Have there been any major family stressors in the past year?
  —Does the family have any major socioecomomic limitations that could impede following the report recommendations?
- *Birth and Developmental History*
  —Did the mother receive adequate prenatal care?
  —Was the child carried full-term?
  —What was the birth weight of the child?
  —Were there any complications during pregnancy or delivery?
  —Did the child achieve developmental milestones within normal age limits?
- *Health History*
  —Does the child have a history of any major illnesses?
  —What is the status of the child's weight, height, sight, and hearing?
  —Has the child experienced any ear infections or hearing problems?
  —Has the child taken any medications, and if so, what dosage?
  —Is there any history of neurological problems (e.g., seizures, head injury, high fever)?
  —Is there a positive family history of either or both sides of the biological family for health related problems?
  —Is the child right or left handed?
  —How many days of school has the child missed each year, on average?

- *Educational History*
  —How many schools has the child attended?
  —Has the child been retained?
  —Has the child received any special education services?
  —What is the history of the child's educational performance? Have there been any dramatic changes in the child's school performance in the past year?
  —Does the child like school?
  —What are the child's best subjects in school?
  —What school subjects are the most challenging for this child?
  —What specific academic or behavioral interventions has the child received?
- *Social History*
  —In which social activities does the child engage?
  —Does this child have many friends?
  —Describe the types of friends this child has and the activities in which he or she engages.
- *Previous Test Results*
  —Review the major highlights of any prior test results.
  —Be sure to mention changes in placement, diagnosis of a psychological disorder or special education classification, and interventions that were implemented.
  —Do not restate the entire content of a prior report in this section. Report only the highlights of previous testing. The reader can read the prior report for more information as needed.
  —If the same test was administered previously, it might be helpful to report those scores in this section or in the later section of the report to illustrate changes in scores over time.

Information about the child's family, birth and developmental, health, educational, and social histories may be obtained by using a structured developmental history (e.g., BASC-2 Structured Developmental History: Reynolds & Kamphaus, 2004).

Current Assessment Instruments and Procedures

In this section of the report, the school neuropsychologist should list the names of the current assessment instruments and the procedures used. As a rule of thumb, list the procedures used or tests administered first to last from the top down. For example, "Record Review" is often the first procedure used in an evaluation so it can be listed first. The developmental/clinical interview with the parent/guardian could be used next, followed by classroom observation, and then a detailed list of the names of the tests administered. It is a good practice to list the name of the test and then abbreviate it. The abbreviation for the test can be used thereafter in the report. For example, the Behavior Assessment System for Children–Second Edition: Teacher Rating Scale (BASC-2 TRS).

DON'T FORGET

Do not get "locked into" a fixed battery approach. Plan the test battery based on the referral question(s), but expand or eliminate tests based on the student's actual test performance. Be flexible!

Related to the Dos and Don'ts of Neuropsychological Report Writing presented in Rapid Reference 13.2, limit the number of procedures and tests to only those needed to answer the referral question. Before starting an evaluation, it is appropriate to design a test battery to fully answer the referral question(s). Keep in mind that the planned test battery may need to change as the assessment progresses. For example, the student may perform poorly on a test that measures visual-spatial processing and the examiner may want to add an additional test to the battery to further explore that neurocognitive area of functioning.

In order to have this flexible battery approach to assessment, the examiner will need to score and minimally interpret the test results as soon as possible. For example, if the student is administered the Woodcock-Johnson III Tests of Cognitive Abilities (Woodcock, McGrew, & Mather, 2001a), and no short-term or long-term memory problems are evident, it may not be necessary to administer a battery of memory and learning tests (e.g., WRAML-2: Sheslow & Adams, 2003), even though the WRAML-2 was part of the initially planned assessment battery. A flexible battery based on the referral question and the subsequent performance on the tests is a best practice.

Assessment Validity

The old adage "garbage in and garbage out" applies here. The school neuropsychologist can construct a thorough test battery and administer it to a student. However, the results could be meaningless or questionable if the child does not cooperate, puts forth poor effort, and is distracted during the examination. Armengol, Kaplan, and Moes (2001) suggested that factors that could compromise the test validity and reliability include:

> diminished attention, effort, or motivation; capacity to understand and remember test instructions (e.g, cultural, linguistic, academic, or intellectual limitations); physical limitations; affective or anxiety disorders; personality problems (e.g., hostility, paranoia), or other distracting conditions

(e.g., pain, sleep deprivation, illnesses); and any suspicions of malingering, exaggeration of deficits, or other deliberate or subconscious attempts by the patient to manipulate the results of the examination. (p. 99)

In this section of the report, the examiner should report test observations such as: level of conversational proficiency, level of cooperation, level of activity, level of attention and concentration, level of self-confidence, style of responding (e.g., impulsive or reflective), and response to challenging tasks (see the Woodcock-Johnson III Tests of Cognitive Abilities Test Session Observations Checklist on the cover of the Test Record Booklet as an example: Woodcock, McGrew, & Mather, 2001a). In addition, any overt pathognomonic signs, such as excessively large or excessively small handwriting, should be reported as well.

When the validity of the assessment results is in question, the examiner should include statements in this section such as "the results of test *x* must be interpreted with caution because . . ." Or, if the results appear valid, the examiner should make a statement such as "these results appear to be an accurate reflection of [the student's] current levels of functioning."

Evaluation Results

Standardizing the Test Descriptors. When interpreting a battery of test results for a parent or an educator, the descriptors of a child's performance level (e.g., average, above average, below average) vary widely across test instruments. For example, a standard score of 84 is labeled as "below average" on some tests and "slightly below average" on other tests. In an effort to make the test results easier to comprehend for parents and educators, it is recommended that a common set of performance-level descriptors be used for all tests scores. The exception to this classification schema would be tests that use a truncated *t*-score distribution to indicate psychopathology. Those tests use descriptors such as average, at-risk, and clinically significant. It is recommended that those types of tests keep these descriptors intact.

It is recommended that the classification labels for all tests administered, with those exceptions previously mentioned, be reported according to the following scale:

Standard Score	Scaled Score	Percentile Rank (%)	Classification Label
>132	>16	99–100	Well Above Expected
116–132	14–16	86–98	Above Expected
111–115	13	76–85	Slightly Above Expected

Standard Score	Scaled Score	Percentile Rank (%)	Classification Label
86–110	8–12	18–75	At Expected
81–85	7	10–17	Slightly Below Expected
68–80	4–6	2–9	Below Expected
<68	<4	<2	Well Below Expected

Organizing the evaluation results section of the report. Rapid Reference 13.4 presents a list of suggested report headers for the evaluation results section of the school neuropsychological report. It is suggested that the evaluation results section of the report be organized following the conceptual model of school neuropsychological assessment presented in the previous chapter. Lichtenberger, Mather, Kaufman, and Kaufman (2004) refer to this type of organization as an "ability by ability" way to organize a report (p. 83).

Classroom observations do involve an evaluation of the student's behavior within the natural environment. Typically, practitioners are encouraged to observe the student across multiple settings including structured and unstructured academic activities and structured and unstructured nonacademic activities (e.g., lunch, recess, walking down the hall). It is best practice to try to

Rapid Reference 13.4

Suggested Report Headers for an Evaluation Results Section of a School Neuropsychological Report

I. Classroom Observations
II. Sensorimotor Functions
III. Attentional Processes
IV. Visual-Spatial Functions
V. Language Functions
VI. Memory and Learning
VII. Executive Functions
VIII. Cognitive Efficiency, Cognitive Fluency, and Processing Speed
IX. General Intellectual Functioning
X. Academic Achievement
XI. Social-Emotional Functioning and Adaptive Behavior

observe the student before he or she knows that an evaluation will be taking place.

In most psychoeducational reports, the results of the general intellectual functioning scores are reported first in the test results section. Too much emphasis has been placed on global measures of intelligence while ignoring or deemphasizing the subcomponents of cognitive processing such as attention, memory, executive functions, and so on. In a school neuropsychological report, it is suggested that the subcomponents of cognitive processing be reported first and given the priority of focus.

In all of the evaluation results sections except the classroom observations and the general intellectual functioning sections, it is suggested that the remaining sections be further subdivided into three areas:

- *Presenting concerns*—a list of the presenting concerns relevant to the area being assessed. If a concern is expressed, state it in terms of severity (mild, moderate, or severe). Also try to get the perspective from both the parent(s)/guardian(s) and a teacher.
- *Current levels of functioning*—the test results are presented relevant to the area being assessed. This section may need to be subdivided (see Rapid Reference 13.5).
- *Summary of results*—this section should address how the presenting concerns relate to the current levels of functioning.

In addition to the developmental history information reported in the background information section of the report, a school neuropsychologist should gather information regarding the current presenting concerns about the child. The presenting concerns information should be ideally obtained from both a teacher and the child's parent(s)/guardian(s). In Appendix B, there is a checklist that can be used to gather information on the presenting concerns. The form is called the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth* (Miller & Lang, 2005). The checklist was designed to mirror the areas assessed in the school neuropsychological conceptual model that is presented in this book.

In some report writing models, all of the presenting concerns are listed in the beginning of the report, often within the background information section. The problem with this approach is that it forces the reader of the report to keep flipping back to the previous section of the report to compare the presenting concerns with the current assessment findings. Putting both the presenting concerns and the current assessment results in the same section leads to better integration of the information.

Rapid Reference 13.5

Expanded Report Headers for an Evaluation Results Section of a School Neuropsychological Report

I. *Classroom Observations*

II. *Sensorimotor Functions*
- Presenting concerns
- Current levels of functioning
  - —Sensory functions
    - Visual
    - Auditory
    - Kinesthetic
    - Olfactory
  - —Motor functions
    - Fine motor coordination
    - Gross Motor Coordination
- Summary of sensorimotor functions

III. *Attentional Processes*
- Presenting concerns
- Current levels of functioning
  - —Selective/focused attention
  - —Shifting attention
  - —Sustained attention
  - —Divided attention
  - —Attentional capacity
- Summary of attentional processes

IV. *Visual-Spatial Functions*
- Presenting concerns
- Current levels of functioning
  - —Visual perception (motor response)
  - —Visual perception (motor-free response)
  - —Visual-perceptual organization
  - —Visual scanning/tracking
- Summary of visual-spatial functions

V. *Language Functions*
- Presenting concerns
- Current levels of functioning
  - —Auditory/phonological processing
  - —Oral expression
  - —Listening comprehension (receptive language)
- Summary of language functions

VI. *Memory and Learning*
- Presenting concerns
- Current levels of functioning
  - —Verbal immediate memory
  - —Visual immediate memory
  - —Verbal-visual associative memory
    - Verbal-visual associative learning
    - Verbal-visual delayed associative memory
  - —Verbal (delayed) long-term memory
    - Verbal learning
    - Verbal delayed recall
    - Verbal delayed recognition
  - —Visual (delayed) long-term memory
    - Visual learning
    - Visual delayed recall
    - Visual delayed recognition

(*continued*)

    —Working memory
        ◦ Verbal working memory
        ◦ Visual working memory
    —Semantic memory (comprehension-knowledge)
- Summary of memory and learning functions

VII. *Executive Functions*
- Presenting concerns
- Current levels of functioning
    —Cognitive Areas
        ◦ Problem solving, fluid reasoning, & planning
        ◦ Shifting attention
        ◦ Working memory
    —Preprogrammed motor movements
    —Behavioral/emotional regulation
- Summary of executive functions

VIII. *Cognitive Efficiency, Cognitive Fluency, and Processing Speed*
- Presenting concerns
- Current levels of functioning
    —Cognitive efficiency
    —Processing speed
    —Cognitive fluency
- Summary of rate of responding functions

IX. *General Intellectual Functioning*
- Presenting concerns
- Current levels of functioning
- Summary of general intellectual functions

X. *Academic Achievement*
- Presenting concerns
- Current levels of functioning
    —Basic reading skills
    —Reading comprehension skills
    —Mathematics computations
    —Mathematical reasoning
    —Written expression
- Summary of rate of responding functions

XI. *Social-Emotional Functioning*
- Presenting concerns
- Current levels of functioning
- Summary of rate of responding functions

After the basic cognitive processes are presented, the overall general intellectual functioning scores are presented along with the current levels of academic achievement. Social-emotional functioning and adaptive behavior are reported last. For each of the neurocognitive functions or processes (Sections II–VIII) there are subcomponents that may or may not be addressed in the report based upon the referral question(s). Rapid Reference 13.5 provides a more detailed list of the subcomponents that can be considered for inclusion in the report.

Summary

The summary section of a school neuropsychological report is a review of the major findings of the evaluation. Keep in mind that some educators and outside consultants working with the student may read only the summary section of the report. Be careful to note that this is not a section of the report that repeats verbatim prior sections of the report (Lichtenberger, Mather, Kaufman, & Kaufman, 2004). Also, it is not an appropriate practice to introduce new content in the summary section that has not been introduced elsewhere in the report. For example, the revelation that, "Johnny had a head injury prior to the evaluation," is information that should not be introduced for the first time in this section of the report. Review the reason(s) for referral, the highlights of the background information, and test results. This is an ideal place in the report to restate the referral question(s) and answer directly based on the interpretation of the current assessment data.

It is suggested that when reviewing the test results, discuss the student's strengths first, followed by the student's weaknesses. By the time a student gets to a neuropsychological evaluation, the student may have been evaluated multiple times. Too often evaluations focus on what a student cannot do for special education qualification purposes while deemphasizing the strengths of the student. Lead with the student's strengths in the summary section and the parent might continue to read more optimistically through the next section that describes the student's weaknesses.

In the summary section, it is important to interpret the results within the student's developmental, social-emotional, cultural, and environmental backgrounds. For example, be careful not to suggest neuropsychological deficits that are actually caused by an overall dampening of neurocognitive processing due to social-emotional trauma or dysfunction or cultural factors.

Diagnostic Impressions

Should the presence or absence of a brain lesion/dysfunction be suggested in a school neuropsychology report? A school neuropsychologist needs to know about brain physiology and should know how to recognize signs of brain dysfunction. However, too often neuropsychological reports from outside consultants to the schools will proclaim diagnostic statements such as "Johnny has a right parietal lesion." While Johnny's teacher might find that diagnosis fascinating, she or he will probably not know what to do to better educate Johnny based on that information. Statements like that also scare the parent(s) needlessly. It would be best if the neuropsychologist/school neuropsychologist would describe the constellations of deficits and/or strengths associated with a right parietal lobe dysfunction and then in

DON'T FORGET

When writing the summary section of the report, lead with the child's strengths before presenting the areas of concern.

the next section of the report suggest prescriptive interventions that target the deficit areas. It is probably best practice never to use the word *lesion* in a school neuropsychological report, or to refer to specific anatomical locations of the brain unless previously noted by the medical community. Lesion is a word best used by a physician who has direct access to neuroimaging tools such as MRI or CAT scans. As a school neuropsychologist interested in measuring and describing functional strengths and weaknesses, a better word to describe a neuropsychological deficit is *dysfunction*.

Should a Diagnostic Statistical Manual (DSM) diagnosis be used in the report? In some states and local school districts, school psychologists are expressly forbidden to use a *DSM-IV* diagnosis in their reports. A good rule of thumb is whether the report will be used by outside practitioners (e.g., psychologist, counselor, speech pathologist) that rely on third-party reimbursement for their fees. The private practitioner will appreciate the school neuropsychologist communicating with them in a common language (i.e., the *DSM-IV* diagnosis; Lichtenberger, Mather, Kaufman, & Kaufman, 2004). The school neuropsychologist must still use the language of IDEA to determine eligibility for special education services. A *DSM-IV* diagnosis alone does not qualify a student for IDEA special education services. This is a misunderstanding that many private practitioners have about writing diagnostic statements in reports based on the *DSM-IV* exclusively.

Finally, it is imperative that school neuropsychological reports not simply end with a diagnosis of the student. It would be a waste of the student's time and effort to participate in a comprehensive school neuropsychological evaluation only to come away with a diagnosis or set of diagnoses.

Intervention Strategies and Recommendations

Organization of the intervention strategies and recommendations section. The real value of a school neuropsychological assessment is to target interventions that capitalize on a student's strengths and work to improve the student's weaknesses. A dubious practice that is used by some practitioners is to provide a very long list of recommendations and not have them listed in any organized manner. Parents and teachers will want to prioritize the top interventions they can provide to help the student. Too many recommendations in a report will overwhelm the reader and it will run the risk that none of the recommendations will be followed. Another critical consideration in making recommendations is to use those intervention strategies that have a proven effectiveness and are most appropriate to provide in the home or academic environments.

Lichtenberger, Mather, Kaufman, and Kaufman (2004) suggested that the reasons that recommendations are not followed are because

> the recommendations are too vague, not shared with appropriate personnel, too complex, too lengthy, inappropriate for the person's age or ability levels, not understood by the person responsible for implementation, impossible to implement in the setting, too time-consuming, and rejected by the client or student. (p. 162)

A good practice is to divide the recommendations section into a *minimum* of two parts: recommendations for school and recommendations for home. It is also a good practice to add a section entitled "Recommendations for the Student." The student is obviously the focus of the home and school recommendations and needs to be an active participant in recommendations as well, particularly as the student reaches middle childhood and adolescence. An additional section may be warranted that could be entitled "Recommendations for the Outside Consultant or Agency." This section would contain recommendations for agency or private mental health professionals, educational consultants, or physicians that may end up reading the report.

Each of the recommendations sections should be further subdivided into the areas that need to be addressed. For example, if the current assessment found that the student had poor processing speed, then make recommendations for what the parent(s), school personnel, child, and agency personnel (if applicable) can do to help improve the student's processing speed. It is suggested that within each section that addresses a particular processing deficit or concern, that the report writer hierarchically arrange the recommendations from the most important to the least important. The report writer should ask the question: "If the parent could only do one thing different to help this student, what would that be?" Make sure that recommendation is at the top of the list. Try to stay within the limit of five or fewer recommendations for each area.

Remediation versus compensation issues. A question that has been debated for a long time in education is: How long should an intervention last before it is determined to be ineffective and the decision is made to try another intervention? Our profession is grappling with this issue currently as a Response to Intervention (RTI) model is implemented. Within the RTI model the second tier consists of targeted interventions. It is within this tier that questions as to the length and methods of the intervention will need to be addressed before reassessment and further prescription of intervention is deemed necessary.

The issue of remediation versus compensation can be looked at more broadly as well. For example, Fletcher and Lyon (1998) reviewed the research on the remediation of reading disorder and found that remediation of reading skills in students past the fourth grade is difficult. Thus, in the area of reading, there appears to be a critical period in which basic reading skills (e.g., phonological awareness and decoding) must be taught. If it is discovered that an 8-year-old does not have good phonological decoding skills, then intensive remedial strategies can be targeted at the problem. However, if a 14-year-old has still not acquired basic phonological decoding skills, then the focus of the intervention needs to be more compensatory then remedial. In this case the 14-year-old student might benefit from learning a whole word as he or she sees it in space; therefore new vocabulary words may be learned using flash cards. A basic rule of thumb for reading, as well as many other academic skills, is that more "bottom-up" strategies should be explored in the early years, and more "top-down" strategies in the later years. These "top-down" or metacognitive strategies are often more compensatory in nature. At some point calculators replace an inability to perform manual mathematical calculations and word processors replace an inability to write grammatically correct sentences without spelling errors.

In summary, the recommendations that are made in a school neuropsychological report should be organized and prioritized to aid the reader. Recommendations should be based on intervention strategies that have a research base of effectiveness. And finally, recommendations should be tailored in such a way that the student's strengths help compensate for his or her weaknesses. School neuropsychological evaluations can provide educators and parents a wealth of information that can be used to improve educational quality for students.

In this chapter, a model for a school neuropsychological report has been presented. In the next chapter, a case study will be used to illustrate a sample school neuropsychological evaluation.

TEST YOURSELF

1. **The comprehensive model described in this chapter would need to be used for each student who needs a school neuropsychological evaluation.** True or False?
2. **The title of a school neuropsychological report should be:**
   (a) School Neuropsychological Evaluation
   (b) It depends on the rules of practice within the state.
   (c) Neurocognitive Assessment
   (d) Neuropsychological Evaluation
3. **If a school neuropsychologist must use jargon in a report, it is best practice to define the jargon in terms a layperson understands.** True or False?
4. **A school neuropsychologist should consider using a *DSM-IV* diagnosis in his or her report when:**
   (a) The school neuropsychologist should never use a *DSM-IV* diagnosis in his or her report.
   (b) If the school neuropsychologist wants to qualify the student as Severely Emotionally Disturbed under IDEA.
   (c) The report will be used by the classroom teacher to craft a set of educationally relevant interventions.
   (d) The report will be used by a specialist outside of the school district such as a private practitioner or agency personnel and the district allows the use of the *DSM-IV* diagnoses.
5. **Introducing new information into the summary section of the report is acceptable practice.** True or False?
6. **Which of the following referral questions is stated in the most complete way?**
   (a) Is Johnny learning disabled?
   (b) What is causing Johnny to have reading problems and what interventions would work best for him?
   (c) Is Johnny dyslexic?
   (d) Is Johnny reading disabled?
7. **Which of the following reasons listed are good reasons for including data in the school neuropsychological report?**
   (a) The examiner who evaluates the student years later will have something to compare the current results to.
   (b) The data will provide support for the diagnostic conclusions and related educational recommendations.
   (c) The data will help the examiner reconstruct the reasoning behind the diagnostic conclusions made in the report.
   (d) All of the above are good reasons to include data in the report.

Answers: 1. false; 2. b; 3. true; 4. d; 5. false; 6. b; 7. d

Fourteen

SAMPLE SCHOOL NEUROPSYCHOLOGY REPORT

The following report is based on an actual case study. The names and identifying information have been changed to mask the identity of all parties involved.

This school neuropsychological report is comprehensive for purposes of illustrating the school neuropsychology assessment model. In everyday practice, school psychologists will not typically have the time to conduct an assessment this thoroughly. When applying the school neuropsychological assessment model, it is important that the referral question(s) guide the compilation of the assessment instruments used to answer the referral question(s).

School Neuropsychological Evaluation

IDENTIFYING INFORMATION

Student's Name: John Doe	Date of Birth: 02/08/1997	Age: 8-0
School: Anywhere Elementary	Grade: 2.6	
Parents: Mr. & Mrs. Doe	Home Language: English	
Examiner: Dr. Seymour Children		
Date of Report: 02/12–13/2005		

REASON FOR REFERRAL

Mr. & Mrs. Doe were concerned that John was not progressing well in reading. John is also taking 18 milligrams of Concerta® daily to control symptoms of hyperactivity and inattention. The parents were concerned about how much John's attentional difficulties could be accounting for his current delays in reading. The Does requested to have John evaluated to determine his processing strengths and weaknesses and to obtain recommendations designed to maximize his learning potential.

BACKGROUND INFORMATION

Family History

John lives with his biological mother and father. He has a younger sister who is 4 years old. English is the primary language spoken at home. Mrs. Doe reported that John likes to watch TV, play sports, play video games, play on his computer, collect things, and he likes art. According to his mother, John prefers to play alone but he does play with others sometimes.

Birth and Developmental History

Mrs. Doe was under the care of a physician throughout her pregnancy. During the pregnancy, Mrs. Doe took prenatal vitamins and iron supplements. She was taking antibiotics the last 5 months of the pregnancy as a result of surgery to remove the ovarian cyst. The mother reported that she did not use alcohol, caffeine, or any drugs during pregnancy other than those previously listed and prescribed by her physician. The mother gained 28 pounds during John's pregnancy. John was carried to full term.

After a labor that lasted 12 hours, John was born weighing 6 pounds and was 19 inches long. The labor was reported by Mrs. Doe to be easy. John was born vaginally and head first. At birth he was a little jaundiced, but not to a marked degree and no treatment was necessary. Mrs. Doe could not remember the APGAR scores at birth, but there was no evidence of any concerns.

In terms of John's development, his mother reported that large muscle skills and self-help skills occurred within the normal time frame as compared to other siblings. John had good neck and arm muscle development as an infant. It was reported by the mother that John had some gastroesophageal reflux as an infant, but his appetite was good and his growth rate was normal. John was reported to have some delay in language. He did not start talking in complete sentences until he was 3 years old. A speech and language therapist came to the home to work with John once a week when he was 3 years old. The speech therapy did not seem to improve John's speech at the time. John started to talk in sentences at age 4.

John's early temperament as a child up to the age of 5 was described by his mother as:

- high physical activity level
- regular and predictable sleeping and eating schedule
- inhibited and cautious in unfamiliar situations
- concentrated well

- socially very friendly with others
- stayed focused on activities
- a high sensitivity to his environment (e.g., noises bothered him)
- a high degree of emotions (overacting)
- a very happy mood

Health History

John's overall health is good. He gets sick no more than average according to his mother. He does have some significant allergies and he takes Zyrtec® daily to treat his allergies. He seems to have a persistent cough, which was noted during the testing session, that his mother reported to be related to ongoing allergy problems. John has had three ear infections since birth and all have been successfully treated with antibiotics.

When John started school, he demonstrated high levels of hyperactivity and distractibility that interfered with his learning. He has been taking 18 milligrams of Concerta® for the treatment of ADHD, Predominately Hyperactive Type, for the past several years. Mrs. Doe reported that when John is on Concerta®, "he is more calm. When he is off the medication, he is climbing the walls (e.g., will not sit still, runs in circles, runs into the walls)."

Mrs. Doe reported that John has been having trouble gaining weight. She feeds him extra protein and is monitoring his weight gain closely. Mrs. Doe believes that the poor weight gain may be a side effect of the Concerta®.

School History

John attends Anywhere Elementary in Anywhere School District in Anywhere, USA. John is in the second grade. He has never repeated or skipped a grade in school. John is placed in a regular classroom with some supplemental help from a reading teacher. He is not identified for any special education services at this time. Mrs. Doe reported that John likes school most of the time but he does not like doing homework. It was reported that at school, John gets along with his classmates and his teacher. The teacher says that he disrupts the class a lot. The mother drew a diagram that showed that John was sitting right next to the classroom teacher's desk in an effort to closely monitor his behaviors. Mrs. Doe reported that John's best subjects are math and art and his hardest subjects are reading and writing.

Previous Testing Results

In the public schools, John was administered the Otis-Lennon School Ability Test (OLSAT). The OLSAT assesses verbal and nonverbal reasoning abilities that are related to success in school. Although the total score is the best overall indicator of school-learning ability, a student's ability to learn in school is dependent on both types of skills. The Verbal processes measured are Verbal Comprehension and Verbal Reasoning. Nonverbal processes are Pictorial Reasoning, Figural Reasoning, and Quantitative Reasoning. These are his OLSAT scores from the first and second grades:

	School Ability Index	Verbal School Ability Index	Nonverbal School Ability Index
1st Grade	125	117	128
2nd Grade	100	99	101

Note: The School Ability Indices have a mean of 100 with a standard deviation of 16.

John was also administered the Wide Range Achievement Test as a screener. He achieved standard scores of 63 in reading and 104 in mathematics. As a result of a review of these screening results he is currently being referred for a dyslexia evaluation within Anywhere School District.

CURRENT ASSESSMENT INSTRUMENTS AND PROCEDURES

Record Review
Child Neuropsychological History (CNH)
Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth (NPCC)
Parent Interview
Classroom Observation
Woodcock-Johnson III Tests of Cognitive Abilities (WJIII-Cog)
Woodcock-Johnson III Tests of Achievement (WJIII-Ach)
NEPSY–A Developmental Neuropsychological Assessment
Behavior Assessment System for Children–Second Edition: Parent Rating Scale (BASC-2 PRS)
Behavior Assessment System for Children–Second Edition: Teacher Rating Scale (BASC-2 TRS)

ASSESSMENT VALIDITY

John accompanied the examiner to the testing room with ease. Mrs. Doe left John in the care of the examiner during the morning testing session since she had to go to work. John separated well from his mother and seemed eager to work in a one-to-one session. John is a Caucasian child with a fair complexion who appears to be underweight for his age. John wrote with his right hand. John's attention span was excellent for a child his age and for a child with a history of attentional difficulties. Frequent breaks were taken, generally one every hour. Because of John's history of inattention and hyperactivity, his behavior was monitored closely. He seemed to put forth good effort on all of the tasks presented to him. He did display some nervous behaviors (e.g., shaking his hands) when he was asked to perform some timed tests. Despite being a "bit uptight" during the two timed tests, he was able to concentrate on and perform the task. Overall, the test results appear to be a valid estimate of John's current levels of functioning.

EVALUATION RESULTS

Performance levels for all tests administered will be reported according to the following scale:

Standard Score	Scaled Score	Percentile Rank (%)	Classification Label
>132	>16	99–100	Well Above Expected
116–132	14–16	86–98	Above Expected
111–115	13	76–85	Slightly Above Expected
86–110	8–12	18–75	At Expected
81–85	7	10–17	Slightly Below Expected
68–80	4–6	2–9	Below Expected
<68	<4	<2	Well Below Expected

The only exception to this classification scheme will be the BASC-2 behavioral rating scale, which used different performance-level descriptors.

The test results section is organized into the following areas:

I. Classroom Observations
II. Sensorimotor Functions
III. Attention
IV. Visual-Spatial Functions
V. Language Functions
VI. Memory and Learning
VII. Executive Functions
VIII. Speed and Efficiency of Cognitive Processing
IX. General Intellectual Functioning
X. Academic Achievement
XI. Social-Emotional Functioning

I. Classroom Observations

John was observed in his regular classroom setting on the morning of [DATE]. John's desk was placed right next to the overhead projector in the front of the classroom. Mrs. Smith, John's teacher, reported that she recently moved John to this placement in order to keep him close to her. The classroom activities included a group math assignment, a group reading activity, and a transitional time to a restroom break. Since it was a holiday, the entire classroom appeared excited about the day and the parties scheduled for the afternoon. Mrs. Smith had a well-managed classroom and she kept on top of the behaviors that could disrupt instruction. Throughout the observation period, John sat very quietly at his desk. He demonstrated no signs of hyperactive behaviors. Occasionally, he did get distracted from the classroom activities and played with his fingers, hands, or lower lip. He consistently did not raise his hand to volunteer to answer any questions posed by the teacher. On the one occasion he was asked a direct question by the teacher, he gave an answer that was related to the content of the story, but he could not respond correctly to the query. About 95 percent of the time, John seemed to be paying attention and was not overly active or distracted by other classroom events.

II. Sensory-Motor Functions

Presenting Concerns

On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth* (Miller & Lang, 2005), Mrs. Doe reported that John was not experiencing any gross or fine motor coordination problems at home or at school. He recently passed both his visual and hearing screenings at the school. In the sensory areas, Mrs. Doe reported that John is overly sensitive to noise. According to his mother, John "holds his ears and starts to cry if something is too loud. If his sister makes noises that irritate him, sometimes he cries." Mrs. Doe also reported that John is a very picky eater. He will refuse food that is not to his liking. He does not like it when spices and herbs are used in his food (e.g., parsley or pepper).

Current Levels of Functioning

John's sensorimotor skills were formally evaluated using the NEPSY. The NEPSY is a comprehensive instrument designed to assess neuropsychological functioning in preschool and school-age children. The Sensorimotor Functions domain of the NEPSY is designed to assess the coordination and integration of multiple systems that mediate the production of speech, smooth and efficient limb and body movements, and dexterous movements of the hands and fingers. These systems also mediate equilibrium, eye movements, and visual-spatial processing, and are important in carrying out an intention in order to engage in purposeful behavior.

John's sensorimotor skills are all within the average range of functioning for his given age group (see the following table). On the Fingertip Tapping test, one of the tasks required John to touch his thumb to each of his fingers in succession, one at a time, starting with the index finger, then repeat the pattern again. Seventy-three percent of the children John's age use "visual guidance" to help them complete this task and John was no exception. As children get older, this task becomes more automatic, but younger children often have to add the additional visual modality to help them regulate this behavior. John's use of "visual guidance" on this task is mentioned here because the reader of this report will note that John often relies on visual processing across multiple systems to help improve his learning.

Sensorimotor Functions			
NEPSY Subtests	**Scaled Score**	**Percentile Rank (%)**	**Classification**
Fingertip Tapping	11	26–75	At Expected Level
Imitating Hand Positions	7	11–25	Slightly Below Expected Level
Visuomotor Precision	9	26–75	At Expected Level

John is right-handed, yet on the Imitating Hand Positions test, he actually was able to reproduce hand positions better with his nondominant, left hand. This test was one of the last ones administered to John after a long day of testing and he got a little silly making the hand positions. The score obtained on this test may be a minimal estimate of his true abilities in this area.

On the Visuomotor Precision test, John was asked to trace a path from a starting to stopping point as quickly as possible while staying within the lines. Often times, children with attentional processing difficulties and hyperactive behaviors will be impulsive on this task by rushing through it and making many errors. John's completion times and error rates were within the average range for his age. This may be a reflection of the beneficial effects of the Concerta® medication.

Sensorimotor Functioning Summary

John's Sensorimotor functions appear to be average for a child his age. There were no significant areas of concern in this domain of functioning.

III. Attention

Presenting Concerns

On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth* (Miller & Lang, 2005), Mrs. Doe reported that John has experienced problems with attention in the past that started when he was around 5 years old. His mother reports that John has difficulty paying attention in class because he gets "distracted a lot." She also reported that his mind appears to go blank at times, or he loses his train of thought. The example that she gave for this was "while he is reading, he will talk about the picture and then forget where he was reading." John does seem to be able to sustain his attention when he is playing video games. Mrs. Doe reported that John has exhibited significant signs of inattention and hyperactivity in the past. The characteristics endorsed by the parent that reflect *inattentive behaviors* were as follows:

Mild Problems in these areas:

- Difficulty organizing activities.
- Avoids or dislikes activities that require a lot of mental effort (e.g., school work, homework).
- Loses things necessary for tasks at home or school.
- Very forgetful.

Moderate Problems in these areas:

- Inattention to details or makes careless mistakes.
- Difficulty sustaining attention over time in schoolwork or play.

- Does not seem to listen when spoken to.
- Does not follow through on instructions/fails to complete schoolwork or other activities.

Mrs. Doe reports that John "hates homework. When he loses on video games he cries. He always wants a friend to come over and play with him, but once they are there, he plays by himself."

The characteristics endorsed by the parent that reflect *hyperactivity* were as follows:

Mild Problems in these areas:
- Fidgety, restless when seated.
- Difficulty staying quiet.
- Runs or climbs when it is inappropriate to do so, or feels very restless.

Moderate Problems in these areas:
- Leaves seat in classroom or other situations when required to remain seated.
- Always moving or acts as if driven by a motor.

Severe Problem in this area:
- Talks excessively.

Several years ago, Mrs. Doe took John to her family doctor, who prescribed Concerta® for John. The mother reports that John concentrates best "after he takes his pill in the morning." Mrs. Doe reported that when John is on Concerta® "he is more calm. When he is off the medication, he is climbing the walls (e.g., will not sit still, runs in circles, runs into the walls)."

The characteristics endorsed by the parent that reflect *both inattentive and hyperactive behaviors* were as follows:

Moderate Problems in these areas:
- Blurts out answers before questions are completed.
- Difficulty waiting turn in class or in games.
- Interrupts or intrudes frequently.

Mrs. Doe reported that John "is impatient." John's inattentive and hyperactive behaviors were reported by the mother to have a slow progressive onset. Compared to other children his age and to his sister, Mrs. Doe sees John as having more problems in attention, concentration, and hyperactivity than the others.

Current Levels of Functioning

John was evaluated in 1 long day of testing. Typically, children with a history of Attention-Deficit/Hyperactivity Disorder (ADHD) are not able to sit still for prolonged periods of time and focus their attention. The testing session was broken into 1-hour increments and John was able to work well one-to-one for prolonged periods of time. He did well over a 3-hour testing session in the morning, with an hour lunch break, and a 3½-hour testing session over the afternoon. John showed excellent attention span and focus for a child his age.

Attention is a complex and multifaceted construct when an individual must focus on certain stimuli for information processing. In order to regulate thinking and to complete tasks of daily living, such as schoolwork, it is necessary to be able to attend to both auditory and visual stimuli in the environment. Attention can be viewed as the foundation of all other higher-order processing. In other words, if attention is compromised it can adversely affect other cognitive processes of language, memory, visuospatial skills, and so on. Attention can be divided into five subtypes: selective attention, shifting attention, divided attention, sustained attention, and attentional capacity. The test results will be reported broken down into those subtypes of attentional processing.

Selective/Focused attention refers to the vigilance in monitoring information. An example of selective/focused attention would be the child's ability to pay attention to only the classroom teacher when there is the noise and the visual distracters of the classroom to ignore. John's performance on several measures of selective/focused attention are presented in the following table.

Selective/Focused Attention				
Test: Subtest	**Standard Score**	**Scaled Score**	**Percentile Rank (%)**	**Classification**
WJIII-Cog: Auditory Attention	91	—	28	At Expected
NEPSY: Auditory Attention and Response Set Total Score	—	8	11–25	At Expected
NEPSY: Auditory Attention and Response Set: Part A score	—	5	3–10	Below Expected
NEPSY: Auditory Attention and Response Set: Part B score	—	11	26–75	At Expected
NEPSY: Visual Attention	—	11	26–75	At Expected

On the WJIII-COG Auditory Attention Test, John was asked to pay attention to a male voice on a tape player that was saying to point to a target picture (e.g., "point to *sun*") while there was an increased background noise level across test items (an auditory distracter). Imagine trying to pay attention to someone sitting across from you in a restaurant that keeps getting more crowded and noisy during a lunch hour; that sums up the demands of this task. John performed well on this task. The added visual pictures that he had to point to when the target word was spoken made this task easier for John. John's selective/focused attention is best when it is purely visually based or has at least some visual cues.

The NEPSY Auditory Attention and Response Set test is broken down into two parts. Part A measures simple auditory selective attention and sustained attention (see later in report). The child is instructed to put a red foam chip into a box lid every time the word *red* is spoken and ignore all other colored chips. John had a lot of difficulty with this task. The practice trial was repeated twice and John seemed to get the idea of what he was supposed to do; however, when the task itself started, John made many errors. John correctly placed 27 red foam squares into the box as per the task instructions, but he also placed 27 other-colored foam squares into the box. He was told to ignore all other colors except the red foam squares. He would have undoubtedly continued to put in some other colored squares if he had not run out of that particular color during the task. The poor performance on this task could be caused by a variety of factors. In John's case, the integrated data from the rest of this case study suggest that John's poor performance on this test may be a function of his poor memory skills (which lead to poor comprehension) and his poor auditory selective/focused attention.

On the second more cognitively challenging part of the Auditory Attention and Response Set test (Part B), the child was asked to put a yellow foam square into the box when the word *red* was spoken, a red foam square into the box when the word *yellow* was spoken, and put a blue foam square in the box when the word *blue* was spoken. John was able to correctly shift and selectively focus his attention to the correct target pieces, but he again put in extra pieces in the box when he was not supposed to. A compensatory strategy that John may have learned is that when a task gets exceedingly complex and challenging, just guess on everything with the hope that something will be right.

On the NEPSY Visual Attention test, John achieved an average score. He was asked to pick out a set of cat pictures from a visual array on the first part and match two faces on the second part of the test. John did show an unusual behavior on this test that is important to note. The task is set up so that the pictures to find or match are spread across two pieces of paper with a staple in between. On both parts of the test, John initially ignored all of the stimulus items on the right side of the page and only started matching the items on the left side of the page. Once he was reminded to look on both sides of the page he matched an equal number of targets on both sides. He did not show any other signs of a unilateral neglect problem (ignoring one half of a visual space) across the rest of the testing.

Shifting attention refers to the ability to maintain mental flexibility in order to shift from one task to another. Some children get stuck "in one gear" and cannot easily change from one activity to another. Completing a math worksheet that has both addition and subtraction problems on the same page requires the child to shift attention between the addition and subtraction problems. A measure of John's shifting attention is reported in the following table.

Shifting Attention				
Test: Subtest	**Standard Score**	**Scaled Score**	**Percentile Rank (%)**	**Classification**
NEPSY: Auditory Attention and Response Set: Part B score	—	11	26–75	At Expected

The only measure of shifting attention that was administered to John was the NEPSY Auditory Attention and Response Set: Part B test. As reported in the prior selective/focused attention section, John achieved an average score in this area. However, John made so many commission errors (putting into the boxes extra colored foam pieces) that he ran out of black pieces about two-thirds of the way through the test. If he had extra black pieces to continue to put into the box in error, he would have most probably continued to do so. Therefore, John's score of 11, which is average, on this test is probably an overestimate of his true performance. The positive result was that John was able to shift his cognitive set and put into the box the yellow pieces when he heard the word *red* and vice versa. John's ability to shift his attention appears to be better developed than his ability to selectively focus his attention.

Divided attention refers to the ability to respond to more than one task simultaneously. A child listening to the teacher while coloring a picture is an example of divided attention. A measure of John's divided attention is reported in the following table.

Divided Attention				
Test: Subtest	**Standard Score**	**Scaled Score**	**Percentile Rank (%)**	**Classification**
WJIII-Cog: Auditory Working Memory	98	—	46	At Expected

On the WJIII-COG Working Memory test, the child is verbally presented a set of words and numbers. The child is instructed to recall the words in the order they were sequentially presented first, followed by the numbers in the order in which they were sequentially presented second. John performed well on this test for his age group. It was easier for him to remember the words in the right order compared to the numbers. This is an area in which the Concerta® might be providing some beneficial effects.

Sustained attention refers to the ability to maintain an attention span over a prolonged period of time. Measures of John's sustained attention are reported in the following table.

On the WJIII-Cog Pair Cancellations test, John was asked to pick out a particular repeated visual stimulus within a much larger visual array. John achieved an average score on his visual sustained-attention task. The Auditory Attention and Response Set test on the NEPSY contains elements of sustained attention as well, only in the auditory mode. John's poor performance on portions of the Auditory Attention and Response Set test were not caused by a sustained attention problem.

Sustained Attention				
Test: Subtest	**Standard Score**	**Scaled Score**	**Percentile Rank (%)**	**Classification**
WJIII-Cog: Pair Cancellations	105	—	63	At Expected
NEPSY: Auditory Attention and Response Set: Part A score	—	5	3–10	Below Expected
NEPSY: Auditory Attention and Response Set: Part B score	—	11	26–75	At Expected

Attentional capacity refers to how much information can be attended to before the child gets overwhelmed. Measures of John's attentional capacity are reported in the following table. The Numbers Reversed test on the WJIII-Cog measured attentional capacity and working memory. On the WJIII-Cog Numbers Reversed test, John was asked to listen to a string of verbally presented numbers then recall them in reverse order. John achieved a score that was slightly below average compared to other children his same age. Numbers Reversed also involves working memory that will be discussed later in the report.

Attentional Capacity				
Test: Subtest	**Standard Score**	**Scaled Score**	**Percentile Rank (%)**	**Classification**
WJIII-Cog: Numbers Reversed	89	—	24	Slightly Below Expected

Behavioral Ratings (Attention & Hyperactivity)

The Behavior Assessment System for Children–Second Edition (BASC-2) is an integrated system designed to facilitate the differential diagnosis and classification of a variety of emotional and behavioral disorders of children. Any score on the BASC-2 in the clinically significant range ($T = 70+$) suggests a high level of maladjustment in that area. Scores in the at-risk range ($T = 60$–69) identify either a significant problem that may not be severe enough to require formal treatment or a potential of developing a problem that needs careful monitoring.

The following chart shows the BASC-2 results from the Parent and Teacher forms for the Hyperactivity and Attention Problems scales. The norms were calculated two ways: (1) using a normative comparison based just on males John's age and (2) using a clinical sample of ADHD boys his own age. Neither the Hyperactivity nor the Attention Problems scales were in the at-risk or clinically significant range for either rater using either set of norms. It is important to note that these rating scales were filled out based on the behaviors observed while John is taking his Concerta® medication.

Behavioral Ratings				
BASC-2 Ratings	**Norm Group Comparison**	***T*-Score**	**Percentile Rank (%)**	**Classification**
Parent Rating—*Hyperactivity*	All males his age	57	79	Average
Teacher Rating—*Hyperactivity*	All males his age	59	83	Average
Parent Rating—*Attention Problems*	All males his age	54	67	Average

(*continued*)

Behavioral Ratings				
BASC-2 Ratings	**Norm Group Comparison**	***T*-Score**	**Percentile Rank (%)**	**Classification**
Teacher Rating—*Attention Problems*	All males his age	54	67	Average
Parent Rating—*Hyperactivity*	ADHD males his age	43	25	Average
Teacher Rating—*Hyperactivity*	ADHD males his age	50	55	Average
Parent Rating—*Attention Problems*	ADHD males his age	38	13	Average
Teacher Rating—*Attention Problems*	ADHD males his age	38	13	Average

Summary of Attentional Processing

John has been previously diagnosed with ADHD, Predominantly Hyperactive Type and is taking 18 milligrams of Concerta® daily. The Concerta® seems to be effectively treating the hyperactivity. John did not evidence any major signs of hyperactivity during the one-to-one testing session. He did become a little agitated on one of the timed tests and started to move his hands back and forth excitedly, but that was the extent of any hyperactive behaviors observed. The BASC-2 behavioral rating indicated that the Concerta® medication has helped to normalize the attentional processing difficulties and hyperactive behaviors observed in the classroom. His attentional difficulties seem to be specifically related to his poor memory skills (which lead to poor comprehension) and his poor auditory selective/focused attention. He does not seem to have problems with visual selective/focused attention. Adding visual cues to a selective attention task will improve John's performance. John's shifting, divided, and visual sustained attention appears to be within the slightly below average to average range for his age.

IV. Visual-Spatial Processes

Presenting Concerns

On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth* (Miller & Lang, 2005), Mrs. Doe reported no difficulties with visual-spatial (nonverbal) skills at this time or in the past.

Current Levels of Functioning

John's current levels of visual-spatial functioning across several measures are presented in the following table.

Visual-Spatial Processes Summary

John's visual-spatial skills represent his processing strength across all of the areas. John learns best when information is presented to him as a visual format.

Visual-Spatial Processes				
Test: Subtest	**Standard Score**	**Scaled Score**	**Percentile Rank (%)**	**Classification**
WJIII-Cog: *Visual-Spatial Thinking* Cluster	111	—	78	Slightly Above Expected
—Spatial Relations	100	—	50	At Expected
—Picture Recognition	107	—	67	At Expected
NEPSY: Design Copy	—	16	76–99.9	Above Expected
NEPSY: Arrows	—	10	26–75	At Expected

V. Language Processes

Presenting Concerns

On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth* (Miller & Lang, 2005), Mrs. Doe reported that John distorts sounds, has a slow labored speech, and speaks in a monotone voice. John is not receiving any speech or language therapy at this time.

Current Levels of Functioning

The language domain can be categorized into auditory/phonological processing, oral expression, and listening comprehension (receptive language). Estimates of John's current levels of functioning across these language areas are presented in the following table.

Language Processes				
Test: Subtest	**Standard Score**	**Scaled Score**	**Percentile Rank (%)**	**Classification**
Auditory/Phonological Processing				
WJIII-Cog: *Auditory Processing* Cluster	95	—	38	At Expected
—Sound Blending	100	—	50	At Expected
—Incomplete Words	65	—	1	Well Below Expected
—Auditory Attention	91	—	28	At Expected
WJIII-Cog: *Phonemic Awareness* Cluster	80	—	9	Below Expected
—Sound Blending	100	—	50	At Expected
—Incomplete Words	65	—	1	Well Below Expected
—Sound Awareness	86	—	18	At Expected
NEPSY: Phonological Processing	—	5	3–10	Below Expected
Oral Expression				
WJIII-COG: *Oral Expression* Cluster	88	—	21	Slightly Below Expected
—Story Recall	77	—	6	Below Expected
—Picture Vocabulary	95	—	38	At Expected
NEPSY: Speed Naming	—	10	26–75	At Expected
—Completion Time	—	—	26–75	At Expected
—Accuracy	—	—	76–99.9	Above Expected
Listening Comprehension (Receptive language)				
WJIII-Cog: *Listening Comprehension* Cluster	98	—	45	At Expected
—Understanding Directions	92	—	29	At Expected
—Oral Comprehension	105	—	63	At Expected

John's *auditory/phonological processing* varied from the well below expected level to the at expected level. His strength was his ability to do whole to part blending of sounds. For example, on the WJIII-Cog: Sound Blending test he was given the whole *cat* sounded out phonetically "cuh-a-tuh." He was able to blend the sounds together and identify the whole word. However, when he was given the WJIII-Cog: Incomplete Words test and asked to identify the whole word he made frequent phonological type errors. For example, he identified *crapper* for *cracker; dirdee* for *dirty;* and *sweher* for *sweater.* On the NEPSY: Phonological Processing test, John achieved a scaled score of 5, which is very low for a child his age. He made similar phonological encoding errors on this test as on the Incomplete Words test. John did achieve a low average score on the WJIII-Cog: Sound Awareness test. This indicates that John has at least low average skills in identifying rhyming words and manipulating phonemes. Currently, John has some basic phonological skills that he can perform in isolation but he cannot seem to apply them to reading words.

John's *oral expression skills* varied widely across tests. John performed best on the WJIII-Cog: Picture Vocabulary test where he had lots of visual cues to aid in his recall of picture names. His performance on the NEPSY: Speeded Naming test was also within the average range. He was able to fluently identify the size, color, and shape of objects quickly and efficiently. This task is fairly automatic for most children his age. His poorest performance in this area was related to the WJIII-COG: Story Recall test. This test was described in the memory section of this report. John's poor performance on this test was attributable to his poor memory skills rather than his oral expression skills. Generally, John's oral expression skills fall within the average to slightly below average range for his age.

John's *listening comprehension skills (receptive language)* were all within the average range for his given age group.

Summary of Language Functioning

John has relative strengths in the language domain in the areas of oral expression and listening comprehension. He does have some significant problems with phonological encoding. The phonological encoding deficits seem to be the principal reason for John's current reading difficulties. The phonological encoding deficits are causing him to have poor reading fluency, poor reading comprehension, and poor encoding of verbal information.

VI. Memory and Learning Processes

Presenting Concerns

On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth* (Miller & Lang, 2005), Mrs. Doe reported that John has experienced some memory problems in the past. Mrs. Doe identified the following area of concern for John:

- John forgets where he leaves toys, schoolwork, or other objects.

Mrs. Doe stated that John seems to learn best in a one-to-one situation.

Current Levels of Functioning

Memory is a significant contributor to the learning process. Memory is comprised of three interactive systems: short-term memory, active working memory, and long-term retrieval. Each of the types of memory may be tested using different modalities; for example, visual short-term memory or auditory short-term memory. John's memory and learning skills as assessed across several measures are presented in the following table. Memory and Learning is divided into *immediate memory (verbal and visual), verbal-visual associative memory (learning and delayed memory), long-term retrieval* (verbal and visual), *working memory,* and *semantic memory.* Estimates of John's memory and learning are presented in the following table.

Memory and Learning Processes				
Test: Subtest	**Standard Score**	**Scaled Score**	**Percentile Rank (%)**	**Classification**
Immediate Memory: Verbal				
WJIII-Cog: *"Verbal" Short-term Memory* Cluster	76	—	6	Below Expected
—Numbers Reversed	89	—	24	Slightly Below Expected
—Memory for Words	71	—	3	Below Expected
Immediate Memory: Visual				
WJIII-COG: *"Visual" Short-term Memory*—Picture Recognition	107	—	67	At Expected
NEPSY: Memory for Faces	—	8	11–25	Slightly Below Expected

Memory and Learning Processes				
Test: Subtest	**Standard Score**	**Scaled Score**	**Percentile Rank (%)**	**Classification**
—Immediate Memory	—	7	11–25	Slightly Below Expected
Verbal-Visual Associative Learning				
NEPSY: Memory for Names	—	7	11–25	Slightly Below Expected
—Learning Trials	—	5	3–10	Below Expected
WJIII-COG: Visual-Auditory Learning	71	—	3	Below Expected
Verbal Long-Term (Delayed) Memory				
NEPSY: Narrative Memory	—	4	3–10	Below Expected
—Free Recall	—	—	<2	Well Below Expected
—Cued Recall	—	—	3–10	Below Expected
WJIII-Cog: Retrieval Fluency	91	—	28	At Expected
Visual Long-Term (Delayed) Memory				
NEPSY: Memory for Faces —Delayed Recall	—	9	26–75	At Expected
Verbal-Visual Delayed Associative Memory				
NEPSY: Memory for Names —Delayed Recall	—	6	11–25	Below Expected
Working Memory				
WJIII-Cog: *Working Memory* Cluster	92	—	29	At Expected
—Numbers Reversed	89	—	24	At Expected
—Auditory Working Memory	98	—	46	At Expected

Memory and Learning Processes				
Test: Subtest	**Standard Score**	**Scaled Score**	**Percentile Rank (%)**	**Classification**
Semantic Memory (Comprehension-Knowledge)				
WJIII-COG: *Comprehension-Knowledge* Cluster	81	—	10	Slightly Below Expected
—Verbal Comprehension	90	—	25	At Expected
—General Information	72	—	3	Below Expected
WJIII-COG: Picture Vocabulary	95	—	38	At Expected

Comprehension-knowledge measures the breadth and depth of a person's acquired knowledge, the ability to communicate one's knowledge.

John's *verbal memory skills* were scattered from the at expected level to the well below expected level. John does not learn verbal material well. This represents a fundamental weakness for John as compared to his other skills. Within the verbal memory area, John achieved the highest score on the WJIII-COG Auditory Working Memory test. This test was described in the Attention section. John's performance may have been enhanced specifically in this test, because of the working memory and the divided attention influences that are processing strengths for John. John was able to memorize numbers and manipulate them in his working memory (WJIII-Cog: Numbers Reversed). However, John's performance was poor when asked to memorize words in isolation (WJIII-Cog: Memory for Words) or memorize word-picture associations (NEPSY: Memory for Names), or memorize the essential elements of a verbally presented story (NEPSY: Narrative Memory). John has significant difficulties with the encoding of verbal memory. For example, on the NEPSY: Narrative Memory test John could not correctly remember the names of the characters in the story so he made up names.

On the Memory for Names test, John showed signs of phonological encoding errors. For example, he recalled *egg* for *a, vee* for *be,* and *ver* for *there*. On the initial learning trial of the NEPSY Memory for Names test, John was being taught the name that went with each picture. His response to each item was "I got it," even though the examiner had to expose the card for 10 seconds. Despite his idea that he got it, he did not recall correctly any of the items. This was an active learning test, in which he is retaught the name–picture association each time he made an error. After reteaching the name–picture associations twice he was only able to recall 3 of the 8 names correctly. This indicates that John does not benefit well from reteaching verbal-visual association.

John's *visual memory skills* and *working memory* represent relative strengths. John's immediate visual short-term memory and delayed visual memory recall were within the average range of functioning for his age. John appears to learn new information best when only the visual mode is used. He is also able to manipulate information in active or working memory at an age-appropriate level.

John's *long-term memory skills* varied based on the retrieval of previously learned material or recall of newly learned material. His visual long-term retrieval (WJIII-Cog: Picture Vocabulary) fell within the average range of functioning for his age. The visual modality and the recall of previously learned information helped his performance on this task. John also performed equally well on a verbal fluency task (WJIII-Cog: Retrieval Fluency) in which he had to retrieve verbal information from memory. John is able to recall both verbal and visual information from his long-term memory because he seems to have good storage and retrieval processes in place. However, on learning new information that required encoding, John does not perform as well. His verbal-visual associative learning (WJIII-Cog: Visual-Auditory Learning) was below expected level. This test teaches the child word-symbol associations that the child has to read. This test parallels the activities associated with reading real words. The child has to learn to associate sounds (phonemes) with symbols (letters). This test is also an active learning task. When John made a mistake recalling the correct word for a symbol, he was retaught the word. Again, John did not seem to benefit from the relearning or the verbal feedback.

John's breadth and depth of acquired knowledge was assessed using the *comprehension-knowledge* measures from the WJIII-Cog. The Verbal Comprehension test is composed of four sections: picture vocabulary, knowledge of synonyms, knowledge of antonyms, and knowledge of verbal analogies. Only a total test score is generated across all four areas, but in general John performed better on the Picture Vocabulary section than the other verbally loaded sections. The General Information test is composed of two sections: where questions and what questions. John performed poorly on both sections. He demonstrated some word retrieval problems, such as calling the motion *sweep* as *wipe*. He identified a microphone as *hear music*, which was conceptually in the area of music but not the right answer.

Summary of Memory Functioning

John has some significant memory problems that account for a partial cause of his current reading difficulties. John's visual memory skills are well developed for his age; however, his verbal short-term and delayed memory skills are below average. John has particular difficulties learning new sound-symbol associations, which is a crucial skill in learning to read. Effective memory takes good encoding, storage, and retrieval. If John stores memories correctly he can retrieve both verbal and visual information accurately. John has difficulties with encoding new information.

VII. Executive Functions

Presenting Concerns

On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth* (Miller & Lang, 2005), Mrs. Doe reported that John has experienced some problem-solving skills problems in the past. Mrs. Doe identified the following areas of concern for John:

- Learning new or complex activities or concepts.
- Becoming frustrated and giving up easily.

Mrs. Doe reported that John likes to take things apart and put them back together again. He has some atypical methods of solitary play (e.g., he will line up all of his cars and classify them by color and then only play with a certain group of colored cars at one time). Within the behavioral domain, Mrs. Doe is concerned that John "cries real easy all the time." She wondered if the Concerta® that he is taking could affect John's emotional regulation.

Current Levels of Functioning

Executive functioning can be conceptualized into three broad areas: cognitive, motor programming, and behavioral/emotional. Each of these broad areas has some relationship to the frontal lobes of the brain. The *cognitive* aspects of executive functioning includes problem solving, attentional shifting, planning, organizing, working memory, and retrieval fluency. The *motor* aspects of executive functioning include preprogrammed motor movements (e.g., touching fingers together in a prescribed order). The *behavioral/emotional* aspects of executive functioning relate to the inhibitory controls of behavior (e.g., impulsivity, regulation of emotional tone). John's executive functioning was assessed by several measures across the WJIII-COG and the NEPSY as presented in the following table.

John achieved average scores within the *problem solving, fluid reasoning, and planning areas* of executive functioning. *Shifting attention* is also included in this section because it is considered a hallmark characteristic of frontal lobe functioning. As reported earlier in this report under the Attention section, John's shifting attention abilities fall within the average or at expected levels for his age. *Working memory* measures the ability to hold information in immediate awareness while performing a mental operation on the information.

John achieved average to slightly below average scores on the working memory subtests. The slightly below average score on the Numbers Reversed test may be due to an attentional capacity problem as discussed earlier.

Executive Functions: Cognitive Area				
Test: Subtest	**Standard Score**	**Scaled Score**	**Percentile Rank (%)**	**Classification**
Problem Solving, Fluid Reasoning, & Planning				
WJIII-Cog: *Executive Processes* Cluster	109	—	72	At Expected
—Concept Formation	103	—	58	At Expected
—Pair Cancellation	105	—	63	At Expected
WJIII-Cog: *Fluid Reasoning* Cluster	105	—	63	At Expected
—Concept Formation	103	—	58	At Expected
—Analysis/Synthesis	107	—	67	At Expected
NEPSY: Tower Test	—	9	11–25	At Expected
Shifting Attention				
NEPSY: Auditory Attention and Response Set: Part B score	—	11	26–75	At Expected
Working Memory				
WJIII-Cog: *Working Memory* Cluster	92	—	29	At Expected
—Numbers Reversed	89	—	24	At Expected
—Auditory Working Memory	98	—	46	At Expected

Executive Functions: Preprogrammed Motor Movements			
NEPSY	**Scaled Score**	**Percentile Rank (%)**	**Classification**
Fingertip Tapping	11	26–75	At Expected

The only test that was administered that measured preprogrammed motor movements was the Fingertip Tapping test from the NEPSY, as reported in the Sensorimotor functioning section of the report. John achieved an average score in this area (see previous table).

Executive Functions: Behavioral/Emotional Regulation

This area was not formally assessed, but there was plenty of anecdotal evidence reported from Mrs. Doe that raises concerns in this area. John did not exhibit any major signs of impulsivity during a long testing session, although he does have a history of acting impulsively when he is unmediated. As reported in the background information section, John has a history of anxiety attacks. Currently, John's mother reported that he cries frequently and becomes easily upset. On the BASC-2, Mrs. Doe's rating of John resulted in an at-risk categorization of the depression scale. The teacher did not report seeing the same degree of crying in school as has been reported in the home. Other scales such as anxiety, somatization, and withdrawn behaviors all fell within the average range for John based on both parent and teacher ratings.

Summary of Executive Functioning

John has some strengths in the executive functions area including problem solving, planning, organizing, shifting of attention, and working memory. John's cognitive fluency was below average for his age and is probably a contributing factor for his poor reading skills. Behaviorally and emotionally, John is having some difficulties regulating his emotional tone. He cries frequently when he gets frustrated or even when losing a video game. It remains unclear if Concerta® relates to John's change in regulating his emotional tone. John does have a history of some internalizing of emotional problems, such as dealing with anxiety.

VIII. Speed and Efficiency of Cognitive Processing

Presenting Concerns

On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth* (Miller & Lang, 2005), Mrs. Doe reported that John has experienced some speed of processing problems. She reported that he is a slow reader and he takes a long time completing homework.

Current Levels of Functioning

The skills in this area relate to the speed of processing rather than the relative strength or weakness of processing. Measures of John's speed and efficiency of processing are reported in the following table. On the WJIII-Cog, the *Cognitive Efficiency* cluster is composed of two different types of automatic cognitive processes: processing speed and short-term memory. *Cognitive fluency* is a measure of cognitive automaticity, or the speed with which an individual performs simple to complex cognitive tasks. *Processing Speed* measures the ability to perform automatic cognitive tasks, particularly when measured under pressure to maintain focused attention. Often children with untreated symptoms of ADHD have low processing speed scores. John's processing speed scores fell within the average or at-expected level compared to his same-aged peers. This average score may reflect the beneficial effects of the Concerta®.

The speed of processing area that appeared to be weak for John is his *cognitive fluency*. Cognitive fluency measures the fluency of retrieval from stored knowledge. Researchers have demonstrated that fluency plays a crucial role in reading. When John reads his fluency is slow and disjointed rather than being fluid and automatic. John's poor cognitive fluency plays a major role in his poor reading.

Summary of Speed and Efficiency of Cognitive Processing

Cognitive Efficiency represents the capacity of the cognitive system to process information automatically (automatic processing facilitates complex cognitive functioning). Cognitive Efficiency is composed of "auditory" short-term memory and processing speed. John's processing speed is within the average range but his auditory short-term memory is poorly developed. The Cognitive Efficiency score is low because his short-term memory score is low. These weaknesses are the cause of John's slow reading and his need to take longer to complete assignments.

Speed and Efficiency of Cognitive Processing				
Test: Subtest	**Standard Score**	**Scaled Score**	**Percentile Rank (%)**	**Classification**
Processing Speed				
WJIII-Cog: *Processing Speed* Cluster	94	—	34	At Expected

(continued)

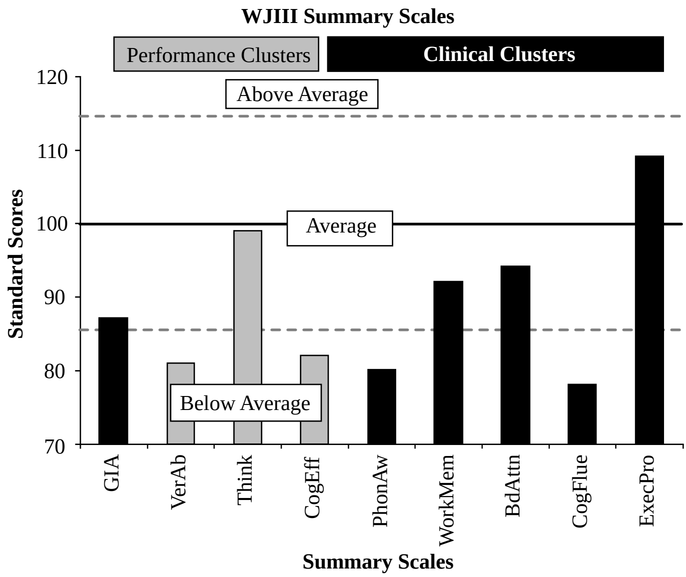
Speed and Efficiency of Cognitive Processing				
Test: Subtest	**Standard Score**	**Scaled Score**	**Percentile Rank (%)**	**Classification**
Processing Speed				
—Visual Matching	94	—	35	At Expected
—Decision Speed	95	—	38	At Expected
Cognitive Efficiency				
WJIII-Cog: *Cognitive Efficiency* Cluster	82	—	12	Slightly Below Expected
—Processing Speed	94	—	34	At Expected
—Short-term memory	76	—	6	Below Expected
Cognitive Fluency				
WJIII-Cog: *Cognitive Fluency* Cluster	78	—	7	Below Expected
—Retrieval Fluency	91	—	28	At Expected
—Rapid Picture Naming	76	—	5	Below Expected
—Decision Speed	95	—	38	At Expected

IX. General Intellectual Ability

The WJIII-COG is a comprehensive set of individually administered tests that measure cognitive ability. The battery assesses general intellectual ability and specific cognitive abilities in seven broad areas of processing. The individual subtests do not measure innate capacity or potential, but rather facilitate the identification of cognitive strengths and weaknesses that are associated with the student's learning abilities.

The General Intellectual Ability (GIA) score of the WJIII is a measure of overall intellectual functioning. John achieved a GIA score equal to 87. There is a 90 percent chance that his true GIA score falls within the 85 to 89 standard score range. The average GIA score is 100 with a standard deviation of 15, which places John in the slightly below average range of overall cognitive abilities for his age. This overall measure of John's general intellectual functioning is somewhat lower than the most recent estimate from the OLSAT that was administered this school year. The OLSAT is a group-administered ability test with a narrow range of cognitive abilities being assessed, therefore it is not unusual for this test to have higher scores than the WJIII-COG, which is sampling a broader range of cognitive functions.

The WJIII provides overall Performance Cluster Scores and Clinical Cluster Scores that represent broad categories of cognitive ability. A graph of John's Performance Cluster and Clinical Cluster scores is presented in the following.



John's *Executive Processes,* such as problem solving and planning, are strengths compared to his other cognitive abilities. John's *Thinking Ability* fell within the average range principally because of his strengths in visual-spatial processing and fluid reasoning. His *Working Memory Cluster* score and his *Broad Attention Cluster* score fell within the average range as well.

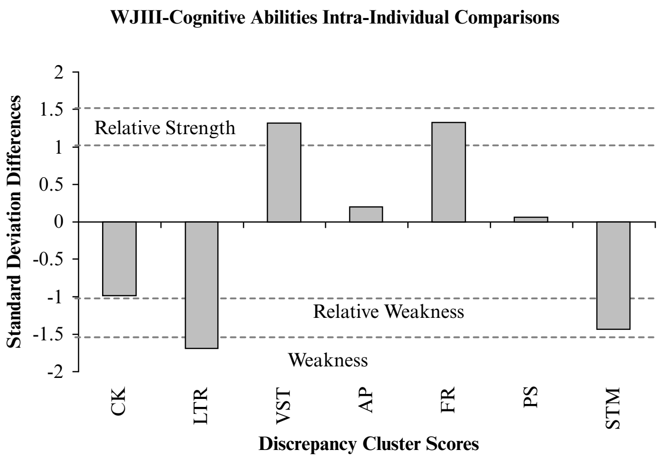
John's relative weaknesses fell within the *Verbal Abilities, Cognitive Efficiency, Phonemic Awareness, and Cognitive Fluency Clusters.* Verbal Abilities measure language development that includes the comprehension of individual words and the comprehension of relationships among words. As reported earlier in the language processing area, John has some weaknesses in the processing of verbal information.

Phonemic Awareness measures the knowledge and skills related to analyzing and synthesizing speech sounds. This is a major area of weakness for John that is adversely affecting other cognitive abilities such as language and memory. Cognitive fluency measures the fluency of retrieval from stored knowledge. Fluency is a major contributing factor in reading. John's fluency is being adversely affected by his poor phonological encoding.

The WJIII-COG score can also be categorized into seven cognitive factors. John's scores on the cognitive factors are listed in the following table.

WJIII-Cognitive Factor Scores	**Standard Score**	**Percentile Rank (%)**	**Classification**
Comprehension-Knowledge	81	10	Slightly Below Expected
Long-Term Retrieval	72	3	Below Expected
Visual-Spatial Thinking	111	78	Slightly Above Expected
Auditory Processing	95	38	At Expected
Fluid Reasoning	105	63	At Expected
Processing Speed	94	34	At Expected
Short-Term Memory	76	6	Below Expected

The interpretations of these cognitive strengths and weaknesses have been rendered in the previous sections of the test results. The following graph illustrates John's strengths and weaknesses within the seven WJIII-Cog cognitive factors. Memory deficits are John's weakness, but the underlying cause of the memory difficulties is the poor phonological encoding.



X. Academic Achievement

Presenting Concerns

On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth* (Miller & Lang, 2005), Mrs. Doe noted that John's best subjects are math and art and his hardest subjects are reading and writing.

Current Levels of Functioning

John was administered the Woodcock-Johnson III Tests of Achievement (WJIII-Ach). The WJIII-Ach test scores are presented in the following table.

WJIII: Achievement Test Results	Standard Score	Percentile Rank (%)	Classification Related to Age Norms	Predicted Achievement/ Achievement Discrepancy
Basic Reading Skills	91	28	At Expected	No
—Letter-Word ID	83	13	Slightly Below Expected	
—Word Attack	102	56	At Expected	
Reading Comprehension	82	11	Slightly Below Expected	No
—Passage Comprehension	82	12	Slightly Below Expected	
—Reading Vocabulary	88	21	At Expected	
Mathematics Calculations	104	62	At Expected	No
—Calculations	106	64	At Expected	
—Math Fluency	100	50	At Expected	
Mathematics Reasoning	98	46	At Expected	No
—Applied Problems	100	50	At Expected	
—Quantitative Concepts	96	40	At Expected	

WJIII: Achievement Test Results	Standard Score	Percentile Rank (%)	Classification Related to Age Norms	Predicted Achievement/ Achievement Discrepancy
Written Expression	94	34	At Expected	No
—Writing Fluency	94	33	At Expected	
—Writing Samples	96	40	At Expected	
Oral Expression	88	21	Slightly Below Expected	No
—Story Recall	77	6	Below Expected	
—Picture Vocabulary	95	38	At Expected	
Listening Comprehension	98	45	At Expected	No
—Understanding Directions	92	29	At Expected	
—Oral Comprehension	105	63	At Expected	

As previously reported, John's General Intellectual Ability (GIA) score was 87 (±2), which fell within the low average range. The column on the right shows the predicted achievement scores based on the cognitive abilities compared to the actual achievement scores. The word *no* indicates that John is working up to his ability in all of the academic areas. John did exhibit signs of phonological processing deficits in the Reading Fluency test, Letter-Word Identification test, and the Writing Samples test. For example, he wrote *haching* for *hatching, kan* for *can, luk* for *look,* and so on.

A global measure that is not reported in the table is John's *Academic Fluency* score of 85, which fell within the slightly below expected level range for his age. The Academic Fluency score is related to the Cognitive Fluency score reported earlier. John has a very slow rate of retrieval of information that slows down his overall cognitive processing and his production of academic work.

Summary of Academic Achievement

John is currently working up to his ability in all of the basic academic areas. He does exhibit some reading deficits based on phonological errors. Both his reading comprehension and his written expression are adversely effected by his poor phonological decoding skills.

XI. Social-Emotional Functioning and Adaptive Behavior

Presenting Concerns

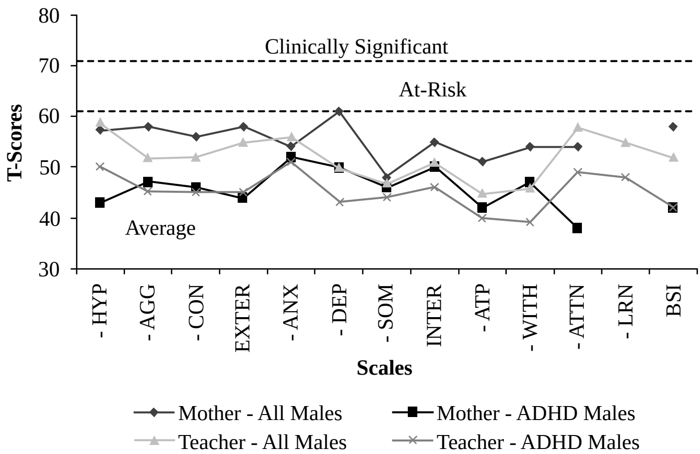
On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth* (Miller and Lang, 2005), Mrs. Doe reported that John has had a history of being inattentive and hyperactive, which is being regulated by medication. Mrs. Doe also reported that he has poor eating habits (described earlier) and that he tends to be emotional (e.g., cries easily).

Current Levels of Functioning

The BASC–Second Edition (BASC-2) is an integrated system designed to facilitate the differential diagnosis and classification of a variety of emotional and behavioral disorders in children and to aid in the design of treatment plans. The BASC-2 is divided into Clinical Scales and Adaptive Scales. There is a separate form for parents (BASC-2 Parent Rating Scale) that the mother completed and a form for teachers (BASC-2 Teacher Rating Form) that was completed by John's second grade teacher. For each rater, mother and teacher, John's scores were compared to all males his age and to a clinical group of boys for ADHD. The Clinical Scales are displayed in the following graph. *T*-scores between 60 and 69 are considered at-risk behaviors and *T*-scores above 70 are considered clinically significant behaviors. All of the scores, regardless of the norm group comparison, fell within the average range except for the mother's rating of Depression symptoms that were in the at-risk range when John was compared to all other boys his age in the standardization sample.

The BASC-2 Adaptive Behavior scores for both raters, mother and teacher, are illustrated in the following graph. Again, two normative comparison groups were used, all boys in the standardization sample John's age, and a clinical sample of ADHD boys John's age. For these adaptive behaviors, *T*-scores that fall below 30 are classified as clinically significant, and *T*-scores between 31 and 40 are classified as at risk. The Socialization scale from the mother rated John in the at-risk range as compared to other boys his age. This is consistent with the mother's reports of John preferring solitary play.

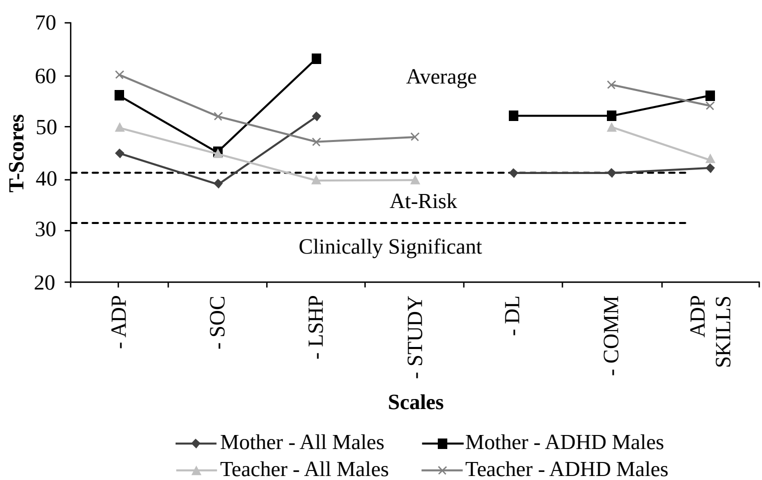
BASC-2 Clinical Scales



Summary of Social-Emotional Functioning

It is encouraging to see that John is not experiencing any major behavioral problems, emotional problems, or maladaptive behaviors at this time. In terms of John's adaptive behaviors, areas to monitor include his social skills, lesser developed leadership skills, and his weak study skills.

BASC-2 Adaptive Behavior Scales



SUMMARY

John was referred for this psychoeducational evaluation due to current difficulties in school in the areas of reading and written expression. John is currently reading about a grade and a half below his current grade placement in school. John has previously been diagnosed with ADHD, Predominantly Hyperactive Type, and is taking 18 milligrams of Concerta® daily. John's mother reported that the Concerta® makes a major improvement in John's activity level. No hyperactive or impulsive behaviors were noted in the current testing session with John. Mrs. Doe expressed concern about the increase in John's crying and wondered whether this was related to using Concerta®. According to Concerta®'s product information packet, the most common side effects of Concerta are headache (14 percent), upper respiratory tract infection (8 percent), abdominal pain (7 percent), vomiting (4 percent), loss of appetite (4 percent), insomnia (4 percent), *increased cough (4 percent),* pharyngitis (4 percent), sinusitis (3 percent), and dizziness (2 percent). The manufacturers of Concerta™ did not report any increased emotional episodes while taking the medication. John did have a persistent cough that his mother attributed to allergies, but could be related to the Concerta® use.

John had a delay in language acquisition and he received early childhood services from the Anywhere School District. His language improved starting at age 4. John's teacher has implemented some behavioral controls in the classroom to help John remain on task. She has him sitting right next to her at the front of the room. John was a delight to work with on a one-to-one basis. He attended well to a range of tasks. He put forth good effort and was not distractible or overactive. No hyperactive and very few inattentive behaviors were observed during the individualized testing.

John has *relative strengths* in the areas of sensorimotor skills; visual-spatial processing; visual short-term memory; shifted, divided, and sustained attention; problem solving; fluid reasoning; planning; processing speed; shifting attention; working memory; preprogrammed motor movements; oral expression; and listening comprehension.

John's *weaknesses* are his poor phonological encoding of sounds, poor selective or focused attention, and his poor auditory short-term memory. These weaknesses adversely affect his reading accuracy, reading comprehension, reading fluency, retrieval of verbal information (short term and long term), and written expression. The phonological encoding deficits and his poor auditory short-term memory seem to be the principal reasons for John's current reading difficulties. John has particular difficulties learning new sound-symbol associations, which is a crucial skill in learning to read. Effective memory takes good encoding, storage, and retrieval. If John stores memories correctly he can retrieve both verbal and visual information accurately. However, John has difficulties with encoding new verbal information, and reading is largely verbal. In addition to the phonological processing difficulties, he has some difficulties with focusing his attention on "target" events while ignoring other competing stimuli. This means that John will still have some difficulty figuring out what is important to attend to and what is important to ignore. This generally manifests itself as appearing distracted in the classroom. The Concerta® medication has helped regulate John's hyperactivity, distractibility, impulsivity, and inattention to a significant degree but there are still some lingering concerns in these areas. Despite the weaknesses that John is dealing with on a daily basis, his teacher and mother did not rate his behavior or emotional status as being significantly impaired.

DIAGNOSTIC IMPRESSIONS

According to the Individual with Disabilities Education Act (IDEA) of 1997 and the State Special Education Rules and Regulations that interpret IDEA, John does not qualify under the Specific Learning Disabilities (SLD) classification based on the traditional significant discrepancy between his overall ability and his achievement scores. In the classroom, John is not working up to his ability levels, but he achieved achievement scores commensurate with his overall cognitive abilities on the individually administered tests.

John is currently being referred for a dyslexia screening by the school district. Based on the results of this evaluation, John appears to have many of the characteristics associated with dyslexia, which is an impairment in phoneme/grapheme knowledge and rapid word recognition. Specifically, John seems to have a subtype of dyslexia called dysphonetic dyslexia.

A dysphonetic reader has:

- Poor phonological awareness—John has some basic skills but he has trouble applying them consistently.
- Trouble learning sight words—John is still at the level when he tries to sound out everything. Use of flash cards would help increase his sight word vocabulary and increase his reading fluency as well.
- Difficulty sounding out words—John makes many errors for his age in sounding out words.
- Trouble applying strategies for word analysis—John has not learned those strategies.

- Over relies on content cues—John gets distracted by the visual pictures of a story and loses sight of the words.
- Reads slowly—John is a very slow reader.
- Avoids reading—Not yet, but that is the concern.
- Loses place when asked to read aloud—John does this all the time because he gets distracted with pictures, or he is taking so long to sound out the words that he does not comprehend what he is reading.
- Misreads words—John consistently does this.

The lack of a significant discrepancy between John's overall ability and his reading skills may not be currently present, but if targeted interventions are not started as soon as possible, John may "test his way" into a handicapping condition within the next 1 to 2 years. Consistent with the No Child Left Behind Legislation and the newly revised focus on the prevention of reading problems in young children, it seems that early intervention is warranted in John's case.

In terms of the diagnosis of ADHD, John was evaluated while he was on medication. John demonstrated excellent attention and normal activity level for a child his age during a long testing session. The diagnosis of ADHD, Predominantly Hyperactive Type, is reaffirmed based on the beneficial effect of the medication in alleviating the hyperactive behaviors and because he is still having some difficulties selectively focusing his attention that is consistent with problems of inattention.

An Individual Education Plan (IEP) team at John's school will decide if there is sufficient evidence in this report and other school-based data to determine eligibility for special education services or for Section 504 accommodations.

INTERVENTION STRATEGIES AND RECOMMENDATIONS

Recommendations for Instruction at School:

- Keep in close contact with John's parents to facilitate a coordinated support system for John's learning.
- It is recommended that he be evaluated by a speech and language therapist at school to further explore some of his deficits in phonological processing.

1. Methods to improve John's selective/focused attention.
    - Continue to structure John's environment to minimize auditory and visual distracters. Try placing John in a study carrel in the back of the room during activities that require undivided or focused attention.

- Encourage John to keep his desk clean of unnecessary objects that could serve to distract him.
- Maximize the high-interest material and visual cues in assignments. John can sit for long periods of time playing video games, so he can focus and sustain his attention.
- John may not do as well on timed tests because of the increased anxiety level. Try to minimize the use of timed tests or make allowances for extra time to be taken to complete the assignment.
- Make sure you have John's attention before giving him oral instructions. Keep oral instructions as short and simple as possible.
- Provide immediate feedback on assignments. Incorporate programmed learning materials or computer programs when possible.
- Allow John to channel his excess energy into more acceptable activities. For example, allow him to stand during seatwork or use activities (e.g., such as running an errand, arranging classroom materials, cleaning the chalkboard) as reinforcement for task completion.

2. Methods to improve John's reading.
   - Enhance the curriculum interventions that target phonological encoding. John has some basic skills in rhyming and alliteration but he needs some instructional help with blending of sounds, segmentation, and manipulation of phonemes.
   - To encourage the use of letter/sound correspondence, use magnetic letters or letter tiles and show John a word, say the word, scramble the letters, and ask him to rebuild and pronounce the word.
   - Emphasize visual cues to reading. John learns best using visual cues.
   - To improve John's reading fluency, have him engage in multiple readings. Multiple readings require the child to read the same passage aloud over and over again while recording the completion time and number of errors. Do multiple readings no more than 3 to 4 times. Use reading level material that maximizes the decodable text and provides concrete measures of progress for the child. Modeling and practicing words between readings will increase fluency as well.
3. Methods to improve John's memory.
   - Keep oral directions short and simple and supplement with visual cues when possible.
   - Ensure that verbal directions are understood. Tell him what to do, pause, put a hand on his shoulder and make eye contact, and ask

him to verbalize what you just asked him to do. This process will reinforce his short-term memory.
- Teach memory strategies (e.g., chunking, verbal rehearsal, use visual imagery).
- When introducing new skills, provide John with pictures to look at or a way to visualize and form associations regarding what is being learned.
- Present all types of verbal information accompanied by visual stimuli that clearly illustrates the concepts being taught. Examples are: pictures, charts, graphs, semantic maps, and so on.

Recommendations for Instruction at Home

- Keep in close contact with John's teachers to facilitate a coordinated support system for John's learning.

1. Methods to improve John's selective/focused attention.
   - Provide a consistent place and time for John to work on his schoolwork. The workspace should be as free from distractions as possible. Help John find a way to better organize his schoolwork so it will be easier to monitor what has and has not been completed.
   - Provide frequent positive reinforcement for John's ability to stick with a task and focus on the task at hand. Effort should be praised as it is accomplished rather than on final outcome (such as a grade).

2. Methods to improve John's reading.
   - Check out the Earobics™ program (available at http://www.donjohnston.com/catalog/earobics.htm for home use at a reasonable cost). It is a computer-based program designed to improve phonological processing, fluency, and comprehension.
   - Use flash cards to help increase John's sight word vocabulary and increase his reading fluency. For every new reader or unit in a schoolbook, look up the new words that will be introduced and put them on flash cards individually. Make a game out of memorizing the new words in the deck of flash cards and reinforce his efforts. Always keep a minimum of 20 percent of the words in the deck that he already knows and the rest of the words that he is still working on.
   - Play rhyming games at home (e.g., how many words can you think of that rhyme with *cake*?).

- Read to John interactively; that is, engage him in the story by having him respond to questions, repeat phrases, and predict what's going to happen next.
- Discuss stories with John as he reads them. Have him retell you the major parts of a story he just read.

3. Methods to improve John's memory.
   - Whenever possible tie learning tasks to John's areas of high interest as this will maximize its storage into long-term memory.
   - As with the previous school recommendation, if the parents want to make sure that John understands what they are asking him to do, tell him what to do, pause, put a hand on his shoulder and make eye contact, and ask him to reiterate what was just asked of him. This process will reinforce his short-term memory.

4. Follow-up with the physician about possible side-effects of Concerta®.
   - Since John was having such a lingering cough and that is a known side effect of Concerta®, make sure to mention that symptom to John's physician during his next regularly scheduled visit.

Seymour Children, Ph.D., ABSNP
School Neuropsychologist
Anywhere School District

Fifteen

CLINICAL INTERPRETATION GUIDELINES

In this chapter, a set of clinical interpretation guidelines for school neuropsychologists will be presented. The chapter is divided into three sections. The first section presents some guidelines related to selecting a test or assessment battery. Topics in this first section include: relating the assessment to the referral question(s), adopting a flexible approach to assessment, understanding the neurocognitive demands of assessment measures, understanding the role of "brief" and behavioral rating measures, and knowing when to stop testing. The clinical interpretation guidelines that will be discussed in this chapter are outlined in Rapid Reference 15.1.

The second section of this chapter presents some guidelines related to data interpretation and analyses. Topics in the second section include: the importance of asking children about the strategies they used to approach tasks, cautions about self-fulfilling prophesies, over- and under-interpretations of the results, integrating reported problems with observation and assessment data, and the introduction of a depth of processing interpretation model. The final section of the chapter provides two examples of clinical interpretation.

SELECTING A TEST OR ASSESSMENT BATTERY

Relating the Assessment to the Referral Question(s)

As illustrated in Chapter 12, General Intellectual Ability and Academic Achievement, not all cognitive ability tests or achievement tests measure the same constructs. Make sure to select a test or battery of tests designed to answer the referral question(s). For example, if the referral question is: "Why can't Johnny read?" it would be best practice to have some tests of phonological awareness, auditory processing, and reading achievement in the test battery. Some school psychologists and related educational assessment personnel rely on only one assessment battery to answer all referral questions. Practitioners need to be trained

Rapid Reference 15.1

Clinical Interpretation Guidelines for School Neuropsychologists

- Relate the assessment to the referral question(s).
- Adopt a flexible approach to assessment.
- Understand the neurocognitive demands of any given task.
- Remember that two or more tasks that report to measure the same construct may or may not.
- Don't forget to ask children how they approach the tasks.
- Understand the role of *brief* measures and behavioral rating scales.
- Get a feel for what constitutes the right amount of testing. Avoid over- or under-testing.
- Integrate reported learning and/or behavior problems with observable behavior and assessment data.
- Use a "vector analysis" to confirm hypotheses about the assessment data.
- Avoid under-interpretations and over-interpretations of the assessment data.
- Be cautious with a student who appears to be following self-fulfilling prophecies.
- Appreciate the multiple causes of behavior.
- Implement a depth of processing interpretative model.

CAUTION

Some assessment specialists rely on only one fixed assessment battery to answer all referral questions. Assessment specialists need to select assessment instruments that have constructs related to the referral question(s).

to administer a wide variety of assessment instruments or components of instruments and ideally should have access to those instruments within the schools.

Adopting a Flexible Approach to Assessment

Assessment specialists (e.g., school neuropsychologists, school psychologists, educational diagnosticians, psychometrists) should be flexible during the assessment process itself. In the previous example, the referral question was "Why can't Johnny read?" An assessment specialist could plan an evaluation to address the potential phonological and auditory processing causes of a reading problem, only to find significant short-term memory problems and poor processing speed during the course of the evaluation. If a particular processing disorder is suspected as a result of observations of the child during testing or based on samples of his or her test performance, the assessment specialist needs to alter the assessment battery and further explore those suspected deficit areas. In some states, the assessment must be preplanned and agreed to by the parent(s)/guardian(s). In these cases, it may be necessary to go back to the parties of the informed consent and ask to broaden the scope of the assessment to further explore the suspected processing deficits.

Understanding the Neurocognitive Demands of the Assessment Measures

It is important for school neuropsychologists to understand the neurocognitive demands of a particular test. Any time samples of behavior are taken on a test, the test may be measuring several abilities. Test publishers and test authors generally attempt to make tests/subtests as factorially pure as possible during test construction. However, it is not uncommon for a particular test to measure more than one neurocognitive process: referred to as primary and secondary abilities. An example would be the WJIII-COG Numbers Reversed Test that requires attentional capacity and working memory.

Figure 15.1 illustrates the conceptual variables that are measured by a particular test. Anytime a sample of behavior is taken there is also error variance included in the measure. Sources of error variance include environmental factors (e.g., noise in the testing room), examiner variables (e.g., administration errors), and student moderator variables (e.g., the student not feeling well on the day of testing). These sources of error variance can invalidate the interpretation of the

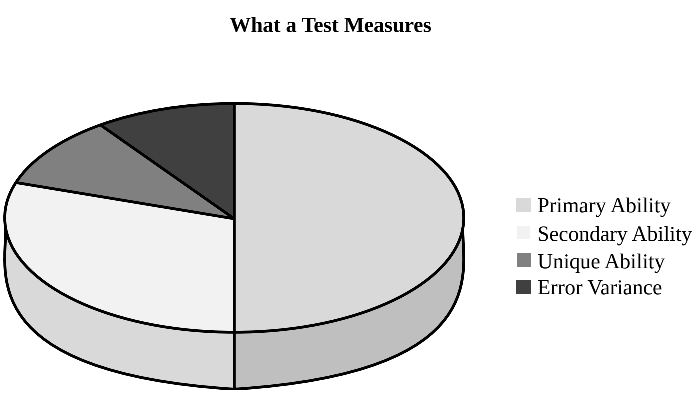


Figure 15.1 Conceptual variables measures by any test

test score. If a student achieves a low score on the WISC-IV Block Design subtest because he or she was extremely distracted and did not put forth good effort, the low performance should not be attributed to poor visual-motor constructional skills. Observed or suspected samples of error variance should be noted in the Assessment Validity section of the report, with the inclusion of a statement that those results should be interpreted with caution or not interpreted at all.

In order to interpret the results of any given test, the school neuropsychologist should understand the neurocognitive demands required by the test. The first step in determining what a test is measuring is to read the test manual and review the technical properties of the test. Look at the intercorrelations of the subtests within a given battery of tests and any reported correlations with other tests that report to measure the same construct. Test technical manuals are often the best source of information to aid in test interpretation. Many of the major tests used by school neuropsychologists also have supplemental interpretative guides, such as those included in the *Essentials Series* published by John Wiley & Sons, Inc. Finally, it is important to read the research studies related to the test as published in the research. Studies that validate the test with various clinical populations and replicate the reliability and validity of the test should be reviewed.

Not All Tests that Report to Measure the Same Construct Actually Do

A common misconception made by practitioners is to assume that two tests that have the same process or skill in their titles must measure the same construct. For example, on the surface it would make sense that the WISC-IV Processing Speed Index and the WJIII-COG Processing Speed Cluster score would measure the same construct. However, if the neurocognitive demands of each subtest are carefully considered, there appear to be differences on how processing speed is being measured. Floyd, Bergeron, McCormack, Anderson, and Hargrove-Owens (2005) examined six samples of children and adults who completed two or more intelligence tests. They found that some of the constructs, such as processing speed, have low levels of exchangeability among tests. A school neuropsychologist must remain current with the ongoing professional research in the field. As a professional specialty, we have had a tremendous increase in the number of assessment tools at our disposal in recent years, and we are only beginning to understand how these instruments relate to each other in a cross-battery assessment approach.

Understand the Role of *Brief* Measures

In some states, there has been a tremendous burden placed on school psychologists to be the sole assessment specialist for determining special education eligibility. This testing pressure, coupled with an ever-increasing shortage of school psychologists across the country, has placed practitioners in an untenable position. School psychologists often do not have the luxury of spending many hours conducting an in-depth evaluation for a child because they have so many more children waiting in line to be tested. Recognizing this dilemma in practice, there have been tests introduced on the market that are designed to shorten the administration time. For example, there are brief intelligence tests, brief achievement tests, and brief behavioral rating scales, all of which are designed to save the examiner time. Some cautions seem warranted here.

In Chapter 1, the Single Test Approach that characterized the early neuropsychology practice was reviewed. The goal in the early history of neuropsychology was to use a single measure (e.g., the Bender Visual-Motor Gestalt Test) to characterize the overall integrity of brain functioning. The Single Test Approach did not work well and was abandoned in favor of using multiple measures. We know that the reliability of a measure increases when there are multiple items within a given test. Conversely, the reliability of a measure decreases when there are fewer items within a given test. Brief measures of intelligence, achievement, or behavioral constructs should be viewed as screeners only and are not substitutes for a more comprehensive test battery.

Understand the Role of Behavioral Rating Scales

Assessment specialists in the schools have access to a variety of behavioral rating scales that may be based on self-report, or on the evaluations of the student by parent(s) or teacher(s). There are behavioral ratings for ADHD, generalized and specific behavioral and personality disorders, and specific cognitive functions (e.g., executive functioning). As an example, let's examine a behavioral rating of executive functioning that is completed by the child's parents. The important concept to remember is that the behavioral rating is the parent's *perception* of the child's executive functioning and not actual samples of the child's executive functioning. Some practitioners rely only on behavioral ratings in their evaluation of the child and do not include direct samples of the child's behavior. It would not be the best professional practice to assume that a child has a working memory deficit based solely on the parents' endorsement of working memory problems for the child. Behavioral rating scales are excellent means of generating hypotheses about the potential cause of a student's current learning or behavioral difficulties and may be useful in determining a comprehensive testing approach, but this use represents a starting point, not a stopping point. Furthermore, if behavioral rating measures are used, a general rule should be a minimum of two samples of behavior collected in two different domains by two different raters.

When Is Enough, Enough, in Terms of Testing?

Jerome is referred for a school neuropsychological evaluation due to a suspected processing deficit in the area of short-term memory. The school neuropsychologist administers Jerome a subtest that measures his memory for words. Jerome achieved an average score on this subtest so the school neuropsychologist concludes that Jerome has no short-term memory problems. What is wrong with this example?

In the previous example, Alicia, the school neuropsychologist, does not have enough assessment data to determine whether Jerome has a short-term memory problem. Jerome may have achieved an average score on a memory for words task because of the added semantic cues. Jerome may have difficulties with visual short-term memory, or with short-term memory of unrelated bits of information (e.g., digit spans). In Chapters 5 through 12, the basic cognitive processes and achievement areas were subdivided into classifications for assessment purposes. To conduct a thorough evaluation, the school neuropsychologist should fully explore the suspected deficit area(s). As a general rule of thumb, it is good practice to administer a minimum of two tests that purport to measure the same suspected deficit area as a means of verifying the deficit.

In the historical practice of neuropsychology, it was common to administer a single measure, such as the drawing of a Greek Cross, and conclude that the child had constructive dyspraxia based on poor performance. A more valid professional practice would be to administer the Greek Cross test and another measure of visuo-spatial processing to validate the hypothesis of poor visuo-spatial constructive skills. Additional guidelines for data interpretation and analyses are presented in the next section. A final point must be made about too much assessment. Assessment for the sake of assessment is never a good practice. One hour of assessment that specifically addresses the referral question(s) is much better than 6 hours of assessment that is only partially related to the referral question(s).

DATA ANALYSES AND INTERPRETATIONS

Ask the Child How He/She Approached the Tasks

In Chapter 1, the contributions of the Boston Process Approach were reviewed in the context of the history of neuropsychology. The basic tenet of this approach to neuropsychological assessment was the idea that how a person arrives at an answer on a test is equally as important as the test score itself. Too often assessment specialists are so concerned about administering a test in a standardized manner that they forget that a child, with a dynamic thinking brain, is sitting in front of them. It is important to administer the test in a standardized manner, but it is equally important to use the testing session to discuss the samples of behavior with the child. After administering a test to a child in a standardized manner, ask the child what was easy and what was hard for him or her to perform. Ask the child what could have been done to make harder tasks easier, and vice versa. Children often have excellent "metacognitive" awareness of their own cognitive strengths and weaknesses and they have identified compensatory methods for their own perceived or actual neurocognitive weaknesses. A school neuropsychologist often looks to "test the limits" in order to best answer the referral question(s).

DON'T FORGET

Too often assessment specialists are so concerned about administering a test in a standardized manner that they forget that a child with a dynamic thinking brain is sitting in front of them.

Be Careful of Self-Fulfilling Prophecies

A school neuropsychologist was evaluating Tonika and she was asked to perform a list-learning memory task. Tonika became very agitated and upset and she indicated that she could not attempt this task because it was too difficult for her and she was "not any good at these kinds of tests." The school neuropsychologist asked Tonika why she thought she could not perform this kind of task. Tonika told the school neuropsychologist that when she was last evaluated she had been administered a similar test and she performed poorly. The test examiner at that time indicated to her that this was a weak area for her and she should avoid tasks in her schooling that involved memorizing verbal material. The school neuropsychologist explained the demands of the current task, calmed Tonika by listening to her concerns, and told her to try her best on the current task. Tonika performed the task and achieved an average score.

What does the previous vignette tell us? Tonika had convinced herself, or had been convinced by a previous examiner, that she could not perform verbal memory tasks. Sometimes children develop these self-fulfilling prophecies about their learning and behavior that can actually disrupt their true potential. In cases like these, it is a good idea to stop the testing, calm the child, explain the demands of the test, indicate that good effort is what is important on the task, and then administer the test. It is important to treat the child as a partner in discovering his/her neurocognitive strengths and weaknesses. Children need to be debriefed by the examiner at the conclusion of the evaluation about what the results showed. Too frequently, children referred for a school neuropsychological evaluation have been told for years that they did not do well, discounting their strengths and developmental changes. Children need to be told about their neurocognitive strengths and taught methods to use those strengths to work around their neurocognitive limitations.

Integrating Reported Problems with Observable Behavior and Assessment Data

How often have assessment specialists (e.g., educational diagnosticians, school psychologists, school neuropsychologists) been relegated to a confined space (e.g., a supply closet, a stage in the auditorium) within a public school to test a child? The generalizability of any test results obtained in these situations should be suspect, at best. Ideally, assessment specialists should take samples of behavior in a variety of settings (e.g., classroom observations, parents' or teachers' perceptions of the child's learning and/or behavioral problems, standardized measures) that relate to the child's everyday environment. In the conceptual school neuropsychological model outlined in this book, it is suggested that parental and teacher concerns about the child's learning should be integrated within the current assessment findings. The Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth available in Appendix B provides a standardized method of collecting concerns about a child's cognitive processing.

Look for Confirming Trends in Data

School neuropsychologists are urged to use a "vector analysis" approach in their clinical interpretations of data. Figure 15.2 illustrates a "vector analysis" approach for a suspected processing speed deficit. Referral concerns, observational data, quantitative and qualitative data must be integrated in order to confirm suspected processing deficits.

In the example presented in Figure 15.2, the data from the four sources converges to support the diagnostic conclusion of a processing speed deficit. Sometimes, the four sources of data do not converge, but rather offer disparate views. The most common form of disagreement is the referral behaviors and classroom observations do not always match the quantitative and qualitative test data. This occurs because educators and parents may misidentify behavioral symptoms and relate those behaviors to the wrong neurocognitive areas. For example, a child may appear to not be "paying attention" in the classroom and referred for attentional processing deficits. After a school neuropsychological evaluation, those

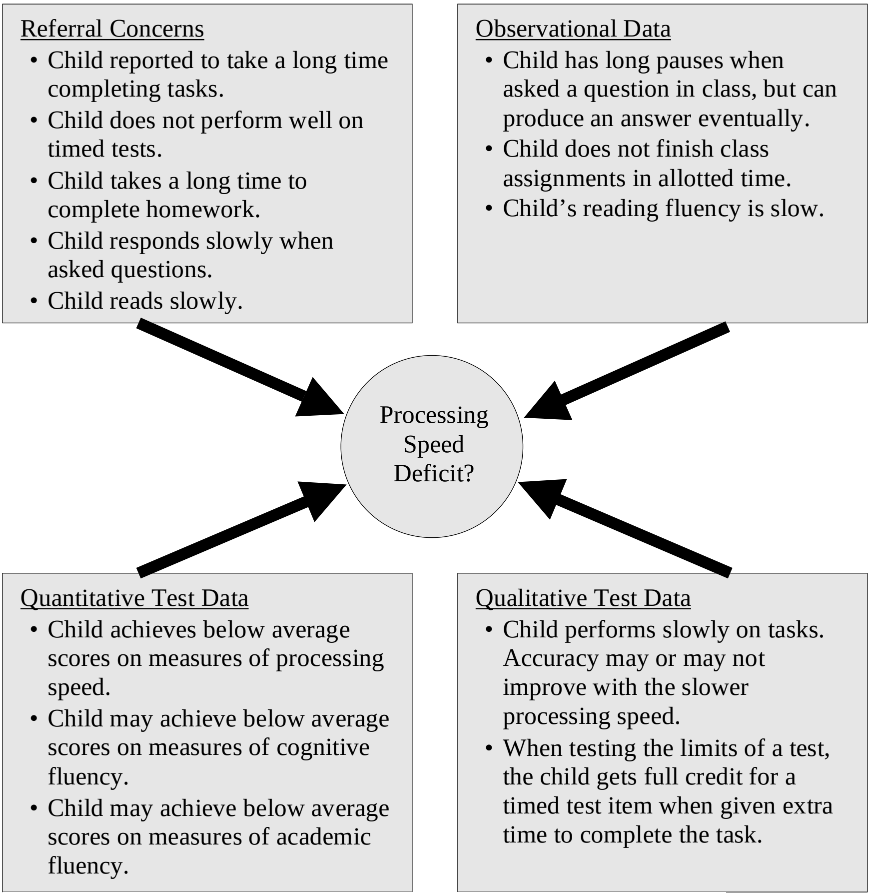


Figure 15.2 A vector analysis model for clinical interpretation

behaviors may be explained by the child's poor auditory processing, and not attentional deficits, as originally suspected. The school neuropsychologist must try to align the four sources of information to support the diagnostic conclusions made in the written report.

Avoid Over-Interpretations

Sally is referred for a school neuropsychological evaluation due to a suspected reading problem that remains resistant to interventions. The school neuropsychologist administered four different tests reported to measure phonological processing. Sally achieved *average scores on three out of four tests but she achieved a very low score on one measure. How should the school neuropsychologist handle interpreting the low score?*

As mentioned in the previous section, the school neuropsychologist must look for confirming trends in the data. In the previous example there is not 100 percent agreement in four samples of behavior that report to measure the same construct. Remember to evaluate the neurocognitive demands of the tasks. Look for similarities on the three tasks on which the child performed well and look for some neurocognitive demand differences on the one task performed poorly. The school neuropsychologist would not want to indicate a universal processing deficit in reading based on the previous sample. When doing a task analysis of the tests administered, one reading test in which Sally performed poorly may use nonsense words that must be read while the other tests used real words. Be cautious of "false positives" that may be due to noncognitive factors (e.g., fatigue, poor motivation).

Avoid Under-Interpreting the Data

Clifford is suspected of having problems with his memory. He constantly forgets to turn in assignments and he does not seem to remember what he is taught from one day to another. He is administered the WISC-IV and he achieves an average score on the Working Memory Index. The school neuropsychologist indicates in the report that Clifford does not have a memory problem. Is this interpretation correct?

When using a limited battery of tests, do not assume that an average score is indicative of across-the-board average skills. For a referral question area, it is a best practice to administer several measures to prove or disprove the suspected weakness. In the previous example, Clifford may have memory problems that relate to long-term memory rather than working memory. As discussed in Chapter Nine, Memory and Learning, there are many subcomponents of memory that need to be assessed when a memory-processing deficit is suspected. In this case, concluding that Clifford has no problems in the area of memory based on one sample of behavior is an under-interpretation of the data.

Depth of Processing Interpretation Model

It is proposed that school neuropsychologists use a *depth of processing model* (see Rapid Reference 15.2) to aid in the clinical interpretation of data. This model has five levels of interpretation. At each level, the school neuropsychologist must consider the noncognitive (e.g., fatigue, poor motivation), environmental, or

Rapid Reference 15.2

Levels of Processing Interpretative Model for School Neuropsychologists

Evidence-based interventions

↑

Consideration of noncognitive factors (e.g., motivation, fatigue), environmental, and cultural factors that contribute to performance at each level.

↑

Level	Focus of Analyses	Needed Knowledge Base (cumulative from one level to the next)
I	Global Index/Factor Scores Only	• Measurement theory (e.g., standardization, reliability, validity). • Ethical and legal principles of assessment.
II	Addition of subtest analyses (e.g., individual subtest and intrasubtest variability)	• Incidence of intrasubtest variability (e.g., technical manual data). • Difference between clinical and statistical significance.
III	Qualitative performance data, supplemental scores, process data, etc.	• Base rates of qualitative performance data. • Neurocognitive demand of each task and the qualitative demands typically elicited. • Interviewing techniques to measure the student's metacognitive awareness of the strategies employed during task performance.
IV	Error analysis, informal samples, testing the limits, etc.	• Evaluation of the patterns of errors within and across subtests and in work samples (e.g., signs of dysnomia). • Linkage of criterion-referenced and curriculum-based measures with standardized measures. • How to test the limits after standardized administration.
V	Neuropsychological interpretation of data.	• Theoretical bases of the assessment instrument. • Construct validity of the test and components. • Functional neuroanatomy.

cultural factors that influence performance on any given test. Also, the school neuropsychologist must consider the linkage between the assessment data and evidence-based interventions at each level.

Level I of the model interprets only the global indices or factors of a test. In order to effectively interpret the data at this level, the assessment specialist must have knowledge of measurement theory, as well as ethical and legal use of assessment data. In the first clinical interpretation case example provided in the next section, it will be illustrated why Level I interpretations only, can mask important neurocognitive deficits.

Level II of the model extends interpretation to the subtest scores. Statistically significant and clinically relevant differences between subtests must be interpreted. A practitioner operating at this level must have an understanding of the technical manuals that describe the intercorrelations of the subtests and the external construct validity of the measures.

Level III of the interpretative model takes into consideration the qualitative behaviors and their relationship to the quantitative scores. Qualitative behaviors are reported as *base rates* by some test publishers (e.g., what was the percentage of children at a particular age level that engaged in a qualitative behavior). In order to understand the importance of qualitative behaviors, the assessment specialist must have a good working knowledge of soft neuropsychological signs, be able to analyze the neurocognitive demands of any given task, and to look for patterns of qualitative behaviors across tasks. A useful technique to investigate the qualitative behaviors is to interview the child about the strategies used in completion of the tasks. Children's metacognitive awareness of their own cognitive processes can be very insightful and useful to the school neuropsychologist.

Level IV of the interpretative model moves beyond the standardized test score results to refine the diagnoses. For example, if a child achieves a standard score of 78 (100 is the mean and 15 is the standard deviation) on a measure of reading accuracy, one can safely conclude that the child is below expected levels for a comparable child his or her age in reading accuracy. However, the standard score itself does not reveal the nature of the reading decoding problem. At this stage of the assessment, the school neuropsychologist should conduct an error analysis of the reading decoding errors to see if there is a pattern of errors that would suggest a particular subtype of reading disorder. Other techniques used may include informal reading samples from a classroom reader, or testing the limits of standardized testing to determine if the child can perform a task when the instructions, methods, or materials are modified.

Level V of the interpretative model requires the school neuropsychologist to be able to understand the neurocognitive demands of any given cognitive task. To accomplish this goal, the school neuropsychologist must have a good knowledge base of the theories used to construct and validate assessment instruments, the construct validity of tests, and a good knowledge of neuropsychological theories and research.

At each level of assessment, the school neuropsychologist must consider potential influences on performance other than neurocognitive processes including: noncognitive factors (e.g., motivation, fatigue), environmental, and cultural factors. A practitioner operating at each stage of the interpretative model takes the data and develops prescriptive interventions that are linked to the assessment data. Finally, the assessment data at each level should be linked to prescriptive and evidence-based interventions. It can be argued that at each increased interpretative level, as the assessment data becomes more precise, the prescriptive interventions should become more targeted and educationally relevant.

In the next section of this chapter two examples of data from case studies will be presented to illustrate either the *Levels of Processing Interpretative Model for School Neuropsychologists* or the multiple causes of test behaviors.

CLINICAL INTERPRETATION EXAMPLES

Interpretative Example 1—Standard Score of 100 on the NEPSY Attention/Executive Functions Domain (When is an at-expected level [average] domain score not necessarily indicative of average ability?)

In this example, the child is a 9-year–6 month-old male. His test scores are presented in the following table. If a clinician interprets only the Attention/Executive Functions Core Index score of 100 (mean of 100, with a standard deviation of 15), the conclusion would be that the child had average attention and executive functions. This would be an example of *Level I analyses* within the *Levels of Processing Interpretative Model for School Neuropsychologists*. This level of interpretation would not take into consideration the child's performance at the subtest level, nor any of the supplemental and qualitative behaviors.

A *Level II analysis* would take into consideration the subtests that comprise the Attention/Executive Functions Core Index Score, in this case: Tower, Auditory Attention and Response Set, and Visual Attention. Overall Full Scale Scores or Indices can be invalid because of a wide scatter within the subtests that comprise the overall score. Be careful of relying on a single score to describe a child's performance. In the case study example number 1, the boy achieved the following scaled scores (mean of 10, with a standard deviation of 3): Tower (12), Auditory Attention and Response Set (8), and Visual Attention (10). Each of these scaled

Interpretative Example 1
NEPSY Test Data–Male Age 9-6

Index/Subscale/ Supplemental/Qualitative	**Score**	**Classification**
Attention/Executive Functions Index	100	At Expected
Tower	12	At Expected
Rule Violations	3–10%	Below Expected
Motor Difficulties	25–75%	At Expected
Auditory Attention & Response Set	8	At Expected
Off-Task Behaviors	3–10%	Below Expected
Auditory Attention (Part 1)	10	At Expected
Omission Errors	11–25%	Slightly Below Expected
Commission Errors	3–10%	Below Expected
Response Set (Part 2)	6	Below Expected
Omission Errors	3–10%	Below Expected
Commission Errors	≤2	Well Below Expected
Visual Attention	10	At Expected
Off-Task Behaviors	3–10%	Below Expected
Cats–Completion Time	3–10%	Below Expected
Cats–Omission Errors	11–25%	Slightly Below Expected
Cats–Commission Errors	11–25%	Slightly Below Expected
Faces–Completion Time	3–10%	Below Expected
Faces–Omission Errors	3–10%	Below Expected
Faces–Commission Errors	≤2%	Well Below Expected

scores fall within the at-expected, or average, range for the child's age. If the clinician stopped examining the data at this level, the conclusion would still be that the child has average attention and executive abilities. Most assessment specialists (e.g., school psychologists, educational diagnosticians, psychometrists) within the schools will stop at Level II in their data analysis.

A *Level III analysis* would take into consideration any supplemental scores, qualitative performance data, and any other process-related data. In the case study example 1, the supplemental scores and qualitative behaviors give a different clinical picture of the child. For example, the child achieved a scaled score of 8 on the Auditory Attention and Response Set subtest, which falls within the low end of the average range. On this particular test, the NEPSY, supplemental, scaled scores are provided for the first part of the Auditory Attention and Response Set task and the second part of the task. The child achieved a scaled score of 10 on the Auditory Attention part of the task and a scaled score of 6 on the Response Set part of the test. Both portions of the test require selective/focused and sustained attention, but the Response Set portion adds a shifting attention component to the test. A hypothesis could be generated that the child may have some problems with shifting attention. This potential area of weakness would not have been uncovered if the interpretation stopped at the Level II stage of interpretation. The qualitative behaviors for the Auditory Attention and Response Set test also reveal that the child produced a large number of commission errors for a child his age. This indicates that the child could have a tendency to guess a lot, or the child put blocks in the box in order to be compliant, or the child was confused about the task. These hypotheses would need to be verified based on all of the assessment data. The qualitative behaviors on the Visual Attention task suggest that the child may have slow processing speed, as reflected by the below average completion times.

A *Level IV analysis* would test some of the hypotheses that were generated in the Level III stage of the analyses. It was hypothesized that the child may have some difficulties with shifting attention. The school neuropsychologist should look for other evidence of shifting attention difficulties in test performance, behavioral observations, and behaviors reported by parents and teachers. Likewise, explore with the teacher if the child makes many commission errors on classroom and homework assignments as well. Conduct an error analysis on some classroom work samples to determine if there is a pattern of errors present. Finally, look at other measures of processing speed across formal assessment and observational data to determine if processing speed is a generalized deficit area.

A *Level V analysis* integrates a neuropsychological perspective into the interpretation of the data. The child in the first case study example appears to have a shifting of attention problem. As presented in Chapter Ten, Executive Functions, the dorsolateral prefrontal circuit regulates set shifting. Since set shifting appears to be impaired, the school neuropsychologist should probably evaluate other neurocognitive functions that are known to be associated with the dorsolateral prefrontal circuit, including possible impairments in verbal and nonverbal retrieval fluency, working memory, organizational skills, problem solving, planning, and goal setting. To apply a neuropsychological perspective to assessment data, a practitioner needs to understand brain-behavior relationships, theories of brain function, and the construct validity of the instruments used in evaluations.

A danger in interpretation of assessment data is not fully interpreting the results. In this first case example, if a practitioner were to stop interpreting the test data at either of the first two levels, the child would have been viewed as having average attentional skills. However, test authors and publishers have included supplemental and qualitative behaviors as part of their test batteries for a reason. In the analysis of the first case study, the supplemental and qualitative scores revealed a difference in the clinical picture of the child.

In the next case study example, test data from the D-KEFS Trail Making Test will be used to make the point about the potential multiple contributors of test behaviors.

Interpretative Example 2—Performance on the D-KEFS Trail-Making Test

As reported in Chapter 10, Executive Functions, The Trail Making Test (TMT) is widely used by practitioners because it is sensitive to overall brain dysfunction; however, it does not reliably localize brain dysfunction. The TMT test is thought to measure alternating and sustained visual attention, sequencing, psychomotor speed, cognitive flexibility, and inhibition-disinhibition. The D-KEFS version of the TMT (D-KEFS-TMT: Delis, Kaplan, & Kramer, 2001) sought to address some of these interpretative limitations by including five conditions (see Rapid Reference 15.3).

In Rapid Reference 15.3, the italic letters represent the principal constructs that are being measured by each condition. For example, in Condition 1, visual scanning and visual attention are the principal constructs being measured. On this task, the child is asked to find all of the number 3s on the page and put a mark with a pen/pencil on them as quickly as possible. The task does require a minimal motor response but that is not the principal construct being measured. Condition 4, Number-Letter Switching, represents the major part of the test.

Rapid Reference 15.3

The D-KEFS Trail Making Test Scores

Score	What Is Measured
Conditions:	
Condition 1—Visual scanning	• *Visual scanning* • *Visual attention* • Motor functions
Condition 2—Number sequencing	• Visual scanning • Visual attention • Motor functions • *Basic numerical processing*
Condition 3—Letter sequencing	• Visual scanning • Visual attention • Motor functions • *Letter sequencing*
Condition 4—Number-letter switching	• Visual scanning • Visual attention • Motor functions • *Shifting attention/Cognitive flexibility/ Divided attention*
Condition 5—Motor speed	• Visual scanning • Visual attention • *Motor functions*
Contrast Scores:	
Condition 4 vs. Condition 1	Contribution of visual scanning and attention to the performance on Condition 4.
Condition 4 vs. Condition 2	Contribution of number sequencing to the performance on Condition 4.
Condition 4 vs. Condition 3	Contribution of letter sequencing to the performance on Condition 4.
Condition 4 vs. Condition 2 + 3	Contribution of sequential processing in general to the performance on Condition 4.
Condition 4 vs. Condition 5	Contribution of motor output to the performance on Condition 4.

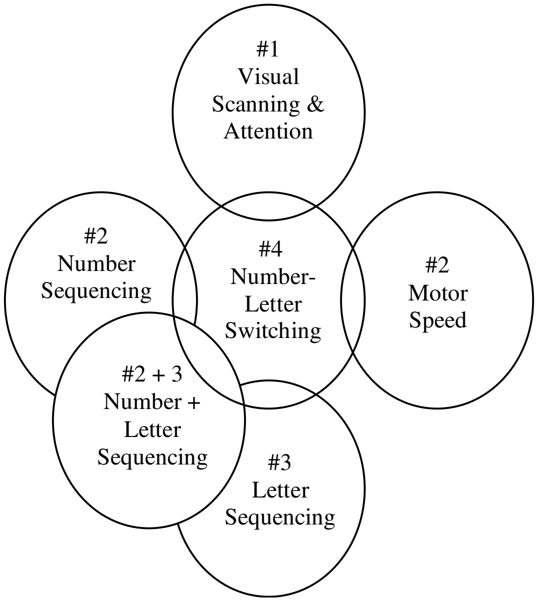


Figure 15.3 Conceptual interpretative model of the D-KEFS Trail Making Test. Poor performance on Condition 4, Number-Letter Switching, may be attributable to poor performance on any one or more of the other conditions.

All of the other conditions and contrast scores were designed to help interpret the child's performance on the number-letter switching condition. Figure 15.3 illustrates the contribution of conditions and contrast scores to the understanding of the number-letter switching condition.

The D-KEFS Condition 4 is considered a classic measure of executive functioning; however, as shown in Rapid Reference 15.4 there are multiple reasons that can be hypothesized for poor performance on this part of the test. The possible explanations for poor performance on the D-KEFS-TMT are organized according to the conceptual school neuropsychological model.

Sensory-Motor Deficits

Motor Impairment

- Look at the D-KEFS-TNT Condition 5 (Motor Speed) to determine if that is a significantly low score.
- Look at the Condition 4 (Number-Letter Switching) versus Condition 5 (Motor Speed) contrast score.

Rapid Reference 15.4

Possible Explanations for Poor Performance of the D-KEFS Trail-Making Test

Possible cause of poor performance	D-KEFS Trail-Making Condition				
	1	2	3	4	5
Sensory-Motor Deficits:					
Poor motor speed	✓	✓	✓	✓	✓
Attentional Processing Deficits:					
Poor selective/focused attention	✓	✓	✓	✓	✓
Failure to maintain cognitive set: distractibility/ sustained attention	✓	✓	✓	✓	✓
Poor shifting of attention				✓	
Poor divided attention				✓	
Poor attentional capacity	✓	✓	✓	✓	
Visual-Spatial Processing Deficits:					
Poor visual-scanning	✓	✓	✓	✓	✓
Language Deficits:					
Failure to maintain cognitive set: poor comprehension of instructions	✓	✓	✓	✓	✓
Memory and Learning Deficits:					
Poor working memory				✓	
Executive Function Deficits:					
Poor cognitive flexibility				✓	
Poor set-shifting				✓	
Speed and Efficiency of Cognitive Processing Deficits:					
Poor processing speed	✓	✓	✓	✓	✓
Intellectual/Academic Deficits:					
Poor generalized intellectual skills	✓	✓	✓	✓	✓
Poor number processing	✓	✓		✓	
Poor letter processing	✓		✓	✓	
Poor generalized sequencing skills		✓	✓	✓	
Noncognitive (Cultural, Social, or Environmental) Factor Deficits:					
Noncognitive factors (e.g., poor effort)	✓	✓	✓	✓	✓

- Look to other measures to confirm motor impairment (e.g., Dean-Woodcock Neuropsychological Battery, WISC-IV Coding, NEPSY Visual-Motor Precision, WRAVMA Pegboard).

Attentional Processing Deficits

The child must allocate attentional resources to complete the D-KEFS-TMT. Poor performance on Condition 4, Number-Letter Switching, may be caused by poor: selective/focused attention, sustained attention or distractibility, shifting attention, or attentional capacity. The examiner should look at other tests of attention to verify hypotheses about which attentional processes could be causing poor performance on the D-KEFS-TMT.

Visual-Spatial Processing Deficits

The child must be able to visually scan the visual stimuli on the D-KEFS-TMT. Poor performance on all of the test conditions may be caused by poor visual scanning abilities. Some children may perform poorly on any test that has a visual component because of poor attention to visual detail.

- Look at the D-KEFS-TNT Condition 1 (Visual Scanning) to determine if that is a significantly low score.
- Look at the Condition 4 (Number-Letter Switching) versus Condition 1 (Visual Scanning) contrast score.
- Look to other measures to confirm visual scanning deficits (see Rapid Reference 7.3 for a list of comparison tests).

Language Deficits

In order to successfully accomplish the D-KEFS-TMT, the child must be able to comprehend the oral instructions that are administered by the examiner. Failure to comprehend the instructions could be a reason for poor performance on each of the D-KEFS-TMT conditions. The examiner should review the child's performance on other measures of receptive language for confirmatory evidence. See Rapid Reference 8.3 for a list of other measures of receptive language.

Memory and Learning Deficits

Condition 4 Number-Letter Switching, on the D-KEFS-TMT requires some aspects of working memory. The child must maintain the number and letter sequencing in his or her head while alternating back and forth between their proper sequences (e.g., 1-A-2-B-3-C . . .). If the examiner thinks that poor working memory is the cause of poor performance on Condition 4 of the D-KEFS-TMT, then the examiner should review other samples of working memory to support or refute that hypothesis. See Rapid Reference 9.3 for a list of other measures of working memory.

Executive Function Deficits

Condition 4 of the D-KEFS-TMT requires the child to use some executive functioning processes such as set shifting, which is a measure of cognitive flexibility. The examiner should evaluate the contrast scores on the D-KEFS-TMT to determine if the child is exhibiting disproportionate impairment in cognitive flexibility relative to the other four baseline conditions (Delis, Kaplan, & Kramer, 2001). If a problem of cognitive flexibility is suspected, the examiner should review other measures of executive processing to support or refute that hypothesis. See Rapid Reference 10.7 for a list of other measures of executive functioning.

Speed and Efficiency of Cognitive Processing Deficits

Since scores for each of the conditions on the D-KEFS-TMT are based on completion time, the test is indirectly measuring processing speed. Similar to each of the other areas, if the examiner suspects that poor performance on the D-KEFS-TMT is a result of poor processing speed, this hypothesis should be verified or refuted by looking at other measures of processing speed. See Rapid Reference 11.1 for a list of other measures of speed and efficiency of cognitive processing measures.

Intellectual/Academic Deficits

If a child has limited intellectual ability (e.g., full scale IQs less than 70) then poor performance on the D-KEFS-TMT may be a function of poor overall cognitive capabilities. The examiner will need to verify this hypothesis by reviewing the results of measures of cognitive processing. The major tests of cognitive abilities are presented in Rapid Reference 12.1.

Noncognitive Factors

Sometimes there is no definitive neurocognitive explanation for why a child performed poorly on a task. Other noncognitive factors such as lack of effort or motivation, fatigue, pain avoidance, or emotional problems (e.g., lethargy due to depression, oppositional behaviors, cultural factors) may be the reason for poor performance on a task. The following is a partial list of noncognitive factors that can cause or contribute to poor performance on a test:

- *Readiness/motivational states:* If fatigue is a possible cause of poor performance, do not include those results and readminister them at another time (test the limits) when the child is not so tired. It is probably best practice to report both test scores (fatigued and nonfatigued) in the report. A dubious practice is to administer a lengthy test battery to a child, with few if any breaks, and then equate poor performance at the end of the session with true neurocognitive deficits. In this example, the deficits may or may not be real, but one must rule out the effects of fatigue as well.
- *Psychological factors:* Review the reasons for referral and the background information provided by the child's teacher(s) and parent(s). Look for clues related to the noncognitive factors that could explain poor test performance. A child that has been diagnosed with major depression and has been prescribed an antidepression medication may appear lethargic and under-motivated. The psychological state of the child or adolescent is an important consideration when interpreting neuropsychological results.
- *Acculturation* is an important factor to consider as a noncognitive factor. If English is not the child's primary language, or if the child has recently arrived in the United States, acculturation may be a major contributing factor to poor test performance. Consider the need for using neuropsychological measures translated into a foreign language (see Rapid Reference 3.7).
- *Environmental* factors (e.g., Maslow's Hierarchy of Needs—a child who is hungry or fearing for his or her safety will not perform well on testing).

If noncognitive factors are causing poor performance, consider invalidating the test results or use strong qualifiers in the "Assessment Validity" section of the report.

The purpose of this second case study is not to frustrate the aspiring or seasoned school neuropsychologist, but to make him or her aware of the multiple explanations for human behavior. The science of psychology, school psychology, and school neuropsychology are still relatively young within the body of knowledge related to each rapidly expanding discipline or subspecialty area. A well-trained school neuropsychologist must be able to use data from multiple sources to generate and test hypotheses about a child's profile of neurocognitive strengths and weaknesses.

In this chapter, a set of clinical interpretation guidelines for school neuropsychologists was presented. The guidelines included the importance of relating the assessment to the referral question(s), adopting a flexible approach to assessment, understanding the neurocognitive demands of assessment measures, understanding the role of *brief* and behavioral rating measures, and knowing when to stop testing. The second section of this chapter presented some guidelines related to data interpretation and analyses. These guidelines included the importance of asking children about the strategies they used to approach tasks, cautions about self-fulfilling prophesies, cautions about over- and under-interpretations of the results, integrating reported problems with observation and assessment data, and the introduction of a *Levels of Processing Interpretative Model for School Neuropsychologists*. The final section of the chapter provided an example of clinical interpretation applied to a common neurodevelopmental disorder.

TEST YOURSELF

1. **Most assessment specialists (e.g., school psychologists, educational diagnosticians, psychometrists) within the schools will stop at Level IV in their data analyses.** True or false?
2. **What is the term used to describe a child that believes he or she cannot perform well on a given task, even though there may be evidence to indicate that the child should perform well on the task?**
   (a) low self-esteem
   (b) major depression
   (c) confabulation
   (d) self-fulfilling prophecy
3. **Level III of the *Levels of Processing Interpretative Model for School Neuropsychologists* related to analyzing:**
   (a) Error analysis, informal samples, testing the limits, etc.
   (b) Qualitative performance data, supplemental scores, process data, etc.
   (c) Global Index/Factor Scores Only
   (d) Neuropsychological interpretation of the data

(*continued*)

4. **To apply a neuropsychological perspective to assessment data, a practitioner needs to understand brain-behavior relationships, theories of brain function, and the construct validity of the instruments used in evaluations.** True or False?
5. **In the case study example 2, poor performance on the D-KEFS Trail Making Test's Condition 4 (Number-Letter Switching) may be attributable to all of the following except:**
   (a) poor visual scanning
   (b) poor attentional processing skills
   (c) poor long-term memory
   (d) poor motivation
6. **Level I of the *Levels of Processing Interpretative Model for School Neuropsychologists* related to analyzing:**
   (a) Error analysis, informal samples, testing the limits, etc.
   (b) Qualitative performance data, supplemental scores, process data, etc.
   (c) Global Index/Factor Scores Only
   (d) Neuropsychological interpretation of the data
7. **Level V of the *Levels of Processing Interpretative Model for School Neuropsychologists* related to analyzing:**
   (a) Error analysis, informal samples, testing the limits, etc.
   (b) Qualitative performance data, supplemental scores, process data, etc.
   (c) Global Index/Factor Scores Only
   (d) Neuropsychological interpretation of the data

Answers: 1. false; 2. d; 3. b; 4. true; 5. c; 6. a; 7. d

Sixteen

THE SCHOOL NEUROPSYCHOLOGICAL MODEL APPLIED TO A COMMON DEVELOPMENTAL DISORDER: AUTISM

In the previous chapters, a conceptual model for school neuropsychological assessment was introduced. This same school neuropsychological assessment model can provide a framework for evaluating common developmental disorders (e.g., ADHD, Autism Spectrum Disorder). It is beyond the scope of this book to illustrate how the school neuropsychological assessment conceptual model applies to all of the common neurodevelopmental disorders. As one example, the school neuropsychology assessment framework will be applied to what researchers have discovered about Autism Spectrum Disorders.

AUTISM SPECTRUM DISORDERS

Autism Spectrum Disorders (ASDs) encompasses Autistic Disorder, Asperger Disorder, and Pervasive Developmental Disorders, Not Otherwise Specified. According to the *DSM-IV* (American Psychiatric Association, 1994), a diagnosis of autism is based on deficits in three major areas: (1) reciprocal social behavior; (2) language development; and (3) repetitive/stereotypic behaviors (or a restricted range of interests). Of interest to the school neuropsychologist are the neurocognitive deficits associated with ASD. Rapid Reference 16.1 presents a summary of the neurocognitive deficits that have been found to be associated with ASD. These findings are reviewed in more detail in the next sections.

Autism and Sensorimotor Functions

See Smith (2004) for a thorough review of the motor problems associated with Autistic Spectrum Disorder. Smith (2004) pointed out that while motor problems are common in ASD children, an abundance of research studies have indicated that motor problems do not differentiate well among the subtypes of autism. The literature review related to sensorimotor deficits found in autistic children will be divided into two sections: fine motor and gross motor functions.

Rapid Reference 16.1

Neurocognitive Deficits Associated with Autism Spectrum Disorder

Neuropsychological Area	Observed Deficit(s)
Sensorimotor Functions	
Fine motor coordination	• Poor gesture imitation and producing symbolic imitations. • Poor immediate and delayed motor imitation ability. • Poor motor planning. • Stereotyped motor behavior. • Difficulties executing novel movements.
Gross motor coordination	• Possible gait abnormalities. • Motor clumsiness; but may be a function of intelligence level.
Attentional Processes	
Selective/focused	• No deficits compared to controls; however, the use of color may facilitate performance in a maladaptive manner in HFA populations.
Sustained	• Mixed findings in the literature.
Shifting	• Deficits in shifting attention across ages in a High Functioning Autism (HFA) sample. Visual shifting attention deficits observed in a PDD/AU sample of young children.
Visual-Spatial Processes	
Visual perception	• ASD children have been shown to have greater perceptual fluency.
Visual-perceptual organization	• ASD children perform average to above average on tasks that involve visual-perceptual organization and reasoning (e.g., WISC Block Design & Object Assembly).

Language Functions	
Oral expression	• Poor use of context. • Poor reciprocal communication and integrated use of verbal and nonverbal communication. • Poor use of unestablished referents. • Poor prosody. • Poor language use (pragmatics). • Perseverative questioning. • Immediate and delayed repetition of words (echolalia). • Contributes little new information to conversations. • Have trouble following the gist of conversations. • Unusual lexical patterns (e.g., made-up words, neologisms, echolalia).
Receptive language	• Poor understanding of idioms, have rigid meanings of words. • Poor semantics.
Memory and Learning	
Encoding	• ASD children have difficulty with encoding of information.
Executive Functions	
Planning efficiency	• No deficits evident in young children, but they seem to develop and become acute in adolescence.
Generalized executive functions	• Poor ability to generate multiple novel responses. • Poor inhibition—high rates of perseverative responses. • Poor Tower of Hanoi performance. • Impaired cognitive flexibility and verbal fluency.
Cognitive Efficiency, Cognitive Fluency, and Processing Speed	
Reaction times	• Slower reaction times than controls.

(*continued*)

Social-emotional Functioning	
Social skills	• In infancy, poor eye gaze, poor facial expressions, and poor body language. Impaired social orienting, shared attention, responses to emotional cues, and symbolic play.
Atypical behaviors	• Stereotyped handling or arranging of objects (e.g., lining up toys, sorting objects by color). • Poor eye gaze, poor facial expressions, and poor body language.

Fine Motor

Children with ASD have been found to manifest some fine motor coordination difficulties, particularly in the area of gesture imitation. Dawson, Meltzoff, Osterling, and Rinaldi (1998) found that an ASD sample had significant impairment in immediate and delayed motor imitation ability (motor and/or memory: motor planning; ability to recall and reproduce events). Smith and Bryson (1994, 1998) also found that autistic children were poor in performing gesture imitation tasks. They believed that fine motor deficits contributed to poor gesture imitation but could not entirely account for those deficits. Children with autism also have deficits in the ability to produce symbolic actions based either on imitation of a model or based on verbal command. Smith and Bryson (1994, 1998) found that children with autism have a limited behavioral repertoire and many activities appear to lack normal goal directedness or purpose. The motor behavior of children with autism is often predominated by stereotypic and perseverative behaviors (e.g., rocking, self-stimulation; Smith, 2004).

Gross Motor

The *Diagnostic and Statistical Manual for Mental Disorder* (*DSM-IV;* American Psychiatric Association, 1994) includes poor motor skills, or clumsiness, as an associated feature of Asperger syndrome. Gunter, Ghaziuddin, and Ellis (2002) suggested that motor problems are a characteristic, but not an essential feature, of autism. Gait abnormalities and hypotonia were reported in early autism research (Vilensky, Damasio, & Maurer, 1981). Motor clumsiness has been reported in some ASD studies (Bonnet & Gao, 1996; Gillberg & Kadesjo, 2003), but the clumsiness may disappear when the effects of IQ are controlled for (Ghaziuddin & Butler, 1998). Miller and Ozonoff (2000) tried to differentiate motor difficulties between an HFA and AS group. They found that only manual dexterity was different between groups when the effects for IQ were controlled. HFA and AU cannot be differentially diagnosed based on Motor Performance alone (Smith, 2004). Novales (2006) found visual-motor skill deficits in a sample of 63 AS children. The visual-motor skills deficits were measured by three NEPSY (Korkman, Kirk, & Kemp, 1998) subtests (Fingertip Tapping, Imitating Hand Positions, and Visuomotor Precision).

Autism and Attentional Processes

Not all of the currently recognized subcomponents of attention (e.g., selective/focused, sustained, shifting, divided, capacity) have been studied in relation to autism. Past research has focused on selective/focused, sustained, and shifting attention. Pascualvaca, Fantie, Papageorgiou, and Mirsky (1998) investigated a sample of ASD children, ages 6 to 12, and found that they had no difficulty with *selective/focused* or *sustained attention*. Brian, Tipper, Weaver, and Bryson (2003) investigated *selective/focused attentional processes* in high-functioning autism (HFA) and matched control samples. Brian et al. (2003) found that the HFA group had normal ability to inhibit visual-spatial distracters and normal ability to direct inhibition to task-relevant stimulus features. They unexpectedly found that the use of color, as a perceptual feature, facilitated performance in the HFA group. It was suggested that the over processing of the single feature of color in the stimuli by the HFA group was a potentially maladaptive response because of the excessive attention to irrelevant details.

The research findings on the effects of ASD on *sustained attention* and *shifting attention* have been mixed. Pascualvaca et al. (1998) found that a sample of ASD children had no difficulty maintaining their attention over time (sustained attention), but did have difficulty shifting their attention when they were already engaged in a particular activity. However, in another study, Nyden, Gillberg, Hjelmquist, and Heiman (1999) did not find any shifting attention deficits in a sample of HFA boys. Goldstein, Johnson, and Minshew (2001) compared a sample of children and adults with high functioning autism (HFA) to a matched control group using a set of attentional measures that corresponded to Mirsky et al.'s (1991) model. Goldstein et al. (2001) found that HFA subjects, regardless of age, showed deficits in sustained and shifting attention. Landry and Bryson (2004) found that a sample of young children (ages 3-8 to 7-6 years) with PDD/autism had marked difficulty in disengaging visual attention and a more subtle difficulty with rapid shifting of attention. Therefore, the prudent school neuropsychologist should be aware that disorders of attention may be present with autistic students, though the integrity of each subcomponent of attention will vary among individuals.

Autism and Visual-Spatial Functions

Visual-spatial functions appear to be largely intact in ASD children. Autistic children have been found to achieve average to above average scores on the WISC Block Design (Bartak, Rutter, & Cox, 1975; Shah & Frith, 1983; 1993), Object Assembly subtests, and an embedded figures task (Shah & Frith, 1983). These measures also require nonverbal reasoning skills, which are executive functions. The only visual-spatial deficits that are problematic in autistic children involve visual search strategies and visual planning (Shah & Frith, 1983).

Autism and Language Functions

Impairment in social communication is a major clinical feature of ASD. Some autistic children have a delay in the development of speech, while others never develop speech (including any attempt at nonverbal gestures; Sicile-Kira, 2004). Researchers have begun to use neuroimaging techniques to investigate the neurological bases of language dysfunction in autism. Boddaert and colleagues (2004) measured the perception of complex sounds in autistic children using regional cerebral blood flow. They found that in the autistic clinical sample there was less activation in the left speech-related areas (auditory associative areas involved in word processing) and dysfunction of specific temporal regions specialized in perception and integration of complex sounds.

Autistic children have marked language deficits including poor:

- use of context (lack of differential responsiveness to words that did not fit with the context; Dunn, Vaughan, Kreuzer, & Kurtzbert, 1999);
- reciprocal communication and integrated use of verbal and nonverbal communication (Gilchrist et al., 2001);
- understanding or demonstrating their understanding of idioms; also more often described as having rigid concept boundaries (rigid meanings of words), using unestablished referents, having difficulty using prosody, and having poor nonverbal communication (Kerbel & Grunwell, 1998);
- turn-taking ability (use of adjacent utterance; Tager-Flusberg & Anderson, 1991);
- language use (pragmatics); persistent (perseverative) questioning; immediate and delayed repetition of words or whole phrases (echolalia); contribute little new information to conversation; insert irrelevant remarks into conversations; have trouble following a conversational topic (see Kutscher, 2005; Wilkinson, 1998 for reviews);

- symbolic behavior (semantics) are delayed due to related pragmatic joint attention difficulties; unusual lexical patterns (made-up words, neologisms, echolalia) are distinctive in autism for their frequency and persistence (see Wilkinson, 1998 for review); and
- prosody of speech (phonological skills are relatively intact); syntactic skills: problem lies in application of pronouns during conversation (comprehension of personal pronouns intact); development of forms of syntax not deviant or delayed relative to other developmental disabilities (but delayed relative to typical chronology; see Wilkinson, 1998 for review).

Autism and Memory and Learning Functions

Memory and learning functions seem to be only selectively impaired in children with ASD. Rapid Reference 16.2 presents the memory functions that are intact and the memory functions that are impaired in children with ASD. Minshew and Goldstein (2001) pointed out that, overall, memory dysfunction is largely the product of failure to utilize organizational strategies, with similar impairments seen in both auditory and visual modalities.

Autism and Executive Functions

Measures of executive functions have not proven to be good diagnostic indicators of ASD in young children (Dawson et al., 2002; Ozonoff et al., 2004) because their performance was similar to that of other children with comparable mental ages. However, Ozonoff and colleagues (2004) found that planning efficiency deficits increased with age (no deficits in young children less than 12 years of age, increased deficits from teenage years through adulthood). When executive function deficits become manifested in adolescents with autism, they are widespread. In a review of the literature, Pennington and Ozonoff (1996) found that autistic individuals demonstrated deficits on 25 of 32 (78 percent) of executive function tasks and autistics never outperformed controls. Similarly, Gioia, Isquit, Kenworthy, and Barton (2002) found that children with autism had pervasive executive dysfunction compared to other clinical groups including ADHD-Impulsive type, ADHD-Combined type, moderate and severe TBI, and reading disabled.

Individuals with autism, particularly adolescents and adults, have been found to have executive function deficits in:

Rapid Reference 16.2

Memory Functions of Children with Autism Spectrum Disorder

Spared	Impaired
Free recall is normal. Larger recency effects than primacy effects, which is normal (Boucher, 1981).	On free-recall tests, autistic boys recalled fewer of the first three words on the list as compared to controls as well as the rest of the words, except for the last 3 words (Boucher, 1981).
Relating words to concepts or organizing concepts in memory (Wilkinson, 1998).	Verbal memory (Ozonoff, Pennington, & Rogers, 1991).
Associative memory intact; words may be encoded semantically, but not very efficiently (Minshew & Goldstein, 2001).	Visual memory task and span of apprehension task performance decreases as task complexity increases (Minshew & Goldstein, 2001).
Delayed memory normal as long as not too complex.	Immediate and delayed memory performance decreases as complexity increases (Minshew & Goldstein, 2001).
Working memory tasks intact (Geurts, Verte, Oosterlaan, Roeyers, & Sergeant, 2004).	Facial recognition memory (Hauck, Fein, Maltby, Waterhouse, & Feinstein, 1998; Howard et al., 2000).
Normal ability to differentiate faces by basic physical structure and normal word recognition memory (Howard et al., 2000).	Social memory (Hauck et al., 1998).

- impaired ability to generate multiple novel responses following a single cue or instruction (may be a failure to generate or use a strategy to improve performance rather than a failure to produce or retrieve lexical items from memory; Turner, 1999);
- impaired regulation of behavior through inhibition and/or monitoring (higher rates of disallowed or perseverative responses on design fluency task; Turner, 1999);
- impaired Tower of Hanoi planning efficiency (Ozonoff, Pennington, & Rogers, 1991). Pennington and Ozonoff (1996) compared executive

functions between clinical samples of studies with ADHD, autism, conduct disorder, and Tourette's. They found that the Tower of Hanoi test was the most successful in discriminating autistic from nonautistic children.

- Wisconsin Card Sorting Test perseverations and failure to maintain set (Ozonoff, Pennington, & Rogers, 1991);
- impaired response inhibition, planning, cognitive flexibility, and verbal fluency (Geurts et al., 2004).

Gilotty, Kenworthy, Sirian, Black, and Wagner (2002) reported that deficits in metacognitive aspects of executive functioning in HFA children contribute to adaptive functioning impairments.

Autism and Social-Emotional Functions

Impaired social functioning is a hallmark feature of autism. This is manifested in infancy by a lack of interest in people as reflected by poor eye gaze, poor facial expressions, and poor body language (Mundy, Sigman, & Kasari, 1994). Dawson and colleagues (1998) also reported that 3- and 4-year-old children with autism evidenced impaired social orienting, shared attention, responses to emotional cues, and symbolic play. Robins, Fein, Barton, and Green (2001) investigated the early detection of autism using a Modified Checklist for Autism (M-CHAT). They found that six items discriminated children on the autism spectrum from normal controls: a child seeking joint attention with another person: (1) protodeclarative pointing; (2) following a point; (3) bringing objects to show the caregiver; (4) social relatedness (interest in other children and imitation); (5) responding to their name when called; and (6) failure of normal behavioral systems to mature.

These poor social skills and poor communication skills can lead to later psychological disorders such as depression and mood disorders. Kim, Szatmari, Bryson, Streiner, and Wilson (2000) found that children with autism and Aspergers syndrome had a higher prevalence for depression than the general population, but no difference in the prevalence rate for anxiety or other mood-related disorders. They found that having a lower nonverbal IQ as a child was a positive predictor for later psychiatric problems.

A school neuropsychologist must know the characteristics of the common neurodevelopmental disorders and the known neuropsychological correlates to those disorders. This knowledge base will aid the school neuropsychologist in constructing an assessment battery to fully address the neuropsychological strengths and weakness of those children with known and suspected neurodevelopmental disorders. This chapter illustrated how the conceptual school neuropsychological model can be used as a framework to evaluate autism spectrum disorders. The model can be easily used as a framework to evaluate other neurodevelopmental disorders such as Attention-Deficit/Hyperactivity Disorder, nonverbal learning disabilities, the effects of low-birth weight and/or prematurity, fetal alcohol syndrome, and so on. It is imperative that school neuropsychologists stay current in this emerging area of specialization. Brain research in basic cognitive processes and the manifestation of those processes within common neurodevelopmental disorders will help shape our educational practices in the future. The challenge for all school neuropsychologists is to strengthen the linkage between our comprehensive assessments and evidence-based interventions in order to make a difference in the life of a child.

TEST YOURSELF

1. All of the following are fine motor coordination deficits observed in ASD children except which one?

(a) poor gesture imitation
(b) poor immediate and delayed motor imitation
(c) motor clumsiness
(d) difficulties executing novel movements

2. Motor clumsiness reported in ASD children may be a function of intellectual level. True or False?

3. Which of the subtypes of attention is most likely impaired in children with ASD?

(a) selective/focused attention
(b) sustained attention
(c) shifting attention
(d) divided attention

4. Which of the following neurocognitive processes generally represents a strength for children with ASD?

(a) sensory-motor functions
(b) attentional processes
(c) language processes
(d) visual-spatial processes

5. **All of the following memory skills are generally impaired in children with ASD except which one?**
   (a) Facial memory recognition
   (b) Verbal memory
   (c) Social memory
   (d) Associative memory
6. **Working memory is generally impaired in most ASD children.** True or False?
7. **Impaired social functioning is a hallmark feature of autism.** True or False?

Answers: 1. c; 2. true; 3. c; 4. d; 5. d; 6. false; 7. true

Appendix A

Test Publishers

Academic Therapy Publications
20 Commercial Boulevard
Novato, CA 94949-6191
800-422-7249 (phone)
www.academictherapy.com

AGS Publishing (now part of Pearson Assessments)
4201 Woodland Road
Circle Pines, MN 55014-1796
800-328-2560 (phone)
www.agsnet.com

BrainTrain
727 Twin Ridge Lane
Richmond, VA 23235
804-320-0105 (phone)
www.braintrain.com

Checkmate Plus Ltd.
P.O. Box 696
Stony Brook, NY 11790
800-779-4292 (phone)
www.checkmateplus.com

Curriculum Associates, Inc.
153 Rangeway Road
North Billerica, MA 01862
800-225-0248 (phone)
www.curriculumassociates.com

Gordon Systems, Inc.
P.O. Box 746
DeWitt, NY 13214
800-550-ADHD (phone)
www.gsi-add.com/gsisite/index.htm

Harcourt Assessment, Inc. (formerly The Psychological Corporation)
19500 Bulverde Road
San Antonio, TX 78259
800-211-8378 (phone)
www.harcourt.com/bu_info/harcourt_assessment.html

Hawthorne Educational Services, Inc.
800 Gray Oak Drive
Columbia, MO 65201
800-542-1673 (phone)
http://www.hes-inc.com/hes.cgi

Hogrefe & Huber Publishers, Inc.
30 Amberwood Parkway
Ashland, OH 44805
800-228-3749 (phone)
www.hhpub.com

Janelle Publications
P.O. Box 811
1189 Twombley Rd.
DeKalb, IL 60115
800-888-8834 (phone)
www.janellepublications.com

KIDS, Inc.
1156 Point Vista Road
Hickory Creek, TX 75065
800-594-4649 (phone)
www.kidsinc.com

Metritech
4106 Fieldstone Road
Champaign, IL 61822
217-398-4868 (phone)
www.metritech.com

Modern Curriculum Press (now part of Pearson Assessments)
4350 Equity Drive
Columbus, OH 43216
800-526-9907 (phone)
www.pearsonlearning.com

Multi-Health Systems, Inc
P.O. Box 950
North Tonawanda, NY 14120-0950
800-456-3003 (phone)
www.mhs.com/index.htm

Pearson Assessments
P.O. Box 1416
Minneapolis, MN 55440
800-627-7271 (phone)
www.pearsonassessments.com

PRO-ED, Inc.
8700 Shoal Creek Boulevard
Austin, TX 78757-6897
800-897-3202 (phone)
www.proedinc.com

Psychological Assessment Resources, Inc.
16204 N. Florida Avenue
Lutz, FL 33549
800-331-8378 (phone)
www3.parinc.com

Riverside Publishing
425 Spring Lake Drive
Itasca, IL 60143-2079
800-323-9540 (phone)
www.riverpub.com/index.html

Sensonics, Inc.
P. O. Box 112
Haddon Heights, NJ 08035
856-547-7702 (phone)
www.sensonics.com

Stoelting Co.
620 Wheat Lane
Wood Dale, IL 60191
630-860-9700 (phone)
www.stoeltingco.com/tests/index.htm

Universal Attention Disorders, Inc.
4281 Katella Ave. #215
Los Alamitos, CA 90720
800-729-2886 (phone)
www.tovatest.com

Western Psychological Services
12031 Wilshire Blvd.
Los Angeles, CA 90025-1251
800-648-8857 (phone)
www.wpspublish.com

Appendix B

Neuropsychological Processing Concerns Checklist for School-Aged Children and Youth

Student's Demographic Information

Student's Name:		Today's Date:		
Street Address:				
City:	State:	Zip Code:		
Student's Age:	Date of Birth:	Sex (circle one):	Male	Female
Student's School:		Current Grade:		
Student's Ethnicity:		Primary Language Spoken at Home:		
Parent/Guardian's Name:				
Parent/Guardian's Address (if different from student's):				
City:	State:	Zip Code:		
Parent/Guardian's Phone #s –	Home:	Work:	Cell:	

Reasons for Referral

Who referred the student?
From (Institution/Affiliation or Professional or Parent/Guardian):
Why was the student referred?
List specific questions to be addressed by this evaluation:

Are there any scheduled IEP meetings coming up that would require a completed report for this evaluation? If yes, what is the approximate date of the next IEP meeting?

Respondent Information

Respondent's Name:		
Relationship to student: ☐ Mother ☐ Father ☐ Teacher ☐ Other—specify:		
Street Address:		
City:	State:	Zip Code:
Day Telephone:	Evening Telephone:	

For each following behavior listed, put a check mark in the "Not Observed" column if the behavior has not been observed in the past 6 months for this child. If the behavior has been observed during the past 6 months, put a check mark in one of the three columns marked Mild, Moderate, or Severe (see following descriptors).

Not observed—behavior not observed in this child.
Mild—behavior occasionally observed in this child.
Moderate—behavior frequently observed in this child.
Severe—behavior almost always observed in this child.

Not Observed	Mild	Moderate	Severe	**Attention Problems**
				Focused or Selective Attention
				Easily distracted by sounds, sights, or physical sensations.
				Inattentive to details or makes careless mistakes.
				Does not know where to start when given a task.
				Sustained Attention
				Difficulty paying attention for a long period of time.
				Mind appears to go blank or loses train of thought.
				Seems to lose place in an academic task (e.g., reading).
				Shifting Attention
				Difficulty stopping one activity and starting another.
				Gets stuck on one activity (e.g., playing video games).
				Apply a different set of rules or skills to an assignment.
				Divided Attention
				Difficulty attending to more than one thing at a time.
				Does not seem to hear anything else while watching TV.
				Easily becomes absorbed into one task (e.g., video game).
				Attentional Capacity
				Stops performing tasks that contain too many details.
				Avoids activities that require a lot of mental effort.
				Seems to get overwhelmed with difficult tasks.

Examples of attentional concerns observed:

For each following behavior listed, put a check mark in the "Not Observed" column if the behavior has not been observed in the past 6 months for this child. If the behavior has been observed during the past 6 months, put a check mark in one of the three columns marked Mild, Moderate, or Severe (see following descriptors).

Not observed—behavior not observed in this child.
Mild—behavior occasionally observed in this child.
Moderate—behavior frequently observed in this child.
Severe—behavior almost always observed in this child.

Not Observed	Mild	Moderate	Severe	**Sensorimotor Functions**
				Motor Functioning **Circle right (R), left (L) or both right & left (B) as applicable**
				Muscle weakness or paralysis. R L B
				Muscle tightness or spasticity. R L B
				Clumsy or awkward body movements. R L B
				Walking or posture difficulties.
				Odd movements (e.g., hand flapping). R L B Specify:
				Involuntary or repetitive movements. R L B Specify:
				Difficulty with dressing (e.g., buttoning & zippering).
				Poor fine motor skills (e.g., using a pencil). R L B
				Tactile/Olfaction Functioning
				Overly sensitive to touch, light, or noise.
				Complains of loss of sensation (e.g., numbness). R L B
				Less sensitive to pain and changes in temperature.
				Difficulty smelling or tasting foods.
				Visual Functioning
				Cannot identify basic colors (color blind).
				Complains of visual problems (e.g., cannot see close or far).
				Difficulty recognizing objects.
				Auditory Functioning
				Hearing acuity problems. R L B
				Does not like loud noises.

Not Observed	Mild	Moderate	Severe	**Sensorimotor Functions**
				Motor Functioning **Circle right (R), left (L) or both right & left (B) as applicable**
				Difficulty with simple sound discrimination. R L B
				Difficulty with pitch discrimination (tone deaf). R L B
				Visual-Spatial Functioning
				Drawing or copying difficulties.
				Difficulties with puzzles.
				Confusion with directions (e.g., gets lost easily).
				Shows right-left confusion or directions (up-down).
				Ignores one side of the page while drawing or reading.
Examples of sensorimotor concerns observed:				

For each following behavior listed, put a check mark in the "Not Observed" column if the behavior has not been observed in the past 6 months for this child. If the behavior has been observed during the past 6 months, put a check mark in one of the three columns marked Mild, Moderate, or Severe (see following descriptors).

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Mild—behavior occasionally observed in this child.
Moderate—behavior frequently observed in this child.
Severe—behavior almost always observed in this child.

Not Observed	Mild	Moderate	Severe	**Language Functions**
				Articulation
				Omits sounds.
				Substitutes sounds.
				Distorts sounds (e.g., slurring, stuttering).
				Phonological Processing
				Difficulty with blending of sounds to form words.
				Difficulty with basic rhyming activities.
				Difficulty with sound discrimination.
				Receptive Language
				Trouble understanding what others are saying.
				Does not do well with verbal directions.
				Expressive Language
				Difficulty finding the right word to say.
				Limited amount of speech.
				Slow labored speech.
				Odd or unusual language or vocal sounds.

Examples of language concerns observed:

For each following behavior listed, put a check mark in the "Not Observed" column if the behavior has not been observed in the past 6 months for this child. If the behavior has been observed during the past 6 months, put a check mark in one of the three columns marked Mild, Moderate, or Severe (see following descriptors).

Not observed—behavior not observed in this child.
Mild—behavior occasionally observed in this child.
Moderate—behavior frequently observed in this child.
Severe—behavior almost always observed in this child.

Not Observed	Mild	Moderate	Severe	**Memory and Learning Functions**
				Short Term Memory
				Frequently asks for repetitions of instructions/explanations.
				Lacks rehearsal strategies while listening/studying.
				Seems not to know things right after they are presented.
				Trouble following multiple-step directions.
				Problems copying from the board and/or taking notes.
				Active Working Memory
				Loses track of steps/forgets what he or she is doing amid task.
				Loses place in the middle of solving a math problem.
				Loses train of thought while writing.
				Trouble summarizing narrative or text material.
				Long Term Memory
				Trouble remembering facts or procedures in mathematics.
				Difficulty answering questions of facts quickly.
				Gets frustrated while trying to convey thoughts on paper.
				Forgets what happened days or weeks ago.
				Forgets where personal items or school work were left.
				Forgets to turn in homework assignments.
				General Learning
				Difficulty learning verbal information.
				Difficulty learning visual information.
				Difficulty integrating verbal and visual information.

Examples of memory and learning concerns observed:

For each following behavior listed, put a check mark in the "Not Observed" column if the behavior has not been observed in the past 6 months for this child. If the behavior has been observed during the past 6 months, put a check mark in one of the three columns marked Mild, Moderate, or Severe (see following descriptors).

Not observed—behavior not observed in this child.
Mild—behavior occasionally observed in this child.
Moderate—behavior frequently observed in this child.
Severe—behavior almost always observed in this child.

Not Observed	Mild	Moderate	Severe	**Executive Functions**
				Problem Solving, Planning, & Organizing
				Difficulty learning new concepts or activities.
				Difficulty solving problems that a younger child can do.
				Makes the same kinds of errors over and over.
				Quickly becomes frustrated and gives up easily.
				Trouble making plans.
				Trouble completing plans.
				Difficulty with organizational skills.
				Behavioral/Emotional Regulation
				Appears to be under-motivated to perform or behave.
				Has trouble getting started with tasks.
				Demonstrates signs of over activity (hyperactivity).
				Demonstrates signs of impulsivity.
				Trouble following rules.
				Demonstrates signs of irritability.
				Lack of common sense or judgment.
				Cannot empathize with the feelings of others.

Examples of executive functioning concerns observed:

For each following behavior listed, put a check mark in the "Not Observed" column if the behavior has not been observed in the past 6 months for this child. If the behavior has been observed during the past 6 months, put a check mark in one of the three columns marked Mild, Moderate, or Severe (see following descriptors).

Not observed—behavior not observed in this child.
Mild—behavior occasionally observed in this child.
Moderate—behavior frequently observed in this child.
Severe—behavior almost always observed in this child.

Not Observed	Mild	Moderate	Severe	**Speed & Efficiency of Cognitive Processing**
				Cognitive Efficiency
				Takes longer to complete tasks than others the same age.
				Slow reading that makes comprehension difficult.
				Homework takes too long to complete.
				Requires extra time to complete tests.
				Responds slowly when asked questions.
				Does well on timed tests.
				Recalls information accurately and quickly.

Examples of weak or slow processing speed concerns observed:

For each following behavior listed, put a check mark in the "Not Observed" column if the behavior has not been observed in the past 6 months for this child. If the behavior has been observed during the past 6 months, put a check mark in one of the three columns marked Mild, Moderate, or Severe (see following descriptors).

Not observed—behavior not observed in this child.
Mild—behavior occasionally observed in this child.
Moderate—behavior frequently observed in this child.
Severe—behavior almost always observed in this child.

Not Observed	Mild	Moderate	Severe	**Academic Functions: Reading**
				Reading: Attention Functions
				Appears distracted while reading.
				Misses important details while reading.
				Loses track of his/her reading place.
				Reading: Phonological Processing & Fluency Functions
				Trouble sounding out words.
				Can't remember words without sounding them out.
				Reads very slowly.
				Reading: Comprehension/Memory Functions
				Difficulty understanding what is read.
				Difficulty identifying main elements of a story.
				Reading: Attitudinal Issues
				Indicates boredom with reading.
				Appears anxious/uptight/nervous while reading.
				Avoids reading activities.

Examples of reading concerns observed:

For each following behavior listed, put a check mark in the "Not Observed" column if the behavior has not been observed in the past 6 months for this child. If the behavior has been observed during the past 6 months, put a check mark in one of the three columns marked Mild, Moderate, or Severe (see following descriptors).

Not observed—behavior not observed in this child.
Mild—behavior occasionally observed in this child.
Moderate—behavior frequently observed in this child.
Severe—behavior almost always observed in this child.

Not Observed	Mild	Moderate	Severe	**Academic Functions: Writing**
				Writing: Graphomotor Output Functions
				Trouble forming letters and words.
				Presses too hard with the pencil/pen while writing.
				Presses too soft with the pencil/pen while writing.
				Others have difficulty reading what the child has written.
				Difficulty holding the pencil or pen correctly.
				Shows preference for printing over cursive writing.
				Writes overly large letters and words.
				Writes overly small letters and words.
				Takes a long time to write.
				Writing: Spatial Production Functions
				Demonstrates uneven spacing between words and letters.
				Trouble staying on the lines.
				Writing: Expressive Language Functions
				Loses train of thought while writing.
				Limited vocabulary for age; uses lots of easy words.
				Difficulty putting ideas into words.
				Uses simple sentence structure & lacks variety.
				Poor spelling in written tasks.
				Poor grammar in writing.
				Has trouble coming up with topics to write about.
				Writing: Attitudinal Issues
				Appears anxious/uptight/nervous while writing.
				Avoids writing activities.
Examples of writing concerns observed:				

For each following behavior listed, put a check mark in the "Not Observed" column if the behavior has not been observed in the past 6 months for this child. If the behavior has been observed during the past 6 months, put a check mark in one of the three columns marked Mild, Moderate, or Severe (see following descriptors).

Not observed—behavior not observed in this child.
Mild—behavior occasionally observed in this child.
Moderate—behavior frequently observed in this child.
Severe—behavior almost always observed in this child.

Not Observed	Mild	Moderate	Severe	**Academic Functions: Mathematics**
				Mathematics: Attentional Functions
				Makes careless mistakes while solving math problems.
				Does not always pay attention to the math problems signs.
				Mathematics: Computational Knowledge
				Knowledge of basic math facts not at grade/age level.
				Exhibits procedural deficits in math (e.g., regrouping).
				Mathematics: Mathematical Reasoning/Comprehension
				Difficulty solving story problems.
				Difficulty with qualitative concepts (e.g., bigger than).
				Math: Attitudinal Issues
				Appears anxious/uptight/nervous when working with math.
				Avoids math activities.

Examples of math concerns observed:

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