Essentials of School Neuropsychological Assessment

Second Edition

- Clear and timely guidance on how to bring neuropsychological information into school-based practice settings
- Practice guidance and tips throughout
- Conveniently formatted for rapid reference

Includes CD-ROM

Daniel C. Miller

Alan S. Kaufman & Nadeen L. Kaufman, *Series Editors*

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Essentials

of School Neuropsychological Assessment

Second Edition

Daniel C. Miller

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To my loving wife, Michie, who for 26 years has been my best friend and best supporter, and to my parents, Roger Carlton Miller and Mary Jane Miller.

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 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) struggles 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 in this second edition another typical *Essentials* book!

In the 1960s and 1970s, when school psychology was formed as a field of practice, little was known about brain-behavior relationships compared to today. School psychology practitioners had to assemble quickly after the passage of the first laws that guaranteed children with special needs rights to a free appropriate public education. Researchers struggled with 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 in the 1980s and 1990s researchers were able to observe the brain processing information with increasingly clearer media and the natural progression of applying the information began in earnest. 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, the following first decade of the century witnessed direct remediative attempts that were based in concrete imaging neuroscience. Work by eminent researchers, such as Sally Shaywitz, Bob Schultz, Ami Klin, Peg Semrud-Clikeman, Erin Bigler, and many others, showed serious and powerful attempts to bring laboratory findings directly into clinical practice. Interventions that were previously based on theory and speculation were 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 has been steadily decreasing and school psychology practitioners are finding themselves in the middle of new information that must be translated into practice.

In the first edition of the *Essentials of School Neuropsychology* we acknowledged that there was “a movement afoot in school psychology to include neuropsychological assessment principles into everyday practice” and that this movement did not evolve as a strong reactionary force loudly proclaiming its right to be heard, but more as “a reflection of practitioners trying to keep up with the advances of modern science.” Some five years later, there is evidence that this quiet and serious grassroots movement is strong and continuing to strengthen as research on neuropsychological aspects of autism, traumatic brain injury, and specific learning disabilities are common in school psychology journals and trade publications. Indeed, the demise of the discrepancy model of learning disability identification has given way to powerful and theoretically based methods of determining cognitive strengths and weaknesses as they relate to academic skills. The latter requires inquiry into brain-behavior relationships and cements school psychology's commitment to translating neuroscientific knowledge to the individual level in the classroom.

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 curriculums to include courses on neuroanatomy, neuropsychological assessment, consultation, and competencies in medical liaison activities. Indeed, school psychology doctoral programs that have a strong emphasis on pediatric neuropsychology are now becoming common as the grassroots movement for continuing education grows.

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 to 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 in a clinical setting, not in a hospital or rehabilitation center, but in 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 —Second Edition* is an important book. It provides us with clear and concise guidance on how to bring neuropsychological information and research into our non-clinical settings. This second edition merges the theoretical application of neuropsychological principles with the Cattell-Horn-Carroll model, which will hopefully assist with translating information to educational personnel in the school system. The second edition also provides supplementary information that is designed to have an immediate practical application. Clinicians can use the Neuropsychological Processing Concerns Checklist for Children and Youth immediately. The sample school neuropsychology report shell is also available. Dr. Miller also has updated the tables of numerous new tests and assessment measures to reflect a commitment to using the best tools of the trade within a practical model. All in all, the additions to the second edition are abundant and happily reflect the passion and strength of progress in the past 5 years.

The guidance in this book is not elementary; it is complex and requires 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 second edition is a welcome addition to the school psychologist's library and, like the first edition, is destined to become dog-eared and well worn!

Elaine Fletcher-Janzen, EdD, NCSP, ABPdN
Chicago School of Professional Psychology
Chicago, Illinois
June, 2012

Series Preface

In the *Essentials of Psychological Assessment* series, we have attempted to provide the reader with books that 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 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 finds 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 "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.

The *Essentials of School Neuropsychological Assessment—Second Edition* provides clinicians with a thoroughly updated practical guide on how to integrate neuropsychological assessment into educational practice. The author, a world leader in the emerging specialty of school neuropsychology, provides a useful review of the history of adult and pediatric clinical neuropsychology and paints a careful picture of the emerging specialization of this rapidly growing field. The book features a list of professional organizations, training requirements, and professional resources, such as books and journals, that relate to school neuropsychology. The author provides an updated, state-of-the-art conceptual framework that can be used to guide practitioners who are interested in conducting school neuropsychological assessments. The current version of the school neuropsychological model (SNP) explained in this second edition is a further integration of Cattell-Horn-Carroll (CHC) Theory with neuropsychological theories. This Integrated SNP/CHC Model is described thoroughly and systematically with a chapter on each component. The author provides a comprehensive case study that illustrates how the school neuropsychological conceptual model can be operationalized and the reader is provided with a step-by-step interpretation guide for making sense of divergent data. The second edition of this book contains a supplemental CD that is filled with copies of rating forms, sample case studies, and a sample report shell template. We believe that *Essentials of School Neuropsychological Assessment—Second Edition* is a vital 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 Child Study Center, School of Medicine

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For the first time in 23 years, I got some time off from the university to work on this book. Special thanks to my dean, Ann Staton, to the associate provost, Michael Stankey, and to the provost and vice president for academic affairs, Robert Neely, for their support of my release time. Also, thank you to Dr. Shannon Rich for stepping in as department chair in my absence.

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Thank you to several of my colleagues who contributed case studies to the supplemental CD. Thank you to my colleagues whom I have had the pleasure to work with in the School Neuropsychology Post-Graduate Training Program since 2002. I continue to be inspired by your professionalism and passionate commitment to school neuropsychology. Special thanks to Marquita Flemming, my senior editor at John Wiley & Sons, and her staff, for making the editorial process run smoothly for this second edition.

Finally, I want to thank the school psychologists I have taught or influenced over the past 20-plus years to integrate neuropsychological

principles into their professional practices. Your collective commitment to providing high-quality services to children and their families is the inspiration that keeps me working hard.

Chapter One

The Emerging Specialization of School Neuropsychology

This first chapter reviews the major reasons why there is an interest in the emerging specialization of school neuropsychology, including the acknowledgment of the neurobiological bases of childhood learning and behavioral disorders, the increased number of children with chronic medical conditions that affect school performance, the increased use of medications with school-age children, the increase in the number of children with severe behavioral and emotional challenges, and the increased emphasis on the identification of processing disorders in children with specific learning disabilities. The chapter also reviews the need for providing neuropsychological assessment and consultation services within the schools. A definition of school neuropsychology is provided and the roles and functions of a school neuropsychologist are outlined. Finally, lists of the recent school neuropsychological publications and scholarly journals, that publish school neuropsychology research are presented.

Reasons Why there is a Growing Interest in School Neuropsychology

There are several reasons why there is a growing interest in school neuropsychology, including: (1) the wealth of research on the neurobiological bases of childhood learning and behavioral disorders; (2) the increased numbers of children in the schools with medical conditions that affect their school performance; (3) the increased use of medications prescribed to children; (4) the increase in the incidence rate of children who had serious educational and behavioral problems; and (5) the increased emphasis on the identification of processing disorders within children diagnosed with a specific learning disability.These reasons will be covered in more detail in this section of the chapter.

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 seasoned veterans or psychology historians 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. 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.

> **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.

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. Starting in the 1970s and continuing through today, the cognitive psychologists were 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.

It is important to acknowledge that the integration of neuropsychological principles into educational practice got off to a rough start. Practitioners who entered the field prior to the 1970s may remember Doman and Delcato's perceptual-motor training (R. Doman, Spitz, Zucman, Delacato, & G. Doman, 1960) for children with “minimal brain dysfunction” or tests such as the *Illinois Test of Psycholinguistic Abilities* (S. Kirk, McCarthy, & W. Kirk, 1968). 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 in the past 30-plus years that supports the biological bases to the majority of childhood disorders.

Caution

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

After passage of Public Law 94–142 in the 1970s, researchers began to investigate the neurobiological bases of learning disabilities and behavioral disorders (Obrzut & Hynd, 1996). The past 40 years have yielded substantial evidence for the biological bases of behavior. There is strong neurobiological evidence for attention deficit hyperactivity disorders (see Hale et al., 2010, for a review), reading disorders (see Feifer, 2010, for a review), written language disorders (see Berninger, 2010, for a review), mathematics disorders (see Maricle, Psimas-Fraser, Muenke, & Miller, 2010, for a review), pervasive developmental disorders (see Bauman & Kemper, 2005; Dooley, 2010, for reviews), autism spectrum disorders (see Lang, 2010, for a review), and Asperger's disorder (see DeOrnellas, Hood, & Novales, 2010, for a review). See D. Miller (2010) for a comprehensive review of the neurobiological correlates to common childhood developmental disorders, academic disabilities, and processing disorders. School psychologists who want to translate this brain-behavior research into practice are increasingly interested in applying neuropsychological principles into their professional practice.

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 hooked up 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 Colaluca & Ensign, 2010; Dooley, 2010, for reviews).

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. Although there has been no noticeable decrease in the number of low-birth-weight infants born each year, 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 early neurological insults. The premature birth rate in the United States rose by more than one third from the early 1980s through 2006; however, the upward trend has finally reversed based on 2007 and 2008 data (J. A. Martin, Osterman, & Sutton, 2010). Martin and colleagues reported that in 2008, 12.3% of all live births were preterm, or premature. In addition to prematurity and low-birth-weight, Rapid Reference 1.1 lists several other major medical influences on school neuropsychology.

Despite this high perinatal mortality rate (741 per 100,000; Miniño, 2011), there has been an improvement in the overall survival of low-birth-weight infants, most likely associated with advanced technology (Meadow, Lee, Lin, & Lantos, 2004). Interestingly, the actual cause of preterm birth remains somewhat elusive. While there are definite risk factors (e.g., African American ethnicity, low socioeconomic status, substance abuse, and poor maternal nutrition), there is essentially no one known identifiable cause (Slattery & Morrison, 2002). A review of the literature reveals that low-birth-weight infants are at risk for neurosensory, cognitive/neuropsychological, behavioral, and school/academic difficulties (Colaluca & Ensign, 2010; Dooley, 2010; Litt, Taylor, Klein, & Hack, 1995; Riccio, Sullivan, & Cohen, 2010).

Modern medical advances have also had an impact on the lives of children with other medical conditions such as cancer, AIDS, demyelinating diseases, traumatic brain injuries, and more rare medical diseases and conditions. The rate of chronic health conditions among children in the United States increased from 12.8% in 1994 to 26.6% in 2006 (Van Cleave, Gortmaker, & Perrin, 2010). Kline, Silver, and Russell (2001) reported that within the population of chronically ill children, 30% to 40% have school-related problems (see Colaluca & Ensign, 2010, for a review). The majority of these children would qualify under the Individuals With Disabilities Education Act (IDEA) category of *other health impaired* (OHI). 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*).

Rapid Reference 1.1

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.

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 a few months, where cognitive rehabilitation took place (D. Miller, 2004). Today it is typical for a child to forego any formal cognitive rehabilitation and return to school soon after he or she is 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 traumatic brain injuries (TBIs). In defense of the managed health care industry, the literature on the effectiveness of cognitive rehabilitation with children has been sparse (Slomine & Locascio, 2009). Despite the fact that TBI and OHI have been disability classifications for decades, school personnel are not often 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 other special education classifications (see Morrison, 2010, for a review). 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 require only 3-year reevaluations, children with TBI need frequent monitoring for changes in academic, behavioral, adaptive, and social-emotional functioning (Morrison, 2010). School neuropsychologists can play a major role in being the liaisons between the school and the medical community, developing transitional/reentry plans for school-age children returning to school after injury or insult, assisting with IEP development and monitoring, and general case management (see Prout, Cline, & Prout, 2010, for a review).

Increased Use of Medications with School-Age Children

There has been a dramatic increase in the number of school-age children taking psychotropic medications. Patel (2005) examined the prevalence rates of antipsychotic use in children and adolescents from 1996 to 2001 across three Medicaid 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 prescriptions. Medicaid Medical Directors Learning Network and Rutgers Center for Education and Research on Mental Health Therapeutics (2010) examined antipsychotic medication use in Medicaid children and adolescents across 16 states. The study found that in 2007, 1.7% of Medicaid children and adolescents received antipsychotic prescriptions, which represents a 10% increase from comparable data in 2004.

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. Constantine, Boaz, and Tandon (2010) reported similar finding based on trends between 2002 and 2007.

School neuropsychologists are not physicians, but they can provide information about how psychotropic medication used to treat common problems like depression, anxiety, and attentional processing disorders 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% of all children. Unfortunately, many children with diagnosable mental disorders do not receive services. The *Report of the Surgeon General on Children's Mental Health: A National Action Agenda* (U.S. Department of Health and Human Services, 2001) indicated that approximately 70% 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 all 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 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 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 et al. (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.

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 are reviewed.

Increased Emphasis on the Identification of Processing Disorders in Specific Learning Disabled Children

In the most recent version of the Individuals with Disabilities Act of 2004 (U.S. Department of Education, 2004), the definition of a Specific Learning Disability (SLD) includes language that stated:

> "[A] disorder in one or more of the basic psychological processes involved in the understanding or in using language, spoken or written, that may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia" but does not

> include "...learning problems that are primarily the result of visual, hearing, or motor disabilities, or intellectual disability, or emotional disturbance, or of environmental, cultural, or economic disadvantage." (34 C.F.R. § 300.8(c)(10))

By requiring an assessment specialist to rule out exclusions such as intellectual disability or perceptual limitations as the causal factors for an SLD, the SLD definition encourages the assessment specialist to determine the reasons why there is a learning delay. The assessment specialist, who is a school neuropsychologist, brings a unique set of skills to bear on the need to identify the underlying neurological deficits that could explain the presence of an SLD. School neuropsychologists have a more sophisticated set of testing instruments that they are trained to use that will help address the neurocognitive strengths and weaknesses of an SLD child and increase the likelihood of academic improvement through targeted, evidence-based interventions.

IDEA 2004 allowed states to move away from the use of discrepancy models for the identification of an SLD. One of the approved approaches for SLD identification is the assessment of processing strengths and weaknesses to determine the underlying causes for an SLD. With this change in the federal law, many assessment specialist practitioners, including school psychologists, have the need to enhance their professional skills. School psychologists trained in how to integrate neuropsychological principles into their professional practice are uniquely qualified to assess processing strengths and weaknesses in SLD children.

The Need for Neuropsychological Assessment in the Schools

This section of the chapter attempts to answer the question, why is there a need for neuropsychological assessment in the schools? The reasons for having access to more neuropsychological assessments accessible in the schools include: (1) the limited access to pediatric neuropsychological services in general; (2) the limited usefulness of some neuropsychological reports; and (3) the unique contributions of school neuropsychological assessments in making diagnoses and linking evidence-based interventions.

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.

> **Don't Forget**
>
> 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.

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-age 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-age children is often difficult.

Limited Usefulness of Some Neuropsychological Reports

Educators may have experienced sitting in an IEP meeting where a parent brings in a report from a neuropsychologist consultant. 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 Shapirio (2004) refer to this report as a “pin the tail on a lesion” type of report. In these cases, the expensive report that the parent brings to the school is frequently filed in the child's educational folder as educationally irrelevant and the experience becomes frustrating for all parties concerned.

Don't Forget

The delivery of neuropsychological services in the schools is more than completing comprehensive assessments. Overseeing the implementation of the evidence-based interventions is crucial.

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 not familiar with educational laws such as IDEA, NCLB, and Section 504 of the Rehabilitation Act or with the organization and operation of schools in general. Hurewitz and Kerr (2011) stated, “because neuropsychologists may provide reports for treatment, school programming, legal disputes, or any combination thereof, it is important that they are familiar with the school programming process and the unique litigation procedures available for children with disabilities in special education” (2011, p. 1058). 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 to 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). To best help the child, clinical neuropsychologists must learn which diagnoses and educational interventions are useful to school districts (Hurewitz & Kerr, 2011). School psychologists with training in neuropsychology can play a role in consulting with clinical neuropsychologists to help determine services needed by the school districts.

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.

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, 2007, 2010) pointed out that many of the new cognitive abilities tests and tests of memory and learning that are 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 D. Miller (2004, 2007, 2010) 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.

The Unique Contribution of School Neuropsychological Assessments

In Chapter 6, the differences among psychoeducational, psychological, and school neuropsychological assessments are discussed. In general, neuropsychological assessments are the most comprehensive of the three types and often encompass both the psychoeducational and psychological components. What makes school neuropsychological assessments unique is the inclusion of more in-depth assessment of individual neurocognitive constructs such as sensory-motor functions, attentional processing, learning and memory, and executive functions.

School neuropsychological assessments are useful for:

- Identifying processing deficits in a child that could adversely affect educational attainment and developing remedial and/or compensatory strategies to maximize the child's learning potential.
- Describing a profile of a child's neurocognitive strengths and weaknesses and relating that information to the child's learning and behavior in the school and home environments.
- Determining whether changes in learning or behavior are associated with neurological disease, psychological conditions, neurodevelopmental disorders, or non-neurological conditions.
- Monitoring educational progress over time in children, particularly in children with severe neuropsychological insults such as traumatic brain injury.
- Providing comprehensive assessment data that will increase the likelihood of success with evidence-based interventions.

Summary of the Need for School Neuropsychological Assessment in the Schools

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 difficult. Traditional reports written by clinical neuropsychologists are often not useful in the schools. These reports tend to be too long and cumbersome, often describe the tests more than the child, and often have recommendations not 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.

Definition of School Neuropsychology

Miller, along with two colleagues, 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. (D. Miller, DeFina, & Lang, 2004)

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.

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

"*[T]o 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 inservice workshops for educational personnel, parents, and others on the neuropsychological basis of development and learning.
- Conducts both basic and applied educational research investigating the efficacy of neuropsychologically based interventions and consultation in the schools.

Don't Forget

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

More recently, Crespi and Cooke (2003, pp. 98–99) 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.
- Provide a theoretical framework that appreciates the value of multidimensional batteries and the inherent complexities and difficulties of making inferences about brain integrity.

Rapid Reference 1.2 summarizes the various roles and functions of a school neuropsychologist.

List of Recent School Neuropsychology Books

Rapid Reference 1.3 lists some of the major school neuropsychology books that have been published in recent years. The vast majority of the authors of the school neuropsychology resource books cited in Rapid Reference 1.3 are school psychologists.

> Rapid Reference 1.2
>
> *Roles and Functions of a School Neuropsychologist*
>
> - Provide neuropsychological assessment and intervention services to schools for students 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 inservice training for educators and parents about the neuropsychological factors that relate to common childhood disorders.
> - Engage in evidence-based research to test for the efficacy of neuropsychologically based interventions.

List of Journals that Publish School Neuropsychological Research

Rapid Reference 1.4 presents a list of journals most relevant to school neuropsychology. Rapid Reference 1.4 also presents a tabulation of the number of published articles related to pediatric/school neuropsychology in each of these journals from 1991 to 2012. These figures were derived by initially going to the online PsycInfo database and searching peer-reviewed journal articles that contained the word “neuropsychology” with age ranges including preschool through adolescence. The numbers of articles that match these criteria are presented in Rapid Reference 1.4.

Despite the certain biological bases of all developmental disorders, school psychologists interested in reading original research on topics related to school neuropsychology must go beyond the traditional school psychology journals (e.g., *School Psychology Review*—The official journal of the National Association of School Psychologists, or the *School Psychology Quarterly*—the official journal of the American Psychological Association's Division 16—School Psychology). These two school psychology journals have published only one original school/pediatric neuropsychology article in the past 21 years, compared to 1,594 original peer-reviewed journal articles published in the top five journals associated with neuropsychology. School neuropsychology professional practice issues and research are currently published across a broad spectrum of journals, with the majority in neuropsychology journals.

Rapid Reference 1.3

Major School Neuropsychology Publications (most recent to oldest)

Barkley, R. A. (2012). *Executive functions: What are they, how they work, and why they evolved.* New York, NY: Guilford Press.

Davis, A. S. (Ed.). (2011). *Handbook of pediatric neuropsychology.* New York, NY: Springer.

Anderson, V., & Yeates, K. O. (Eds.). (2010). *Pediatric traumatic brain injury: New frontiers in clinical and translational research*. New York, NY: Cambridge University Press.

Dawson, P., & Guare, R. (2010). *Executive skills in children and adolescents: A practical guide to assessment and intervention* (2nd ed.). New York, NY: Guilford Press.

Dehn, M. J. (2010). *Long-term memory problems in children and adolescents: Assessment, intervention, and effective instruction*. Hoboken, NJ: Wiley.

Goldstein, S., & Reynolds, C. R. (Eds.). (2010). *Handbook of neurodevelopmental and genetic disorders in children* (2nd ed.). New York, NY: Guilford Press.

Kemp, S. L., & Korkman, M. (2010). *Essentials of the NEPSY-II assessment.* Hoboken, NJ: Wiley.

Koziol, L. F., & Budding, D. E. (2010). *Subcortical structures and cognition: Implications for neuropsychological assessment*. New York, NY: Springer.

Meltzer, L. (2010). *Promoting executive function in the classroom (what works for special-needs learners)*. New York, NY: Guilford Press.

Miller, D. C. (Ed.). (2010). *Best practices in school neuropsychology: Guidelines for effective practice, assessment, and evidence-based intervention*. Hoboken, NJ: Wiley.

Riccio, C. A., Sullivan, J. R., & Cohen, M. J. (2010). *Neuropsychological assessment and intervention for childhood and adolescent disorders*. Hoboken, NJ: Wiley.

Christo, C., Davis, J., & Brock, S. E. (2009). *Identifying, assessing, and treating dyslexia at school.* New York, NY: Springer.

McCloskey, G., Perkins, L. A., & Diviner, B. V. (2009). *Assessment and intervention for executive function difficulties.* Florence, KY: Routledge.

Petersen, R. L., Yeates, K. O., Ris, M. D., Taylor, H. G., & Pennington, B. F. (2009). *Pediatric neuropsychology, Research, theory, and practice* (2nd ed.). New York, NY: Guilford Press.

Semrud-Clikeman, M., & Teeter-Ellison, P. A. (2009). *Child neuropsychology: Assessment and interventions for neurodevelopmental disorders* (2nd ed.). New York, NY: Springer.

Apps, J. N., Newby, R. F., & Roberts, L. W. (2008). *Pediatric neuropsychology case studies: From the exceptional to the commonplace*. New York, NY: Springer.

Castillo, C. L. (Ed.). (2008). *Children with complex medical issues in schools: Neuropsychological descriptions and interventions*. New York, NY: Springer.

Dehn, M. J. (2008). *Working memory and academic learning: Assessment and intervention*. Hoboken, NJ: Wiley.

Fletcher-Janzen, E., & Reynolds, C. R. (Eds.). (2008). *Neuropsychological perspectives on learning disabilities in the era of RTI: Recommendations for diagnosis and intervention*. Hoboken, NJ: Wiley.

Mody, M., & Sullivan, E. R. (Eds.). (2008). *Brain, behavior, and learning in language and reading disorders.* New York, NY: Guilford Press.

Reed, J., & Warner-Rigers, J. (Eds.). (2008). *Child neuropsychology: Concepts, theory, and practice.* New York, NY: Wiley-Blackwell.

Reynolds, C. R., & Fletcher-Janzen, E. (Eds.). (2008). *Handbook of clinical child neuropsychology* (3rd ed.). New York, NY: Plenum Press.

Feifer, S. G., & Della Toffalo, D. A. (2007). *Integrating RTI with cognitive neuropsychology: A scientific approach to reading.* Middletown, MD: School Neuropsych Press.

Miller, D. C. (2007). *Essentials of school neuropsychological assessment*. Hoboken, NJ: Wiley.

Dehn, M. J. (2006). *Essentials of processing assessment.* Hoboken, NJ: Wiley.

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

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

Dewey, D., & Tupper, D. E. (2004). *Developmental motor disorders: A neuropsychological perspective*. New York, NY: Guilford Press.

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

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

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

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

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

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.

Rapid Reference 1.4

Journals Relevant to School Neuropsychology[1]

Journal	**Number of Articles (1991–2012) Related to School/Pediatric Neuropsychology Issues**
Developmental Neuropsychology	502
Child Neuropsychology[2]	407
Journal of Clinical and Experimental Neuropsychology	277
Archives of Clinical Neuropsychology	214
Neuropsychology	194
Applied Neuropsychology	91
Journal of the International Neuropsychological Society	57
Cognitive and Behavioral Neurology	55
Journal of Child Psychology and Psychiatry	38
Aging, Neuropsychology, and Cognition	36
Journal of Cognitive Neuroscience	32
Clinical Neuropsychologist	27
Neuropsychology Review	14
Journal of Intellectual Disability Research	12
Developmental Psychology	10
Brain Impairment	5
International Journal of Developmental Neuroscience	5
Mind, Brain, and Education[3]	4
Journal of Psychoeducational Assessment	4
Psychology in the Schools	4

Journal	**Number of Articles (1991–2012) Related to School/Pediatric Neuropsychology Issues**
Psychological Assessment	3
School Psychology Review	1
School Psychology Quarterly	0

1. Through May 11, 2012.
2. The *Child Neuropsychology* journal was introduced in 1995.
3. *Mind, Brain, and Education* was introduced in 2007.

Chapter Summary

The understanding and respect for the biological bases of behavior has been a part of the field of psychology since its 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.
- Advances in understanding the neurocognitive effects of traumatic brain injury, common neurodevelopmental disorders, and chronic illness.

There continues to be interest in school neuropsychology because school psychologists work every day with children who have known or suspected neurodevelopmental disorders. 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 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, their families, and educators. 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 research that validates the linkage between assessment data and the prescriptive interventions that have been shown to be the most effective.

School neuropsychology has its roots firmly planted in the historical foundations of clinical neuropsychology and school psychology. These historical influences on the emerging specialization of school neuropsychology are the focus of Chapter 2.

Test Yourself

1. The 1970s catalyst for researchers to investigate the neurobiological bases of learning disabilities and behavioral disorders was:

a. Passage of *No Child Left Behind* legislation

b. Doman Delcato's perceptual-motor training

c. Passage of P.L. 94–142

d. The *Illinois Test of Psycholinguistic Abilities*

2. True or False? More children are surviving birth traumas and medical illnesses with known correlates to later academic and behavioral concerns.

3. What term is associated with children who are taking multiple medications, without full consideration of the potential drug interaction side effects?

a. Polypharmacy

b. Substance abuse

c. Combined drug treatment

d. Multipharmacy

4. In what year did traumatic brain injury become part of IDEA?

a. 1976

b. 1990

c. 1997

d. 2004

5. Who is credited as being the first school psychologist to advocate for doctoral school psychologists to be trained in clinical neuropsychology?

a. Alfred Binet

b. Cecil Reynolds

c. David Wechsler

d. George Hynd

6. True or False? A major role of a school neuropsychologist is to identify processing deficits in children that could adversely affect educational attainment and develop remedial and/or compensatory strategies to maximize the children's learning potential.

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. true; 3. a; 4. b; 5. d; 6. true; 7. b

Chapter Two

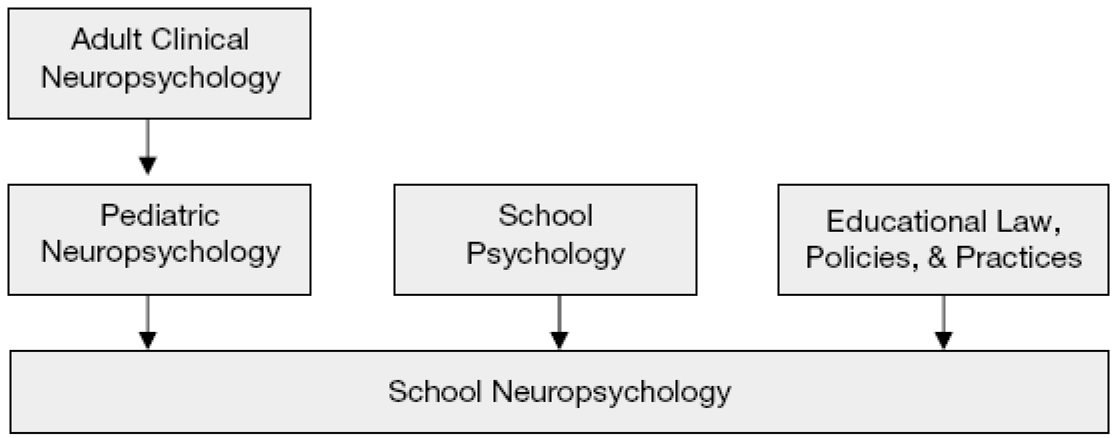
Historical Influences of Clinical Neuropsychology and School Psychology

This chapter focuses on how the fields of clinical neuropsychology and school psychology along with educational policies and law have influenced the emerging specialization of school neuropsychology. The chapter ends with a review of the major historical events and landmark publications (e.g., books and tests) that have been a part of the rapid advances in school neuropsychology.

Historical Influences of Clinical Neuropsychology on School 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 2.1). Several authors (Hartlage, Asken, & Hornsby, 1987; Rourke, 1982) have reviewed the history of adult clinical neuropsychology. Rourke 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.

Figure 2.1 Historical Influences on School Neuropsychology



Single Test Approach Stage

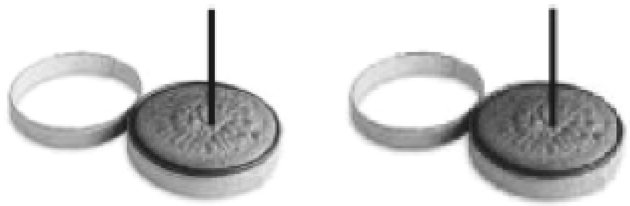
Modern adult clinical neuropsychology has its origins in the mid-19th century researchers (e.g., Broca, 1865, as cited in von Bronin, 1960; Jackson, 1874, as cited in Taylor, 1932) who studied localization of brain functions. Despite the early emphasis on localization of brain functions, such as Broca's and Wernicke's areas, early adult clinical neuropsychology in the United States focused on global brain function and dysfunction.

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

The single test approach dominated the practice of adult clinical neuropsychology from 1900 to 1950. 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 completely baked. In other words, you generalize from a single sample to the rest of the cake. If the toothpick comes out clean, then the rest of the cake is assumed to be baked all the way through (see Figure 2.2). The "single sample" toothpick works well in generalizing to the rest of the cake.

Figure 2.2 Analogy of Baking a Cake



However, if we conceptualize the cake as being the construct of brain organicity (see Figure 2.2), a single test does not generalize well to overall brain function. 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, or overall brain functioning. 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 non-brain-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, that construct would be better measured by taking samples from several "locations" or cognitive processes such as visual-spatial abilities, executive functions, attentional skills, memory and learning functions, and so on. Test batteries that measured 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, World War II 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, Asken, & Hornsby, 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 are reviewed in this section.

Halstead and 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 (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 *Halstead-Reitan's Aphasia Screening* 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.

Luria's Contributions to Clinical Neuropsychology

Alexander Luria was a Russian neuropsychologist who spent more than 40 years evaluating the psychological and behavioral effects of brain-injured adults. Although Luria and Halstead were contemporaries, they took a different approach to understanding brain-behavior relationships. Whereas, Halstead (and subsequently Reitan) used a *quantitative* approach to differentiate brain-injured individuals 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, 1973, 1980) and *The Working Brain* (Luria, 1966).

Luria's original method relied on detailed clinical insight and informal hypothesis testing. U.S. clinicians were suspicious 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 nonimpaired 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 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, and Heinz Warner;

see Hebben & Milberg, 2009) 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* (Semrud-Clikeman & Teeter-Ellison, 2009). 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.

Don't Forget

Luria's conceptualization of "functional systems" within the brain has served as the theoretical foundation for several current tests (e.g., *Das-Naglieri Cognitive Assessment System*: Naglieri & Das, 1997; *Kaufman Assessment Battery the Children—Second Edition*: A. Kaufman & Kaufman, 2004; *NEPSY-II*: Korkman, Kirk, & Kemp, 2007).

The principle of "testing the limits," by asking individuals questions beyond the ceiling levels or by 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.

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. This section reviews 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.

Caution

The Halstead-Reitan tests for children should not be used in clinical practice today. A better practice for practitioners would be to use the *Dean-Woodcock Neuropsychological Battery* (Dean & Woodcock, 2003), which includes many of the original Halstead-Reitan tests but is based on a more recent broad-based, restandardized population.

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). See Reitan and Wolfson (1992) for an expanded description of the HRNTB-OC and RINTB tests, and see Johnson and D'Amato (2011) and Semrud-Clikeman and Teeter-Ellison (2009) for reviews of the HRNTB and RINTB clinical research studies. Semrud-Clikeman and Teeter-Ellison pointed out that the Halstead-Reitan tests for children must be used with caution. Concerns about the HRNTB-OC 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 to predict recovery after a brain insult or injury.

Several researchers have compiled HRNTB-OC 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 40-plus years old, it is recommended that practitioners use the *Dean-Woodcock Neuropsychological Battery* (DWSMB; Dean & Woodcock, 2003). The DWSMB incorporated many of the Halstead-Reitan tests when it restandardized the tests using a broad-based national sample. The DWSMB is also co-normed with the *Woodcock-Johnson III Tests of Cognitive Abilities* (Woodcock, McGrew, & Mather, 2001, 2007a). The DWSMB is 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.

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 child 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 (2011) for an expanded description of the LNNB-CR tests, and see Golden (2011) and Semrud-Clikeman and Teeter-Ellison (2009) for an extensive review of the LNNB-CR clinical research studies. Some studies found the LNNB-CR was useful in discriminating LD (learning disabled) from non-LD children, but little research has been done on the effectiveness of the test in discriminating neurologically impaired children from nonclinical groups.

A major concern about both the Halstead-Reitan and the Luria-Nebraska tests for children is that conceptually both instruments are 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 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.*

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.

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 (SLD) identification practices. Rapid Reference 2.1 highlights these similarities. During the 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 the 2000s 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.

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.

School psychology is in a much more favorable position than clinical neuropsychology was in the 1980s because since the 1990s 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, integrating the principles of cognitive psychology and neuropsychology into school psychology.

Rapid Reference 2.1

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. • Few new tests in the 1980s that addressed the reconceptualization.	• Deemphasis on SLD discrepancy formulas and reemphasis on processing deficits. • Many new assessment measures and intervention techniques designed to address processing deficits.

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 of behavior (or tests). 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 between the sample 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 reliably and validly assess neurocognitive functions. 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 Neuropsychological Tests Specifically Designed for 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 purported 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 were not downward extensions of adult models. The newer neuropsychological batteries for children and stand-alone tests of neuropsychological processes (reviewed in Chapter 7) were 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-age children. Test authors in the 1990s and beyond have provided school neuropsychologists with a rich array of assessment tools that were developed specifically for school-age children.

Influences of Brain Imaging Studies on Learning and Behavior

The TOMAL (Reynolds & Bigler, 1994) was also one of the first measures that used CT scans to validate the constructs being measured. 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) and Odegard, Ring, Smith, Biggan, and Black (2008) have started to use functional imaging techniques to evaluate the effects of specific reading interventions. In the future, neuropsychological test development and validation will include neuroimaging studies.

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% of other 5-year-olds in the standardization sample.” The qualitative information can provide useful clues to interventions. See Rapid Reference 2.2 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 gymnasium stages only to later question if those test results 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 (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. 16). As in the functional stage of neuropsychology, the emphasis on assessment today is more on the prescriptive recommendations rather than on 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 *No Child Left Behind Act of 2001* (NCLB) compliance. If we must continue to use high-stakes assessment, there will always be a percentage of students who fail to reach the cutoff 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.

Rapid Reference 2.2

Tests With an Increased Emphasis on the Qualitative Aspects of Performance

- Luria-Nebraska Neuropsychological Battery—Children's Revision (Golden, 1986).
- Naglieri-Das Cognitive Assessment System (Naglieri & Das, 1997).
- NEPSY (Korkman, Kirk, & Kemp, 1997).
- Wechsler Intelligence Scale for Children—Third Edition, as a Process Instrument (Kaplan, Fein, Kramer, Delis, & Morris, 1999).
- Delis-Kaplan Executive Function System (Delis, Kaplan, & Kramer, 2001).
- Wechsler Intelligence Scale for Children—Fourth Edition Integrated (Wechsler, 2004).
- NEPSY-II (Korkman, Kirk, & Kemp, 2007).

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 using the probe (i.e., the toothpick) and analyze the contents adhering to the toothpick by using technology and other tests that provide qualitative, chemical, physiological, and functional information. Future researchers will continue to advance the knowledge base in all disciplines such as education, psychology (including neuropsychology), school psychology, functional neuroanatomy, biochemistry, electrophysiology, and genetics. 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 School Neuropsychology

Rapid Reference 2.3 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 shifts the focus to the history of school psychology and its influence on school neuropsychology.

Rapid Reference 2.3

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.

Historical Influences of School Psychology on School Neuropsychology

This section of the chapter will address some of the historical influences of school psychology on the emerging specialization of school neuropsychology, including: (1) the influences of federal education laws and national task force reports; (2) the continued expansion of theoretical frames of reference; (3) the influences of cross-battery assessment; and (4) the national educational mandate to link assessment to prescriptive interventions. Each of these influences on school neuropsychology is discussed in more detail.

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 have influenced the practice of school psychology and the emerging movement toward school neuropsychology for years to come. Rapid Reference 2.4 outlines those recent federal laws and task force reports.

Rapid Reference 2.4

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.
- *A New Era: Revitalizing Special Education for Children and Their Families*. Report of the President's Commission on Excellence in Special Education (2002).
- *Minority Students in Special and Gifted Education—Report for the National Research Council*. (Donovan & Cross, 2002).
- 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.
- *White Paper on Evaluation, Identification, and Eligibility Criteria for Students with Specific Learning Disabilities* (Hale et al., 2010, 2010). Learning Disabilities Association of America. Pittsburgh, PA.
- *Memorandum to State Directors of Special Education—A Response to Intervention (RTI) Process Cannot Be Used to Delay-Deny an Evaluation for Eligibility under the Individuals with Disabilities Act (IDEA)* (January, 2011). United States Department of Education—Office of Special Education and Rehabilitative Services.

The *No Child Left Behind Act of 2001* (NCLB) and the *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 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.

> ## Don't Forget
> 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.

NCLB placed 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 Century* (Finn et al., 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 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 key educational policy makers remain unconvinced.

In the reauthorization of the IDEA (2004) law and subsequent 2006 Federal Regulation (34 CFR § 300.307–309) the long-standing definition of SLD remained the same. The IDEA law and regulations 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 (RTI) model is being suggested. The inclusion of RTI as an allowable option for SLD identification has generated the most controversy (see Flanagan & Alfonso, 2011, for a comprehensive review). Concerns have been expressed that districts that have adopted an RTI-only model would have students that are determined to have an SLD by default after repeated failures to respond to evidence-based interventions. In 2011, the U.S. Department of Education's Office of Special Education and Rehabilitation Services released a Memorandum to State Directors of Special Education indicating that a Response to Intervention (RTI) process cannot be used to delay-deny an evaluation for eligibility under IDEA.

It is important to remember that under IDEA 2004, RTI is only one component of the process to identify children with specific learning disabilities in need of special education and related services. Determining why a child has not responded to research-based interventions requires a comprehensive evaluation. The RTI process does not replace the need for a comprehensive evaluation. The IDEA law also 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 2004 reauthorization of IDEA also opened the door to other methods of SLD identification besides the ability achievement discrepancies in the identification of SLD, including a process-oriented, school neuropsychological approach.

In 2010, the Learning Disabilities Association of America released a *White Paper on Evaluation, Identification, and Eligibility Criteria for Students with Specific Learning Disabilities*, which was subsequently published (Hale et. al., 2010). The five conclusions of this white paper are:

1. The SLD definition should be maintained and the statutory requirements in SLD identification procedures should be strengthened.

2. Neither ability-achievement discrepancy analysis nor failure to respond to intervention alone is sufficient for SLD identification.

3. A "third method" approach that identifies a pattern of psychological processing strengths and weaknesses, and achievement deficits consistent with this pattern of processing weaknesses, makes the most empirical and clinical sense.

4. An empirically validated RTI model could be used to prevent learning problems, but comprehensive evaluations should occur for SLD identification purposes, and children with SLD need individualized interventions based on specific learning needs, not merely more intense interventions.

5. Assessment of cognitive and neuropsychological processes should be used for both SLD identification and intervention purposes.

In this book, the author is advocating for a process assessment approach for evaluating children with neurocognitive processing disorders (e.g., ADHD, SLD, TBI).

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-factor (verbal) or two-factor (verbal and visual-spatial) solutions. The theoretical models of intelligence increased dramatically just prior to the start of the integrative and predictive stage of neuropsychology in the 1990s. See Flanagan and Harrison (2012) 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.

> ### Don't Forget
> Current state-of-the-art practice demands that assessments have a theoretical foundation to aid in test interpretation.

The current state of the art 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 Carroll-Horn-Cattell theory served as the theoretical foundation for the *Woodcock-Johnson Third Edition Tests of Cognitive Abilities* (Woodcock, McGrew, & Mather, 2001, 2007), while the Luria-Das Model of Information Processing served as the theoretical model of the *Naglieri-Das Cognitive Assessment System* (Naglieri & Das, 1997) and the *Kaufman Assessment Battery for Children —Second Edition* (A. Kaufman & N. Kaufman, 2004).

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. See Horn and Blankson (2012) for an updated review of *Gf-Gc* theory and Schneider and McGrew (2012) for an updated review of the CHC model of intelligence. 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 (Flanagan, Alfonso, & Ortiz, 2012).

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 evidence-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 student 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.

Summary of Historical Influences of School Psychology on School Neuropsychology

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. Within the past 20 years 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 have 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 (Flanagan & Alfonzo, 2011; Flanagan, Alfonso, Mascolo, & Soleto-Dynega, 2012). There is a conceptual tug-of-war taking place as the school psychology profession struggles to come to terms with all of the 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.

History of School Neuropsychology

The history of school neuropsychology is still emerging as a specialty area. Rapid Reference 2.5 presents some of the historical events and major publications in the emerging specialization of school neuropsychology.

Rapid Reference 2.5

Historical Events and Major Publications in School Neuropsychology

1963	Ernhardt and Graham published the first neuropsychological test battery for children.
1974	*Halstead-Reitan Neuropsychological Test Battery for Older Children* test published (Reitan & Davidson, 1974).
1976	P.L. 94 –142—The Education of All Handicapped Children Act—is passed by the United States Congress.
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 (Golden, 1986).
1986	*Child Neuropsychology: Volume 1—Theory and Research* (Obrzut & Hynd, 1986) book published.
1986	*Child Neuropsychology: Volume 2—Clinical Practice* (Obrzut & Hynd, 1986) 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.
1990s	Several tests of memory and learning specifically designed for school-age 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, 1997).
1992	*Advances in Child Neuropsychology—Volume 1* (Tramontana & Hooper,

	1992) book published.
1995	*Child Neuropsychology* journal published first issue.
1996	*Neuropsychological Foundations of Learning Disabilities: A Handbook of Issues, Methods, and Practice* (Obrzut & Hynd, 1996) book published.
1996	*Pediatric Neuropsychology: Interfacing Assessment and Treatment for Rehabilitation* (Batchelor & Dean, 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, 1997).
1999	American Board of School Neuropsychology (ABSNP) 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.
2004	*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.
2005	*The Neuropsychology of Mathematics: Diagnosis and Intervention* (Feifer & DeFina, 2005) book published.
2005	*Handbook of School Neuropsychology* (D'Amato, Fletcher-Janzen, & Reynolds, 2005) book published.
2006	First national conference for school neuropsychologists held in Dallas, Texas.

2007	NEPSY-II published (Korkman, Kirk, & Kemp, 2007).
2007	First edition of the *Essentials of School Neuropsychological Assessment* (D. Miller, 2007) book published.
2008	*Working Memory and Academic Learning: Assessment and Intervention* (Dehn, 2008) book published.
2008	*Neuropsychological Perspectives on Learning Disabilities in the Era of RTI: Recommendations for Diagnosis and Intervention* (Fletcher-Janzen & Reynolds, 2008) book published.
2008	*Children with Complex Medical Issues in Schools: Neuropsychological Descriptions and Interventions* (Castillo, 2008) book published.
2008	Third edition of the *Handbook of Clinical Child Neuropsychology* (Reynolds & Fletcher-Janzen, 2008) book published.
2009	*Assessment and Intervention for Executive Function Difficulties* (McCloskey, Perkins, & Diviner, 2009) book published.
2009	*Emotional Disorders: A Neuropsychological, Psychopharmacological, and Educational Perspective* (Feifer & Rattan, 2009) book published.
2009	*Pediatric Neuropsychology, Second Edition: Research, Theory, and Practice* (Petersen, Yeates, Ris, Taylor, & Pennington, 2009) book published.
2009	*Child Neuropsychology: Assessment and Interventions for Neurodevelopmental Disorders—Second Edition* (Semrud-Clikeman & Teeter-Ellison, 2009).
2010	*Long-Term Memory Problems in Children and Adolescents: Assessment, Intervention, and Effective Instruction* (Dehn, 2010).
2010	*Neuropsychological Assessment and Intervention for Childhood and Adolescent Disorders* (Riccio, Sullivan, & Cohen, 2010) book published.
2010	*Best Practices in School Neuropsychology: Guidelines for Effective Practice, Assessment, and Evidence-Based Interventions* (D. Miller, 2010) book published.
2011	*Handbook of Pediatric Neuropsychology* (Davis, 2011) book published.
2011	The fifth national school neuropsychology conference held in Dallas, Texas.

The 1960s

As previously mentioned in the history of clinical neuropsychology, Ernhardt, 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. In 1976, P.L. 94–142—The Education for All Handicapped Children Act—was passed by the U.S. Congress.

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 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 *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; Hynd & Willis, 1988; Novick & Arnold, 1988; Obrzut & Hynd, 1986, 1986; 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 the National Association of School Psychologists.

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 was 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-age children (e.g., WRAML, TOMAL, CMS) and with 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, 1991; Reynolds & Fletcher-Janzen, 1997; Teeter & Semrud-Clikeman, 1997) and 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 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

During this decade many more scholarly resources became available to practitioners. In 2000, 2002, and 2005, Steven Feifer and Philip DeFina, two school psychologists/neuropsychologists published three informative books: *The Neuropsychology of Reading Disorders, The Neuropsychology of Written Language Disorders,* and *The Neuropsychology of Mathematics,* respectively. In 2007, Steven Feifer and Douglas Della Toffalo wrote *Integrating RTI With Cognitive Neuropsychology: A Scientific Approach to Reading*.

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

In 2003, Sally Shaywitz, a physician, wrote 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 the *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 2007, the first edition of the *Essentials of School Neuropsychological Assessment* and the NEPSY-II were published.

In 2008, four influential school neuropsychological books were published: Milton Dehn wrote *Working Memory and Academic Learning: Assessment and Intervention*; Elaine Fletcher-Janzen and Cecil Reynolds wrote a timely and influential book called *Neuropsychological Perspectives on Learning Disabilities in the Era of RTI: Recommendations for Diagnosis and Intervention*; Christine Castillo, a pediatric neuropsychologist wrote *Children With Complex Medical Issues in Schools: Neuropsychological Descriptions and Interventions*; and Reynolds and Fletcher-Janzen edited the third edition of the *Handbook of Clinical Child Neuropsychology*.

In 2009, four more school neuropsychological books were published: George McCloskey wrote a book called *Assessment and Intervention for Executive Function Difficulties;* Feifer and Rattan wrote a book called *Emotional Disorders: A Neuropsychological, Psychopharmacological, and Educational Perspective*; Petersen and colleagues wrote *Pediatric Neuropsychology—Second Edition: Research, Theory, and Practice*; and Semrud-Clikeman and Teeter-Ellison wrote *Child Neuropsychology: Assessment and Interventions for Neurodevelopmental Disorders—Second Edition.*

The 2010s

In 2010, Milton Dehn wrote *Long-Term Memory Problems in Children and Adolescents: Assessment, Intervention, and Effective Instruction* and

Riccio and her colleagues wrote *Neuropsychological Assessment and Intervention for Childhood and Adolescent Disorders.* This author edited a comprehensive book called *Best Practices in School Neuropsychology: Guidelines for Effective Practice, Assessment, and Evidence-Based Interventions*.

In 2011, Andrew Davis edited a comprehensive book on pediatric neuropsychology called the *Handbook of Pediatric Neuropsychology*. In July 2011, the fifth annual school neuropsychology summer institute was held in Dallas, Texas.

Chapter Summary

Chapter 2 presents the history of the interest in school neuropsychology with its influences heavily entrenched in clinical neuropsychology, school psychology, and educational policies and law. In Chapter 3, training and credentialing issues for school neuropsychology are discussed, along with a proposed set of training standards and a model program of study.

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 collected contemporary broad-based normative data.

c. Neither test has a strong theoretical basis.

d. Neither test is empirically designed.

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

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. Naglieri-Das Cognitive Assessment System

b. Kaufman Assessment Battery the Children—Second Edition

c. NEPSY-II

d. Test of Memory and Learning—Second Edition

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

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. True or False? According to IDEA (2004), a response-to-intervention model is required for the identification of a specific learning disability.

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

Chapter Three

Training and Credentialing in School Neuropsychology

This chapter focuses on training and credentialing standards and a proposed model curriculum to train school neuropsychologists.

How does the Integration of Neuropsychological Principles Fit within the Broader Field of School Psychology?

The following four questions are posed to the reader:

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

2. Is school neuropsychology a specialty within the broader field of school psychology?

3. Is school neuropsychology an emerging and unique specialization, separate from but related to school psychology and pediatric neuropsychology?

4. Is the integration of neuropsychological principles into the practice of school psychology an expansion of training received at the doctoral level?

These four 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 possible, 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 school psychology association conferences. This level of practice is considered a baseline entry into school neuropsychology and only implies interest in the school neuropsychology field, not *competency* in school neuropsychology.

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.

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 *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 (D. Miller, DeOrnellas, & Maricle, 2008; D. Miller, Maricle, & DeOrnellas, 2009) recognizing that there is still controversy in the school psychology profession over this subject (Pelletier, Hiemenz, & Shapiro, 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-based postgraduate 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; specializing in school neuropsychology does require minimum 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 some years from now, 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.

Finally, the fourth statement suggests that training in school neuropsychology could be an area of specialization within a doctoral school psychology program. Given the increased complexity of school psychology and the requirement for supervised practice, a convincing argument could be made for school neuropsychology training to be at the postspecialist level.

Training and Credentialing Standards

This section of the chapter deals with training and credentialing standards that relate to the emerging specialization of school neuropsychology. A review of what constitutes competency as defined by the major specialty certification boards is presented.

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 such diverse areas 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.

> **Don't Forget**
>
> Not all referrals for comprehensive assessments need a full neuropsychological evaluation.

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 (D. Miller, 2010).

When 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 correlates it with behavior in order to recommend educationally relevant interventions.

Competency is often loosely defined in many professions, particularly as it relates to postgraduate 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 and training should be used more often in the ever changing and often technically and theoretically complex field of school psychology.

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 supervised, competency-based training.

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 and training for the school psychologist interested in practicing as a neuropsychologist?” 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/she most probably will be required to have a doctorate in psychology and be licensed as a psychologist. Licensure as a psychologist in most states is generic. In other words, a doctoral psychologist trained in the specialties of clinical or school neuropsychology, or industrial/organization psychology can be 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 (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.
- Two 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.

To be prepared as a clinical neuropsychologist, most training takes place within PhD or PsyD 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 two specialty boards that certify clinical neuropsychologists: the American Board of Clinical Neuropsychology (ABCN) and the American Board of Professional Neuropsychology (ABN). The American Board of Professional Psychology (ABPP) formally recognized the ABCN in 1984, while the ABN remains autonomous. 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. All three boards require an objective written exam and an oral exam. It is clear from the definitions as set forth by the APA, the International Neuropsychological Society (INS), the National Academy of Neuropsychologists (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.

Recognizing the subspecialization in pediatric neuropsychology within the broader field of clinical neuropsychology remains unclear and somewhat controversial in some professional circles. In 1996, a group of pediatric neuropsychologists expressed concern that neither the ABCN nor the ABN provided board examinations that were sufficient to the task of assessing the unique skills set of pediatric neuropsychologists, and a third certification board was formed and called the *American Board of Pediatric Neuropsychology* (ABPdN). The ABPdN was reorganized in 2004 and in 2007 it submitted an application to the ABPP to become officially recognized as a member, but the application was denied. The ABPdN application for membership to the ABPP was denied in part because Baron, Wills, Rey-Casserly, Armstrong, and Westerveld (2011) pointed out that the ABCN board examination process already had multiple procedural steps in place to assess for pediatric neuropsychology competency. The ABPdN remains a relatively small board in comparison to the ABCN and ABN.

In 2007, the ABN recognized the increased subspecialization within clinical neuropsychology by creating an Added Qualifications Certificate, in addition to the generic board certification credential. Initially, the ABN recognized peer review and additional examination in the areas of child and adolescent neuropsychology, forensic neuropsychology, geriatric neuropsychology, and rehabilitation neuropsychology. Unfortunately, the Added Qualifications Certificate in child and adolescent neuropsychology was dropped as an option by the ABN in 2010.

Although 40.7% of the ABCN Diplomate respondents to the 2010 *Clinical Neuropsychologist/American Academy of Clinical Neuropsychologist Salary Survey* (Sweet, Meyer, Nelson, & Moberg, 2011) serve pediatric patients in their practice, formal recognition of pediatric neuropsychology as a subspecialty has not come to fruition (Baron et al., 2011). However, doctoral level psychologists who are interested in pediatric neuropsychology, and are licensed as psychologists with documented expertise in clinical neuropsychology, have several options to choose from when it comes to board certification.

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. See Rapid Reference 3.1 for a comparison of the requirements of the specialty boards in adult and pediatric neuropsychology and school neuropsychology.

Rapid Reference 3.1

Requirements for Specialty Certification Boards in Neuropsychology and School Neuropsychology

Requirement	ABCN[a]	ABN[b]	ABPdN[c]	ABSNP[d]
Completed doctorate in psychology	Yes[e]	Yes	Yes	No[f]
Completed specialist-level training (60+ hour) in School Psychology	n/a	n/a	n/a	Yes
Completion of an APA[g], CPA[h], or APPIC[i] listed internship	No	No	Yes	No
Completion of a 1,200-hour internship with at least 600 hours in the schools	No	No	No	Yes
Licensed as a psychologist	Yes	Yes	Yes	No
State-certified or licensed as a school psychologist or a NCSP[j] or ABPP[k] Board Certified in School Psychology	No	No	No	Yes
3 years of experience[l]	Yes	Yes	Yes	Yes
2 years postdoctoral residency[m]	Yes	No	Yes	No
Minimum 500 hours each of the past 5 years providing neuropsychological services	No	Yes	No	No
Documentation of approved ongoing CEU workshops	No	Yes	No	Yes
Objective written exam	Yes	Yes	Yes	Yes
Work samples peer-reviewed	Yes	Yes	Yes	Yes
Oral exam	Yes	Yes	Yes	Yes
Number of board-certified individuals as of 1999	444[n]	217[n]	Not Known	10[o]
Number of board-certified individuals as of 10/25/06[p]	562	197	40	197

Number of board-certified individuals as of 10/25/08[q]	632	283	41	354
Number of board-certified individuals as of 10/25/12[r]	864	323	73	490
Percentage change in a 3-year period	36.7%	14.1%	78.0%	38.4%

[a]ABCN stands for the American Board of Clinical Neuropsychology.
[b]ABN stands for the American Board of Professional Neuropsychology.
[c]ABPdN stands for the American Board of Pediatric Neuropsychology.
[d]ABSNP stands for the American Board of School Neuropsychology.
[e]For persons receiving a doctorate after 1/1/2005, the training program must have conformed with the Houston Conference Guidelines (Hannay et al., 1998).
[f]A doctorate in psychology (school or clinical) with a specialization in neuropsychology is recognized but not required. ABPP Board Certified in School Psychology is also recognized.
[g]APA stands for the American Psychological Association.
[h]CPA stands for the Canadian Psychological Association.
[i]APPIC stands for the Association of Psychology Postdoctoral and Internship Centers.
[j]NCSP stands for Nationally Certified School Psychologist.
[k]ABPP stands for the American Board of Professional Psychology.
[l]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.
[m]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: Hannay et al., 1998).
[n]As cited in Rohling, Lees-Haley, Langhinrichsen-Rohling, & Williamson, 2003.
[o]Review of historical records from the ABSNP.
[p]Cited in D. Miller (2007, p. 46). Includes board-certified professionals from both United States and Canada.
[q]Cited in D. Miller (2010, p. 30). Includes board-certified professionals from both United States and Canada.
[r]Data retrieved from certification board websites or through personal communication with their respective offices on 10/25/12.

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

- Does the Diplomate or Board Certification credential applied for reflect the practitioner's past and current training and professional experiences? For example, a clinical psychologist who was trained in neuropsychology would most probably apply for the ABCN or ABN 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 ABN.

- Does the Diplomate credential or Board Certification 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 or Board Certification 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. The National Association of School Psychologists (NASP) has a set of training standards (NASP, 2010) but as previously mentioned, NASP does not endorse specialties within the field of school psychology. D. Miller (2007, 2010) proposed a set of professional guidelines to train school neuropsychologists (see Rapid Reference 3.2). 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 pediatric neuropsychologists emphasize more 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.

Rapid Reference 3.2

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 just 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.
- 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 efficiency, 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, and record review).
- Competency-based supervised experiences, specifically in school neuropsychology (minimum of 500 hours).
- Continuing education requirements (minimum of 6 CEU hours per year).

The entry-level skills and competencies of a school neuropsychologist should first meet the specialist-level training standards as set forth by NASP (2010; *Standards for Graduate Preparation of School Psychologists, 2010)*.

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 on the type of training program and board certification.

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 their 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 3.3.

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 over structural neuroanatomy. School neuropsychologists must also become more familiar with neuroimaging techniques such as functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI), which will increasingly be used in research and clinical practice to study childhood neurodevelopmental disorders (Miller & DeFina, 2010; Noggle, Horwitz, & Davis, 2011).

Rapid Reference 3.3

Model Doctoral School Neuropsychology Curriculum

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

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
  ◦ Attentional processes
  ◦ Visual-spatial processes
  ◦ Language functions
• Report writing.
• Supervised practice (minimum 50 hours).
	School Neuropsychology I,
	Neuropsychological Assessment I
	(3-semester-hour class)

• Theories of, assessment of, and interventions with:
  ◦ Learning and memory functions.
  ◦ Executive functions.
  ◦ Speed and efficiency of cognitive processes.
  ◦ 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,
	Neuropsychological Assessment II
	(3-semester-hour class)

Area of Focus	Possible Class Title
• Genetic and neurodevelopmental disorders.	Genetic and Neurodevelopmental Disorders (3-semester-hour class)
• 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- to 8-semester-hour classes)
Total hours:	27 to 29 hours of concentrated study in school neuropsychology

History of Clinical, Pediatric, and School Neuropsychology

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 in School Neuropsychology

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 on 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. Miller's school neuropsychology conceptual model (2007, 2010, 2012) is presented and illustrated in later chapters of this book.

Specific Theories of, Assessment of, and Interventions With:

- Sensory-motor functions
- Attentional processes
- Visual-spatial processes
- Language functions
- Learning and memory functions
- Executive functions
- Speed and efficiency of cognitive processes
- Broad indicators of general intellectual functioning
- Academic achievement
- Social-emotional functions
- Adaptive behaviors

School neuropsychologists need to know the specific theoretical models that apply to the processes and functions listed above 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 to 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's, pervasive developmental disorder) 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 and health personnel, parents, and educators.

Neuropsychological Evidence-Based Interventions

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 practice. School neuropsychologists must gain proficiency in skills such as integrative report writing, history taking, record review, and clinical interviewing.

Competency-Based Supervised Experiences

Miller stated "Mastering the knowledge base of school neuropsychology is not sufficient to claim competency in school neuropsychology. Supervised experience where the knowledge base can be applied to real-world experiences is a basic requirement of formal training in school neuropsychology" (D. Miller, 2010, p. 35). 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, and 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 (CE) credit annually in order to maintain their Diplomate status. Other organizations also require CEs or 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 3.3 presents a doctoral school neuropsychology curriculum that was modeled after the School Psychology Doctoral Program at Texas Woman's University, Denton, Texas.

Chapter Summary

This chapter discusses the need for training and credentialing models for practitioners with advanced graduate degrees and presents 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-age children and youth.

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 neuropsychology credentialing boards is affiliated with the American Board of Professional Psychology?

a. American Board of School Neuropsychology

b. American Board of Clinical Neuropsychology

c. American Board of Professional Neuropsychology

d. American Board of Pediatric Neuropsychology

4. True or False? All of the certification boards in neuropsychology require passing an objective written exam.

5. Which of the neuropsychology credentialing boards does not currently require a doctorate in psychology?

a. American Board of School Neuropsychology

b. American Board of Clinical Neuropsychology

c. American Board of Professional Neuropsychology

d. American Board of Pediatric Neuropsychology

6. True or False? There is an adopted national set of training standards for school neuropsychology.

7. True or False? A school neuropsychologist must be committed to lifelong learning.

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

Chapter Four

When to Refer for a School Neuropsychological Assessment

This chapter begins with a review of the common referral reasons for a school neuropsychological evaluation. The reasons for referral for a school neuropsychological evaluation covered in this chapter include children with known or suspected neurological disorders (e.g., traumatic brain injury, acquired brain injury), children with neuromuscular diseases (e.g., cerebral palsy, muscular dystrophy), brain tumors, 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), students returning to school after a head injury, students with a documented rapid drop in academic achievement that cannot be explained by social-emotional or environmental causes, students who are not responding to interventions, children with suspected processing weaknesses, and students with significant scatter in psychoeducational test performance. This chapter concludes with a discussion on the consideration of students with special needs.

Common Referral Reasons for a School Neuropsychological Evaluation

When a student is experiencing learning or behavioral difficulties, it is uncommon to start with a neuropsychological evaluation. The next section of this chapter discusses 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 4.1 is under consideration.

This chapter is intended to be a basic review of childhood medical disorders that warrant neuropsychological evaluations. For more comprehensive reviews on the neuropsychological assessment of childhood disorders see the publications listed in Rapid Reference 4.2.

Rapid Reference 4.1

Common Referral Reasons for a School Neuropsychological Evaluation

- A student who is not responding to multiple intervention strategies.
- A student with evidence of processing deficiencies on a psychoeducational evaluation.
- A student with a valid large scatter in psychoeducational test performance.
- A student with a known or suspected neurological disorder.
- A student with a history of a neurodevelopmental risk factor.
- A student returning to school after a head injury or neurological insult.
- A student 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. 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 or in foster care.

Rapid Reference 4.2

Additional Resources for Research Related to Neuropsychological Correlates of Childhood Medical Disorders

Castillo, C. L. (Ed.). (2008). *Children with complex medical issues in schools: Neuropsychological descriptions and interventions.* New York, NY: Springer.

Colaluca, B., & Ensign, J. (2010). Assessment and intervention with chronically ill children. In D. C. Miller (Ed.), *Best practices in school neuropsychology: Guidelines for effective practice, assessment, and evidence-based intervention* (pp. 693–736). Hoboken, NJ: Wiley.

Davis, A. S. (2011). *Handbook of pediatric neuropsychology.* New York, NY: Springer.

Goldstein, S., & Reynolds, C. R. (Eds.). (2010). *Handbook of neurodevelopmental and genetic disorders in children* (2nd ed.). New York, NY: Guilford Press.

Riccio, C. A., Sullivan, J. R., & Cohen, M. J. (2010). *Neuropsychological assessment and intervention for childhood and adolescent disorders. Hoboken*, NJ: Wiley.

Semrud-Clikeman, M., & Teeter-Ellison, P. A. (2009). *Child neuropsychology: Assessment and interventions for neurodevelopmental disorders* (2nd ed.). New York, NY: Springer.

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.

If a student has a positive history for neurological trauma or insult (see examples later) or the school neuropsychologist, parents, or educators suspect a positive, but undocumented, history of neuropsychological trauma or insult, the student is probably a viable candidate for a school neuropsychological evaluation. The only caveat to consider before referring a student for a school neuropsychological evaluation is that the student 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 all right" 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 website, http://www.ninds.nih.gov/disorders/tbi/tbi.htm). TBI is usually the result of the skull suddenly hitting an object or the skull 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 on 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 student with moderate to severe TBI will likely show all of the same symptoms of a mild TBI but 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 website, http://www.ninds.nih.gov/disorders/tbi/tbi.htm).

The neuropsychological consequences of TBI have been extensively investigated by researchers (see Morrison, 2010, for a review). 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 student. Research has not supported long-term neurocognitive deficits associated with mild head injuries (Anderson & Yeates, 2007). However, neurocognitive deficits are associated with moderate-to-severe TBI including problem solving, learning and memory, and attention and concentration (Yeates et al., 2007).

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

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 (Morrison, 2010). As Morrison points out, practitioners that 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 student 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 student 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

In this section, the neuropsychological correlates to acquired or congential brain damage such as anoxia, brain tumors, encephalitis, genetic abnormalities, meningitis, neurofibromatosis, seizure disorders, and sickle cell disease and other cerebrovascular diseases will be presented.

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, and poisoning. Anoxia/hypoxia can cause loss of consciousness, coma, seizures, or even death. The prognosis for anoxia/hypoxia is dependent on how quickly the student's respiratory and cardiovascular systems can be supported and the extent of the injuries. Anoxia or hypoxia may cause irreparable harm to a student. If the student 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 website, http://www.ninds.nih.gov/disorders/anoxia/anoxia.htm). Hypoxia is frequently associated with birth trauma resulting in respiratory distress during labor and delivery. Colaluca and Ensign (2010) report that even relatively minor birth hypoxia may result in significant cognitive impairments including selective and sustained attention, receptive vocabulary in preschoolers, emergent math skills, overall cognitive and academic functioning, and social skills.

Brain Tumors

Rapid Reference 4.3 presents the types and characteristics of childhood 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 treatment can cause a wide range of neurocognitive deficits (see Begyn & Castillo, 2010, for a review). Once the student is medically stabilized and has returned to school, it is important for the school neuropsychologist to establish a baseline profile of the student's neurocognitive strengths and weaknesses. It is equally important to regularly monitor the changes in the student's profile of strengths and weaknesses as the student'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 student 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 (Begyn & Castillo, 2010).

Rapid Reference 4.3

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% to 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.

Tumor type	Characteristics	Incident rate
• 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% to 10% of pediatric brain tumors.
• 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, 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. • Five-year survival rate is low.	• Accounts for 10% to 15% of primary brain tumors in children; average age is about 6 years old.

Tumor type	Characteristics	Incident rate
• 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
http://www.nlm.nih.gov/medlineplus/ency/article/000768.htm

Encephalitis

Encephalitis refers to an inflammation of the brain usually caused by viruses that occur perinatally or postnatally (Semrud-Clikeman & Teeter-Ellison, 2009). Acute symptoms include fever, altered consciousness, seizures, disorientation, and memory loss (Colaluca & Ensign, 2010). Encephalitis is classified according to the type of onset as acute, subacute, or chronic. There is a lack of published research on the neuropsychological effects of encephalitis; however, intellectual disability, irritability and lability, seizures, hypertonia, and cranial nerve involvement are seen in more severely infected children.

Genetic Abnormalities

It is beyond the scope of this book to cover all of the genetic abnormalities that can affect neuropsychological processes. These disorders include, but are not limited to, disorders such as Down Syndrome, Fragile X, Williams Syndrome, Angelman Syndrome, Prader-Willi Syndrome, Turner's Syndrome, Klinefelter Syndrome, and Noonan Syndrome. The neurocognitive deficits associated with these disorders are reviewed by Goldstein and Reynolds (2010) and Riccio, Sullivan, and Cohen (2010).

Meningitis

Meningitis is an 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 to stimuli, vacant stares, rash anywhere on the body, and possible seizures (Meningitis Research Foundation website, 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% of the children who had meningitis also had major long-term deficits including total deafness (11%), bilateral severe or profound hearing loss (5%), mental retardation (6%), spasticity or paresis (4%), and seizure disorders (4%). Methodological problems across studies have made it difficult to document the neuropsychological problems or deficits associated with meningitis (see Colaluca & Ensign, 2010, 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 discharge from acute hospital care, whereas fine motor incoordination, visual-perceptual deficits, and language deficits may become evident when the child starts preschool and be more readily recognized.

Neurofibromatosis

Neurofibromatosis is a rare disorder classified as a neurocutaneous syndrome. There are two forms of neurofibromatosis: NF1 and NF2. NF1 occurs more frequently in children; whereas NF2 does not. NF1 is characterized by spots of skin pigmentation that look like birthmarks, or benign tumors on or under the skin, benign tumors in the iris of the eye, focal lesions in various parts of the brain, and freckles in unexposed body areas such as the armpits (NINDS, 2012). NF2 is characterized by a slow-growing tumor in the eighth cranial nerve and is more rare. NF2 symptoms include hearing loss, poor balance, headaches, and ringing in the ears (NINDS).

Visual-spatial impairment is considered to be one of the major neurocognitive deficits in children with NF1 (Billingsley et al., 2004). Cutting, Clements, Lightman, Yerby-Hammack, and Denckla (2004) reported that children with NF1 had neurocognitive deficits in language, motor, and visual-motor areas. For a more complete review of neurofibromatosis see Moore and Frost (2011), Riccio et al. (2010), or Semrud-Clikeman and Teeter-Ellison (2009).

Seizure Disorders

Seizure disorders can occur throughout childhood and are typically caused by metabolic disorders, hypoxia, head injury, tumors, high fevers, or other congenital problems (Semrud-Clikeman & Teeter-Ellison, 2009). Pinpointing the cause of a seizure can be difficult and may reflect a more serious neurological condition or secondary characteristic of an illness. Up to 70% of all seizure disorders have no known cause and are labeled as *idiopathic* (Freeman, Vining, & Pillas, 2002). In children, the diagnosis of seizure disorders is complicated by clinical manifestations, which are age-dependent and differ substantially from seizure disorders in adults. More than 50% of all seizure disorders begin before the age of 25 and many start in early childhood (Freeman et al., 2002).

The term *epilepsy* is used to describe chronic conditions that involve seizures that affect a wide variety of neuropsychological processes; whereas, seizures refer to *individual episodes.* Seizures interfere with the child's normal brain functions. They can produce sudden changes in consciousness, movement, or sensation. Untreated seizures can lead to an overall dampening of neurocognitive functions and lower achievement (Youngman, Riccio, & Wicker, 2010).

Rapid Reference 4.4 presents the list of the major types of seizures and associated neuropsychological deficits.

Occasionally tonic-clonic seizures persist for long periods of time in a condition called *status epilepticus*, which results in hospitalization. There are other epilepsy syndromes that affect children such as juvenile myoclonic epilepsy, benign rolandic epilepsy, infantile spasms, Lennox-Gastaut syndrome, Rasmussen's syndrome, Landau-Kleffner syndrome, and progressive myoclonic epilepsy (see Youngman et al., 2010, for a review of these seizure disorders). Seizure disorders can affect all of the neurocognitive processing areas, see comprehensive reviews by Salpekar et al. (2011), Semrud-Clikeman and Teeter-Ellison (2009), or Riccio et al. (2010).

Sickle Cell Disease and Other Cerebrovascular Diseases

Cerebrovascular diseases represent a group of vascular disorders that cause brain damage. Some cerebrovascular disorders result in stroke and are sometimes referred to as cerebrovascular accidents (CVAs). Children who experience a CVA as a result of a wide variety of etiologies often have significant and permanent neuropsychological impairments. These impairments include deficits in intellectual functioning, language, attention, verbal learning and memory, visual-spatial processing, and processing speed (Colaluca & Ensign, 2010; Riccio et al., 2010).

Rapid Reference 4.4

Types of Seizures

Type	Characteristics
	Partial Seizures
Simple partial seizures	• Affects movement that starts with jerking in the fingers or toes and progresses to one whole side of the body. • Sensations usually occur on one side of body. May cause things to look, smell, taste, sound, or feel different. • Child stays aware of surroundings.
Complex partial seizures	• Alters consciousness. Child will be unaware of what is happening during seizure. • Often starts with a blank stare, followed by oral movements such as chewing, then repeated movements that seem out of place (e.g., lip smacking, hair twirling, or hand patting).
Secondarily generalized	• Seizures start as partial seizures and become generalized seizures.
	Generalized Seizures
Absence seizures	• Previously known as *petit mal* seizures. • Seizures are brief staring spells often misdiagnosed as ADHD-Inattentive Type. Staring spells may occur more than 100 times in a day. • Distinctive EEG wave pattern used in diagnosis.
Myoclonic seizures	• Brief involuntary muscle jerks involving the limbs or trunk. • May occur as a single seizure or in a cluster.
Clonic seizures	• Jerking of all limbs without prior stiffening.
Tonic seizures	• Stiffness with sudden muscle contractions.
Atonic seizures	• Sudden loss of muscle tone causing child to become floppy and drop to ground.
Tonic-clonic seizures	• Previously known as grand mal seizures. • Often called a convulsion. • Loss of consciousness occurs. • Begins with a sudden cry, fall, bodily stiffness; followed by jerking movements due to muscles tensing (clonic) and then relaxing (atonic) repeatedly.

Sources: Salpekar, Berl, and Kenealy (2011); Semrud-Clikeman and Teeter-Ellison (2009); Riccio, Sullivan, and Cohen (2010); and Youngman, Riccio, and Wicker (2010).

Sickle cell disease (SCD) is a group of genetically transmitted blood disorders that results in chronic anemia. SCD has a high incidence rate in African Americans (Wang, 2007). Neuropsychological deficits associated with SCD include motor functioning and language in young children and a decline in IQ in older children, and generalized difficulties with attention, working memory, and with reading and math across age ranges (Colaluca & Ensign, 2010).

Children with Neuromuscular Diseases

In this section of the chapter, the neuropsychological correlates to childhood neuromuscular diseases such as cerebral palsy and muscular dystrophy will be presented.

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:

> [A]n 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 website, http://www.ucp.org)

CP is generally classified into four subtypes: spastic, athetoid or dyskinetic, ataxic, or mixed. The neuropsychological correlates to CP have not been fully investigated. Semrud-Clikeman and Teeter-Ellison (2009) reviewed the literature on the neuropsychological functioning associated with CP. They 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 on 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. CMD is generally classified into one of six subtypes: Myotonic Muscular Dystrophy (MMD) (aka Steinert's Disease), Duchenne Muscular Dystrophy (DMD) (aka Pseudo-hypertrophic), Becker Muscular Dystrophy (BMD), Limb-Girdle Muscular Dystrophy (LGMD), Facioscapulohumeral Muscular Dystrophy (FSH or FSHD) (aka Landouzy-Dejerine), and Spinal Muscular Atrophy (SMA) (Blondis, 2004). CMD affects all muscle groups and onset begins at or near birth. The progression varies with the subtype with many being slowly progressive and some may shorten the lifespan. Severe mental retardation is often associated with CMD that has structural brain changes. The effects of pure CMD on cognitive abilities are variable (Blondis, 2004).

The infant form of MMD affects a wide variety of muscle groups and is associated with mental retardation, while the juvenile form is associated with learning disabilities before onset of motor problems (Blondis, 2004). ADHD and anxiety disorders are also present in children with MMD. The progression of MMD is slow, often spanning 50 to 60 years.

The DMD subtype of CMD affects the proximal muscle groups and the mean IQ of children with DMD appears to be 85 with a skewed distribution to the left (lower than normal). The age of onset for DMD is early childhood to about 2 to 6 years of age. Children with DMD have neuropsychological deficits in verbal fluency, reading, phonological processing, receptive and expressive language, verbal learning and attention, and working memory and survival is rare beyond the early 30s (Blondis, 2004).

The BMD and LGMD subtypes of CMD mainly affect the limb girdle and proximal muscle groups. The age of onset for both of these subtypes of CMD is adolescence or adulthood. Limited studies suggest that children with BMD have low average verbal and nonverbal IQs, while children with LGMD have a wider range of IQ scores. Children with either of these subtypes of CMD typically survive into mid- to late adulthood (Blondis, 2004).

The FSH or FSHD subtype of CMD initially affects proximal and then later distal muscle groups but does not have an onset until age 20 or later. There are no known neuropsychological correlates to this subtype of CMD (Blondis, 2004). Finally, the SMA subtype of CMD affects proximal muscles, starts in childhood, with symptoms progressing slowly into adulthood. Like the FSH/FSHD subtype, there are no known neuropsychological correlates (Blondis, 2004).

Children with Central Nervous System Infection or Compromise

In this section of the chapter, the neuropsychological correlates of childhood central nervous system infections will be presented. These common central nervous infections or compromises include asthma, end-stage renal disease, HIV/AIDS, juvenile diabetes, leukemia, and spina bifida or hydrocephalus.

Asthma

The Centers for Disease Control and Prevention (CDC) estimated that 9.6 million children (13.1%) less than 18 years of age have been diagnosed with asthma at some point in their lives (2007), making asthma the most prevalent health condition in children. One direct negative consequence of asthma is the increased number of 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 with the most severe forms of asthma (Colaluca & Ensign, 2010). 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.

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). Colaluca and Ensign (2010) 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 student emotional support in dealing with the consequences of the disease.

HIV/AIDS

Human immunodeficiency virus (HIV) infection and the acquired immune deficiency syndrome (AIDS) in children are primarily due to the transmission of the virus from HIV-positive mothers to their children (Dhurat, Manglani, Sharma, & Shah, 2000). Allen, Jesse, and Forsyth (2011) pointed out that while HIV in adults affects a fully mature and myelinated nervous system, this is not the case in the developing brains of children, thus making them more vulnerable. 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-age 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 (Jeremy et al., 2005; Pulsifer & Aylward, 2000). Specific cognitive deficits associated with AIDS in children can include fine and gross motor development (Pearson et al., 2000), attention and executive functioning (Schneider & Walsh, 2008), visual scanning, verbal and nonverbal memory, expressive and receptive language, and psychomotor speed (Pulsifer & Aylward, 2000). Academic deficits in children with AIDS have been found in the areas of mathematics (Pearson et al., 2000) and in writing (Fundarò et al., 1998). Compounding the potential deficits associated with the HIV virus, 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 assess or consult on a child with AIDS to help address some of the potentially related cognitive and behavioral deficits.

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. Children with diabetes might have associated neurocognitive deficits in the areas of visual-motor, memory, and attention (see Riccio et al., 2010, for a review). Rovet found that the age of onset of IDDM will vary the associated neurocognitive deficits. According to Rovet's 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 resulted in a remission success rate of more than 70%. 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 et al. (2001) investigated the long-term outcomes of ALL children at 2, 3, and 4 years postchemotherapy. 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.

Spina Bifida and Hydrocephalus

Spina bifida occurs as a result of the neuronal tube failing to fuse early in the course of gestation (3 to 6 weeks). The neuropsychological deficits associated with spina bifida, are in part, influenced by the level of the lesion within the spinal cord; the higher the lesion, the more impairment (Colaluca & Ensign, 2010). Hydrocephalus is a medical condition that is characterized by the ventricles of the brain overfilling with cerebrospinal fluid, resulting in increased intracranial pressure (Fletcher, Dennis, & Northrup, 2000). Hydrocephalus is not a disease by itself, but rather a symptom of some other physiological disorder (e.g., tumors, infections, or 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 surgical implantation of a shunt to drain the extra cerebrospinal 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 (Colaluca & Ensign, 2010; Fletcher et al., 2000; Loveday & Edginton, 2011). If a preschool or elementary-age child had a history of early onset hydrocephalus, a school neuropsychologist would be encouraged to monitor the potential deficit areas listed above.

Children with Neurodevelopmental Risk Factors

See Riccio et al., (2010) 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. See Horton Jr., Soper, McHale, and Doig (2011) for a review of the neuropsychological correlates related to exposure to other drugs such as opiates/heroin, inhalants or solvents, and hallucinogens such as ACID or Ecstasy. Methamphetamine (Meth) use in children and youth has become a serious problem, as well as babies being born addicted to prescription and street drugs. There appears to be a serious lack of available research on the effects of these types of substance abuse within pediatric populations.

Alcohol Exposure

Fetal alcohol syndrome disorder (FASD) is a broad classification of disorders associated with prenatal exposure of varying degrees. It includes Fetal Alcohol Syndrome (FAS), Fetal Alcohol Effects (FAE), and Partial Fetal Alcohol Syndrome (PFAS) (Streissguth & O'Malley, 2000). Vaurio, Crocker, and Mattson (2011) reviewed the literature on the neuropsychological correlates associated with FASDs. They found that children with FASD had relative strengths in auditory attention, verbal retention, and basic language functions. However, the FASD children had relative weaknesses in overall general intellectual ability, executive functions, visual attention, verbal and nonverbal learning, motor functions, externalizing behaviors, and adaptive behaviors.

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, or at best the research findings are mixed (Horton et al., 2011). 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, or alcohol) or to maternal neglect or abuse.

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 prenatal and childhood exposure to 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, refer to Colaluca and Ensign (2010).

Nicotine Exposure

According to Martin et al. (2003), 11.4% of pregnant women continued 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 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. See Colaluca and Ensign (2010) for a more thorough review of the neuropsychological consequences of nicotine exposure.

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). Riccio et al. (2010) provided an extensive review of the low-birth-weight literature and identified many short-term and long-term neuropsychological deficits. School neuropsychologists should consider conducting a broad-based assessment with children who have a positive history of low birth weight to determine a profile of their strengths and weaknesses.

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. Fried 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, Fried and Simon (2001) found support for a linkage between maternal marijuana use and later deficits in executive functions within the offspring. Goldschmidt, Richardson, Cornelius, and Day (2004) found that regular prenatal exposure to marijuana used by mothers resulted in 10-year-old children having lower achievement scores in reading and spelling. Horton Jr. et al. (2011) suggests that additional research is needed to clarify the extent of any long-term effects of prenatal exposure to marijuana.

Students 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 or other neurological conditions, which resulted in hospitalization. In addition, school neuropsychologists are increasingly getting involved in monitoring athletes for sports-related concussions (Webbe & Salinas, 2011). Regardless of the cause of a student's neurologic injury, it is important for the school district to have a plan in place for students who are coming back to the school after medical recovery.

For example, typically the school discovers that a student has sustained a TBI, if or when the teacher or principal is notified by the parent, or in high-profile car accidents when 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 and mobility specialists can be called on 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 precedent. 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 4.5 highlights some of the roles that a school-based TBI team can play in the student's course of recovery. See Prout, Cline, and

Prout (2010) or Semrud-Clikeman (2001) for more detailed reviews of how school neuropsychologists can help with a TBI student coming back to school. Keep in mind that many of these same principles for school reentry could be applied to any student returning to school after hospitalization for a neurological illness.

Rapid Reference 4.5

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 on 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, and 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 postdischarge set of contacts. • 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.

Students Who Have 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 along with 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. It is important to note that some aggressive brain tumors can cause a sudden change in academic performance, as well as an undiagnosed seizure disorder. If a school neuropsychologist suspects that the child has a neurological condition, first refer the child to a neurologist for a medical evaluation before proceeding with the assessment.

Students Not Responding to Repeated Evidence-Based Interventions

Recent federal educational laws such as No Child Left Behind (NCLB; 2001) and IDEA (2004) have placed an emphasis on early interventions using evidence-based instructional methods. If a student does not respond to multiple interventions, a student 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 6, the differences between psychoeducational and neuropsychological evaluation will be presented.

The purpose of a school neuropsychological evaluation is to determine if there are neurocognitive explanations for a student'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 student 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 student has not shown adequate academic progress in reading, further assessment is needed to help guide alternative interventions.

Children with Suspected Processing Weaknesses

Typically, students with learning problems are administered a psychoeducational evaluation prior to a school neuropsychological evaluation. As an example, if students achieve low scores on the long-term memory cluster on the WJIII-COG (Woodcock, McGrew, & Mather, 2001, 2007a) 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 students compared to their own scores (i.e., ipsative comparisons) and evaluate the students' 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 (e.g., standard score of 85 or lower). Some general interpretative guidelines are presented in Chapter 8. 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).

Students 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 student who obtains standard scores on the WJII-COG ranging from 65 to 115, which is an occurrence obtained by 1% or less of children their age. If an examiner has confidence that the student put forth good effort and motivation while obtaining these scores, then the student is probably a good candidate for a school neuropsychological evaluation. The purpose of the school neuropsychological evaluation would then be to tease out specific neurocognitive strengths and weaknesses, and to develop an intervention plan consistent with the unique learning profile of the student.

Consideration of Students with Special Needs

This section of the chapter discusses what considerations should be made when assessing students with special needs. These accommodations include: modification of the testing materials or standardizes instructions, and recognizing the influences of cultural, social-economic, and environmental factors on test results.

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., 2004a) is an example of a test that has standardized the testing of the limits concept. The WISC-IV Integrated is discussed in Chapter 7. 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-age children assume that the child's motor and sensory functions are intact (Hebben & Milberg, 2009). When a child's motor functions (e.g., cerebral palsy, muscular dystrophy) 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 4.6 presents some possible test modifications for children with special needs.

Rapid Reference 4.6

Possible Test Battery Modification for Students with Special Needs

Testing Students 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 students.

Testing Students with Hearing Impairments

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

Testing Students with Expressive Language Impairments

- Establish that an adequate output channel exists (e.g., pointing).
- Document expressive language deficits on standardized tests (e.g., NEPSY-II: Korkman, Kirk, & Kemp, 2007).
- Use nonverbal tests.
- Give directions through pantomime and gesture.

Testing Students 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 and Milberg, 2009, p. 90.

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

It is assumed that neuropsychological constructs such as sensory-motor functions, attention, memory, and executive functions 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 non-Westernized 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 are 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 website). Ardila, Roselli, and 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 few foreign language neuropsychological tests designed for children. Rapid Reference 4.7 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 three problems with using translators: (1) some of the concepts in the English version of the test are not directly translatable into a foreign language; (2) there is no guarantee that the translator will not embellish or alter the meaning of the question or the student's response via translation; and (3) even if a translator is used, most of the neuropsychological tests lack appropriate normative samples for different cultures (Ortiz, Ochoa, & Dynda, 2012). Even more problematic is the lack of appropriate norms for individuals from different countries. Translated tests that are still using primarily white, American norm groups may result in inaccurate scores (Ortiz et al., 2012). Rhodes (2000) developed a practical guide for using interpreters in a school setting that is relevant to school neuropsychologists.

Rapid Reference 4.7

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; ages 2 to 90+ years.
• *Battelle Developmental Inventory—Second Edition* (Newborg, 2005).	Personal-social, adaptive, motor, communication, and cognitive development in children birth to 7 to 11 years. Spanish version available.
• *Bilingual Verbal Ability Tests—Normative Update* (BVAT-NU: Muñoz-Sandoval, Cummins, Alvarado, Ruef, & Schrank, 2005).	Assesses the total knowledge of a bilingual individual using a combination of two languages for ages 5 to 90+ years. Norms available in 17 languages plus English.
• *CELF-4 Spanish* (Wiig, Secord, & Semel, 2006).	A comprehensive language assessment for Spanish speakers ages 5 to 21 years.
• *Dean-Woodcock Neuropsychological Battery* (Dean & Woodcock, 2003).	Directions for the test are available in Spanish for ages 4 to adult.
• *Expressive One-Word Picture Vocabulary Test, 2000 Edition—Spanish-Bilingual Edition* (EOWPVT-SBE: 2000).	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 years, 11 months.
• *Receptive One-Word Picture Vocabulary Test, 2000 Edition—Spanish-Bilingual Edition* (ROWPVT-SBE: 2000).	Receptive vocabulary for children bilingual in English and Spanish, ages 4 to 12 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* (Wechster, 2004).	The Spanish version of the WISC-IV for ages 6–0 to 16–11 years.
• *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 for ages 2 to 90+ years.

The other major barrier in the assessment of children from non-Westernized 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). 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, 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 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.

Chapter Summary

This chapter reviews the common referral reasons for a school neuropsychological evaluation. The chapter concludes 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 5, a conceptual model for school neuropsychological assessment is presented.

Test Yourself

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

a. A student returning to school after a head injury.

b. A student with a valid large scatter in psychoeducational test performance.

c. A mentally retarded child.

d. A student 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. True or False? 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.

4. Which subtype of cerebral palsy (CP) affects 70% to 80% 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. True or false? Cocaine exposure prenatally leads to serious neurodevelopmental and neurobehavioral disturbances.

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

Chapter Five

An Integrated Model for School Neuropsychology Assessment

This chapter begins with a review of school neuropsychology conceptual models previously reported in the literature. A proposed *Levels of Assessment Model* illustrates where neuropsychological assessment fits within a broader range of assessment. Finally, the evolution of a comprehensive model for school neuropsychological assessment is presented along with a rationale for each of the components.

Prior Models of School Neuropsychological Assessment

Two contemporary models have been proposed in the literature for conceptualizing school neuropsychology: the Transactional Model and the Cognitive Hypothesis Testing Model. A transactional model of child clinical neuropsychology was proposed by Teeter and Semrud-Clikeman (1997; Semrud-Clikeman & Teeter-Ellison, 2009). In this 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. 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 moderating variables (e.g., cognitive, social, and 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 2.

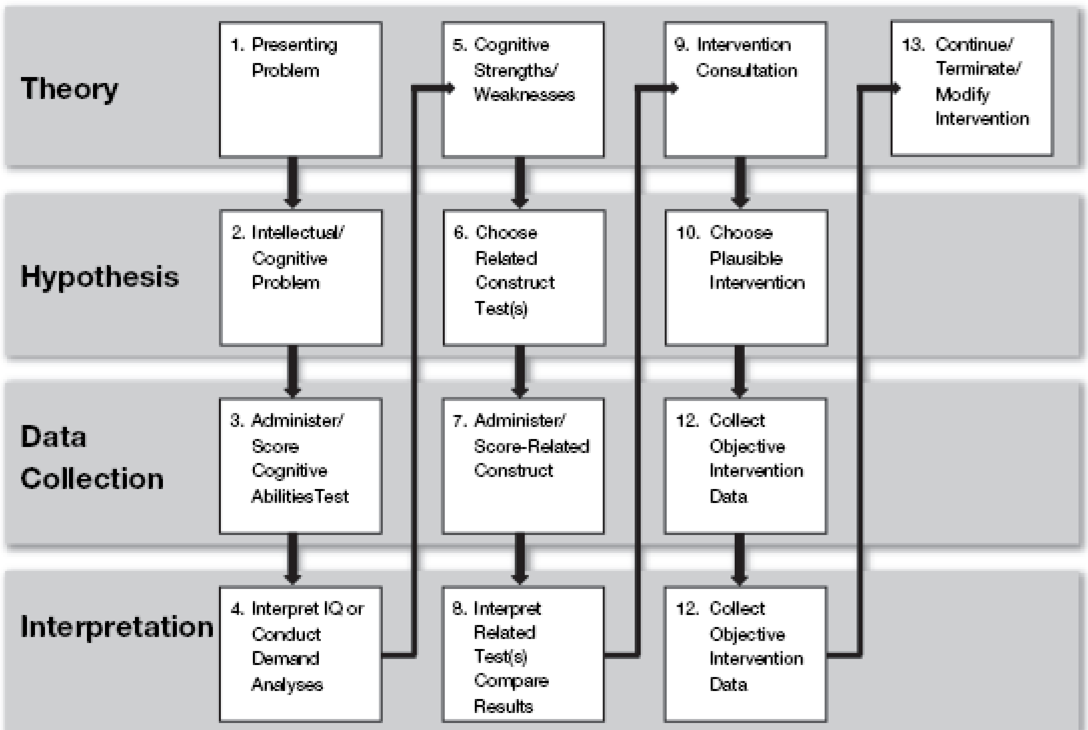
Hale and Fiorello (2004) proposed a Cognitive Hypothesis-Testing (CHT) Model. See Fiorello, Hale, and Wycoff (2012) for an updated discussion of the model. The authors combine two approaches into their model: (1) individual psychoeducational assessment, and (2) intervention development and monitoring, 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 their 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 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 (D. 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 evidence-based problem solving approach.

The CHT Model has four component parts: theory, hypothesis, data collection, and interpretation. Hale and Fiorello (2004) proposed that once a child is referred for a psychoeducational or school neuropsychological evaluation there are up to 13 steps in a CHT evaluation. Figure 5.1 illustrates the CHT Model. Hale and Fiorello 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.

Figure 5.1 The Cognitive Hypothesis Testing (CHT) Model

Source: Adapted from Hale and Fiorello, 2004.



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 (Fiorello et al., 2012). To generate hypotheses about why a particular student 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 neuropsychology 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 above 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 student'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, two previously formulated theories on how to approach school neuropsychology are reviewed. Rapid Reference 5.1 presents a comparison of the basic tenets of these two theories of school/pediatric neuropsychology. In the next sections a levels of assessment model and a conceptual model for school neuropsychological assessment will be presented. These models adhere to many of the same tenets of the transactional model and the CHT Model.

Rapid Reference 5.1

Comparison of Two School/Pediatric Neuropsychology Models

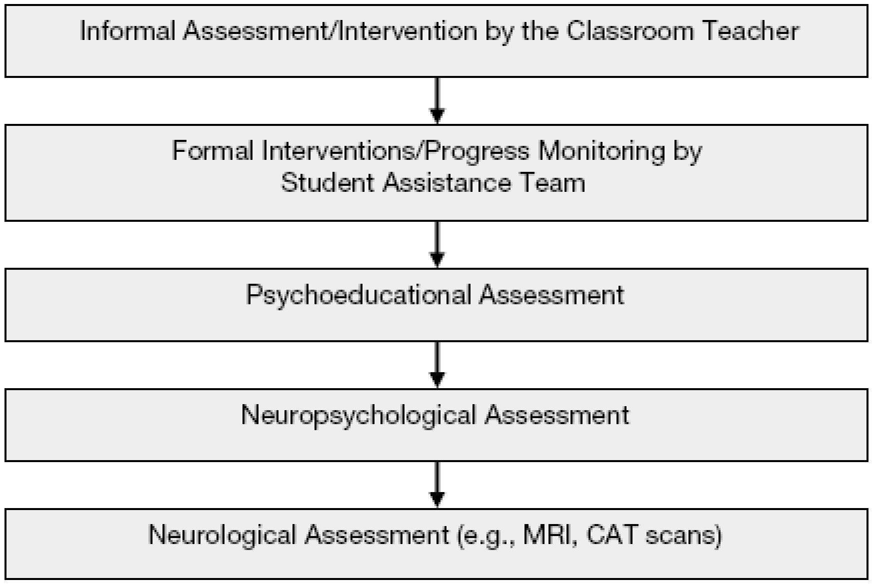
Model	**Principle Tenets**
Transactional model of child clinical neuropsychology (Semrud-Clikeman & Teeter-Ellison, 2009; Teeter & Semrud-Clikeman, 1997)	• Neuropsychological correlates of psychiatric, neurodevelopmental, and acquired disorders of childhood appreciated. • Neurodevelopmental course of those disorders understood. • Importance of the moderating variables on the overall adjustment of children who have neurodevelopmental disorders recognized.
Cognitive Hypothesis-Testing (CHT) Model (Fiorello et al., 2012; Hale & Fiorello, 2004)	• Assess children's behavior within the confines of their 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.

Levels of Assessment Model

It is uncommon for a student 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 5.2 for an illustration of the levels of assessment model.

Figure 5.2 Levels of Assessment Model

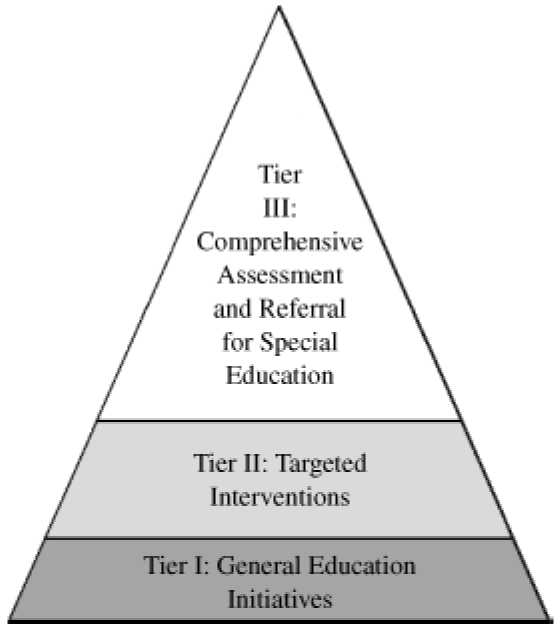
Source: From D. C. Miller, 2007, *Essentials of School Neuropsychological Assessment*, p. 93. Copyright © 2007 by John Wiley & Sons, Inc.



When a student 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 student's parent(s)/guardian(s) may be informed of these interventions and deficit skill levels through normal means (e.g., grades/report cards, parent-teacher conferences). At this level of intervention, the teacher may choose to use a variety of informal measures to assess the student'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 (see Figure 5.3).

Figure 5.3 Illustration of the Traditional Response-to-Intervention (RTI) Model

Source: From D. C. Miller (Ed.), 2010, *Best Practices in School Neuropsychology: Guidelines for Effective Practice, Assessment, and Evidence-Based Assessment* (p. 93). Copyright © 2010 by John Wiley & Sons, Inc.



If a student failed to respond to a series of research-based interventions, the prereferral intervention team may choose to refer the student for a psychoeducational assessment. The purposes of the psychoeducational assessment may be twofold: (1) identify strengths and weaknesses that may be used to target prescriptive interventions, and (2) qualify the student for special education services. A traditional psychoeducational assessment may 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 student fails to respond to special education services or if there is a suspected neurological basis for the student's learning difficulties, the student may be referred for a neuropsychological evaluation. A neuropsychological assessment is more thorough than a psychoeducational assessment (see Chapter 6 for a discussion of the differences between psychoeducational, psychological, and neuropsychological assessments). The purpose of the neuropsychological evaluation is typically not to qualify a student 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 student's neurocognitive strengths and weaknesses that may be used to tailor instructional strategies. The psychoeducational and neuropsychological assessments would fall within the third tier of the RTI model (see Figure 5.3).

There are times after a school neuropsychological (school-based) or pediatric neuropsychological (private practice-based) evaluation has been conducted when the student is referred to a neurologist for a consultation. For example, if the student 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 student may be evidencing signs of a brain tumor or other degenerative neurological disease.

This levels of assessment model is not an invariant sequence, meaning that the only way a student 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 student has suspected seizures, a referral to a neurologist is recommended immediately without other formal assessments. Another example is referring a student for a neuropsychological evaluation if there is a suspected head injury. The farther a student 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

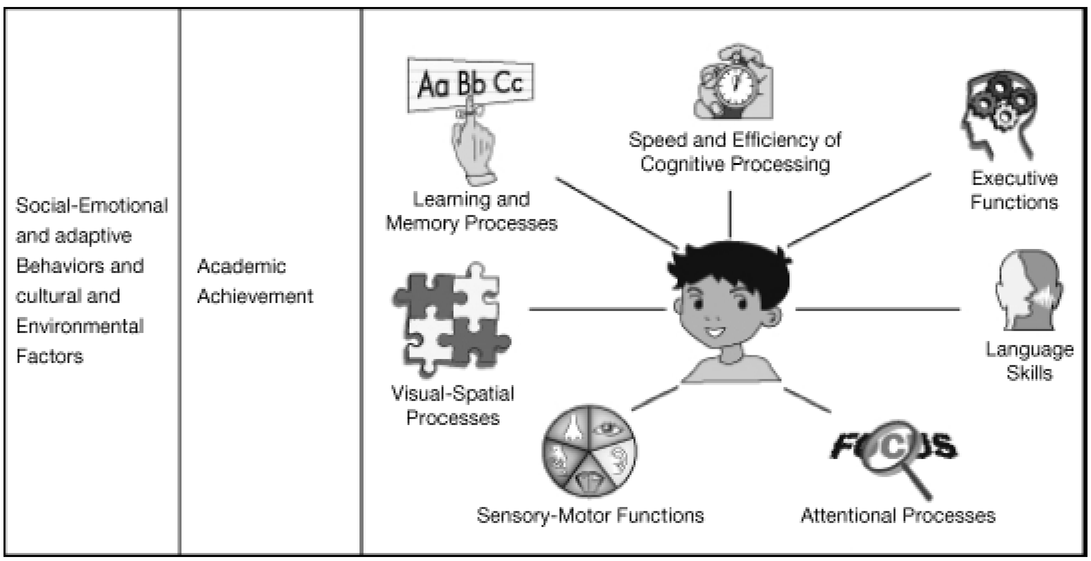
This section of the chapter provides a review of the changes to the school neuropsychological conceptual model between 2007 and 2012 and introduces the new Integrated SNP/CHC Model.

School Neuropsychological Conceptual Model (2007–2012)

Figure 5.4 illustrates a conceptual model for school neuropsychological assessment (D. Miller, 2007, 2010, 2012; D. Miller & Maricle, 2012). Miller introduced the school neuropsychological conceptual model (SNP Model) as a way of organizing school-age, cross-battery assessment data based on the underlying principle neuropsychological constructs being measured. The three purposes of the SNP Model are: (1) to facilitate clinical interpretation by providing an organizational framework for the assessment data; (2) to strengthen the linkage between assessment and evidence-based interventions; and (3) to provide a common frame of reference for evaluating the effects of neurodevelopmental disorders on neurocognitive processes (D. Miller, 2012). The complete SNP Model includes the integration of academic achievement and social-emotional functioning with the major neuropsychological assessment components (see D. Miller, 2007, 2010, 2012; D. Miller & Maricle, 2012, for reviews).

Figure 5.4 Conceptual Model for School Neuropsychological Assessment

Source: D. Miller, 2012; D. Miller and Maricle, 2012.



The SNP Model represents a synthesis of several theoretical and clinical approaches including: Lurian theory (Luria, 1966, 1973), a process-oriented approach to assessment (Milberg et al., 2009), neuropsychological theories (e.g., Mirsky's theory of attention; Mirsky, 1996), the cross-battery assessment approach (Flanagan, Alfonso, & Ortiz, 2012), and Cattell-Horn-Carroll (CHC) Theory (McGrew, 2005). In the initial development of the SNP Model, CHC Theory and cross-battery assessment were used to classify the subtests from the major tests of cognitive abilities into broad classifications. However, these theoretical models did not adequately address other important neurocognitive processes such as sensorimotor functions, attentional processes, working memory, and executive functions (D. Miller, 2012). Therefore, the SNP Model integrated additional neuropsychological theories such as Mirsky's theory of attention (Mirsky, 1996) and Baddeley and Hitch's (1974) theory of working memory (Baddeley, 2000). The SNP Model was also heavily influenced by Kaplan's process-oriented approach (Milberg et al., 2009), which resulted in the inclusion of qualitative, as well as quantitative assessment data. Recognizing what strategies individuals employ during performance on any given task is as important, if not more so, than the test score itself; and was inherent in the SNP Model (D. Miller, 2012).

The SNP Model also follows a Lurian approach in which an individual's neurocognitive strengths and weakness are systematically determined by varying the input, processing, and output demands across a variety of tasks (see Fiorello et al., 2012; Hale & Fiorello, 2004 for a discussion of what is called *conducting demand characteristics analyses*). As an example, it is not sufficient to say a student has an attentional processing problem and stop at that broad diagnostic level. The SNP Model emphasizes the need to further define the type of attentional deficit(s) the student may be experiencing such as a shifting, sustained, or selective attention deficit. Narrowing down to greater neurocognitive processing specificity in assessment for each of the broad SNP classifications will lead to more refined prescriptive remediations, accommodations, and interventions (D. Miller, 2012).

Once the classification schema for the SNP Model was created, individual tests from the major instruments used in the assessment of pediatric cognition, academic achievement, neuropsychological functioning, attention, learning, and memory were classified into the SNP Model using a variety of techniques (see subsequent chapters for specific examples). Published correlational and factorial data were used to group tests together that were shown to measure similar neuropsychological processes or functions. When such data were not available, tests were classified into the SNP Model based on what the authors reported the tests were designed to measure. Recent factorial analyses of more than 900 clinical cases (see preliminary results in D. Miller, 2012) further helped refine the SNP Model as it is presented in this chapter. The SNP Model continues to be refined and evolve based on ongoing research.

The 2012 SNP Model (see Rapid Reference 5.2) consists of seven *broad classifications* representing basic neurocognitive functions and processes, including sensorimotor functions, attentional processes, visual-spatial processes, language functions, learning and memory, executive functions, and speed and efficiency of cognitive processing. D. Miller (2012) noted that within the SNP Model, all of these broad classifications except for speed and efficiency of cognitive processing could be further subdivided into what he referred to as *second-order classifications.* As an example, sensorimotor tasks (*broad classification*) could be further subdivided into the second order classifications of lateral preference, sensory functions, fine motor functions, gross motor functions, visual scanning, and qualitative behaviors. These second-order classifications could be further subdivided into *third-order classifications.* As an example, the second order classification of sensory functions could be further subdivided into the third order classifications of auditory and visual acuity, and tactile sensation and perception. See Rapid Reference 5.2 for the full delineation of the broad classifications broken down by second- and third-order classifications in the 2012 version of the SNP Model.

Rapid Reference 5.2

School Neuropsychology Conceptual Model Classifications

Broad Cassifications	**Second-Order Classifications**	**Third-Order Classifications**
Sensorimotor functions	• Lateral preference	
	• Sensory functions	• Auditory and visual acuity • Tactile sensation and perception
	• Fine motor functions	• Coordinated finger/hand movements • Psychomotor speed and accuracy • Visual-motor copying skills
	• Gross motor functions	• Balance • Coordination
	• Qualitative behaviors	
Attentional processes	• Selective/focused attention	• Auditory selective/focused attention • Visual selective/focused attention
	• Sustained attention	• Auditory sustained attention • Visual sustained attention • Auditory and visual sustained attention
	• Shifting attention	• Verbal shifting attention • Visual shifting attention • Verbal and visual shifting attention
	• Attentional capacity	• Memory for numbers, letters, or visual sequences • Memory for words and sentences • Memory for stories
	• Qualitative behaviors	

Broad Cassifications	Second-Order Classifications	Third-Order Classifications
	• Behavioral rating scales	
Visuospatial processes	• Visual spatial perception	• Visual discrimination and spatial localization • Visual-motor constructions • Visual-motor integration error analyses • Qualitative behaviors
	• Visual spatial reasoning	• Recognizing spatial configurations • Visual gestalt closure • Visuospatial analyses with and without mental rotations
	• Visual scanning/tracking	• Direct measures • Indirect measures • Qualitative behaviors
Language functions	• Sound discrimination	
	• Auditory/phonological processing	
	• Oral expression	• Oral motor production • Vocabulary knowledge • Verbal fluency (rapid automatized naming) • Qualitative behaviors
	• Receptive language	• Receptive language with verbal response • Receptive language with nonverbal motor response • Qualitative behaviors
Learning and memory processes	• Rate of new learning	• Verbal learning • Visual learning • Paired associative learning

Broad Cassifications	Second-Order Classifications	Third-Order Classifications
	• Immediate verbal memory	• Letter recall (no contextual cues) • Number recall (no contextual cues) • Word recall (no contextual cues) • Sentence recall (contextual cues) • Story recall (contextual cues)
	• Delayed verbal memory	• Recall with contextual cues • Recall without contextual cues • Verbal recognition
	• Immediate visual memory	• Abstract designs, spatial locations, or visual sequences with motor response (no contextual cues) • Faces, objects, or pictures with verbal or pointing response (no contextual cues) • Visual digit span with verbal response (no contextual cues) • Picture/symbolic (with contextual cues)
	• Delayed visual memory	• Recall without contextual cues • Recall with contextual cues • Visual recognition • Qualitative behaviors
	• Verbal-visual associative learning and recall	• Verbal-visual associative learning • Verbal-visual associative delayed recall
	• Working memory	• Verbal working memory • Visual working memory • Qualitative behaviors
	• Semantic memory	
Executive functions	• Concept recognition and generation	• Concept recognition • Concept generation

Broad Cassifications	Second-Order Classifications	Third-Order Classifications
	• Problem solving, fluid reasoning, and planning	• Verbal problem solving, fluid reasoning, and planning • Visual problem solving, fluid reasoning, and planning
	• Response inhibition	• Verbal response inhibition • Motoric response inhibition
	• Retrieval fluency	• Verbal retrieval fluency • Nonverbal retrieval fluency
	• Qualitative behaviors	
	• Behavioral Rating Scales	
Speed and efficiency of cognitive processing	• Speed efficiency • Speed efficiency with accuracy • Qualitative behaviors	
Reading achievement	• Basic reading skills	• Phonological decoding • Orthographic coding • Morphological/syntactic coding
	• Reading comprehension skills	
	• Reading fluency	• Rapid phonological decoding • Rapid morphological decoding
Written language achievement	• Written expression • Expository composition • Writing fluency • Orthographic spelling • Handwriting skills • Qualitative behaviors	

Broad Cassifications	Second-Order Classifications	Third-Order Classifications
Mathematics achievement	• Oral counting • Fact retrieval • Mathematical calculations • Mathematical reasoning • Mathematical fluency • Qualitative behaviors	

Source: D. Miller, 2012; D. Miller and Maricle, 2012.

Integrated SNP/CHC Model

As previously stated, one of the goals of the SNP Model was to facilitate clinical interpretation by providing an organizational framework for the assessment data. As the SNP Model was refined through 2012, there were several lingering questions related to the organizational framework of the model. For example, attentional processes were designated as a separate broad classification, when in fact, attentional processes permeate almost every other process and function described in the SNP Model. This is also the case for the speed and efficiency of processing and working memory. All three of these: (1) attention, (2) processing speed, and (3) working memory act as *facilitators* to enhance the performance of other cognitive functions. It can be argued that these three processes do not work in isolation per se, but are cognitive facilitators. One of the major changes to the SNP Model is the creation of a broad classification called *facilitators/inhibitors*, which was initially referred to in an information-processing model by Dean and Woodcock (1999).

In 2010, Flanagan, Alfonso, Ortiz, and Dynda wrote a groundbreaking chapter in this author's edited book, *Best Practices in School Neuropsychology.* They presented the major tests of cognitive processing along with several other major pediatric neuropsychological measures and classified each of the subtests from these measures using the Lurian Block nomenclature, the SNP Model nomenclature, and the CHC Theory nomenclature. They referred to this as an integrated framework based on psychometric, neuropsychological, and Lurian perspectives.

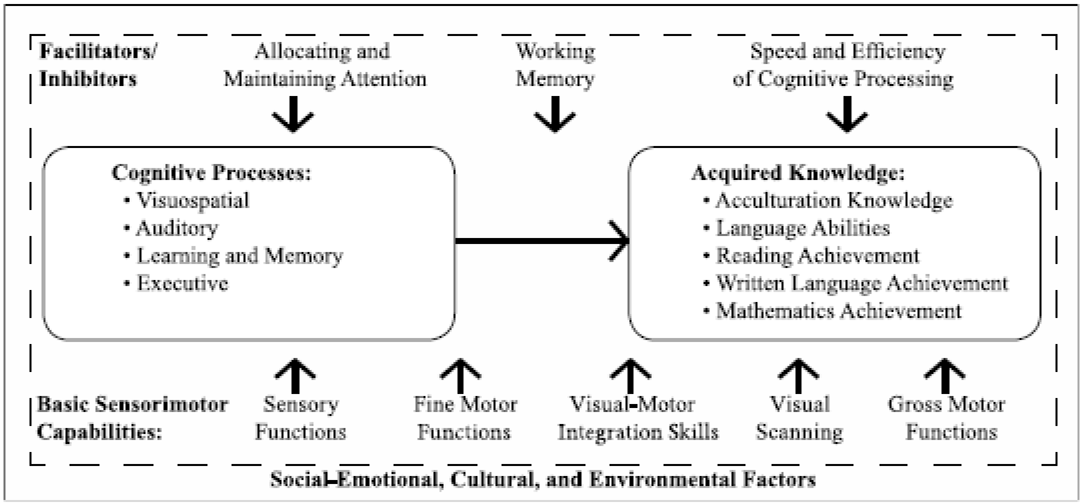
In 2012, Schneider and McGrew wrote:

> The most active CHC "spillover" has been in the area of neuropsychological assessment....It is our opinion that CHC-based neuropsychological assessment holds great potential. Much clinical lore within the field of neuropsychological assessment is tied to specific tests from specific batteries. CHC theory has the potential to help neuropsychologists generalize their interpretations beyond specific test batteries and give them greater theoretical unity. (p. 109)

In updating the SNP Model, one of Miller's goals was to provide a greater integration with some of the CHC theoretical classifications. This effort was based on current psychometric research (Flanagan, Alfonso, & Ortiz, 2012; Horn & Blankson, 2012; Keith & Reynolds, 2012; Schneider & McGrew, 2012; Schrank & Wendling, 2012) and ongoing discussions with the CHC theorists and cross-battery researchers. The constructs or processes that were contained in the 2012 and earlier versions of the SNP Model have not changed in the modified version of the model, but how they are classified in the newly updated *Integrated SNP/CHC Model* has been updated based on current psychometric and theoretical research.

One major change in the Integrated SNP/CHC Model is conceptualizing the model as encompassing four major classifications: (1) basic sensorimotor functions, (2) facilitators and inhibitors for cognitive processes and acquired knowledge skills, (3) basic cognitive processes, and (4) acquired knowledge (see Figure 5.5). All four of these broad classifications are influenced by each other and by social-emotional, cultural, and environmental factors.

Figure 5.5 Integrated SNP/CHC Model



Basic sensorimotor functions within the Integrated SNP/CHC Model include sensory, fine motor, visual-motor integration, visual scanning, and gross motor functions. These sensorimotor motor functions are the basic building blocks for higher-order cognitive processes and influence the acquisition of acquired knowledge.

Don't Forget

The Integrated SNP/CHC Model encompasses four major classifications:

1. Basic sensorimotor functions
2. Facilitators and inhibitors
3. Basic cognitive processes
4. Acquired knowledge

Another fundamental change to the Integrated SNP/CHC Model is the reduction in the number of what is considered to be a cognitive process. In previous versions of the SNP Model (D. Miller, 2007, 2010, 2012; D. Miller & Maricle, 2012), attention, language, and processing speed were all considered to be cognitive processes. As a result of reclassifications within the model, the only remaining cognitive processes are visuospatial, auditory, learning and memory, and executive.

The Integrated SNP/CHC Model includes a broad classification called *facilitators/inhibitors*, which includes three board categories: (1) allocating and maintaining attention, (2) working memory, and (3) speed, fluency, and efficiency of processing. The concept of facilitators/inhibitors used in this model is much broader than the types of facilitators/inhibitors described in Dean and Woodcock's (1999) information-processing model. They included external factors such as sensory-motor deficits and internal factors such as motivation, fatigue, and behavioral style as examples of facilitators and inhibitors.

The facilitators/inhibitors described in the Integrated SNP/CHC Model influence both cognitive processes and acquired knowledge. Let's consider the following example. Think of a student attempting to solve a story problem. For the student to initially encode an auditorially presented story problem, the student must focus attentional resources on the task at hand (a facilitator). Depending on the length of the story problem, the student may have to utilize sustained attention (a facilitator) to maintain focus. The student also has to not pay attention to the extraneous details in the story or to any other distractors in the environment or internal distractors (an inhibitor). In story problems, the student must figure out what elements to extract and then manipulate to solve the problem, which requires working memory and reasoning skills (a facilitator). Story problems are generally thought of as a mathematical reasoning task, but attempting to solve a story problem also requires a combination of facilitators and inhibitors to accomplish the task. The facilitators/inhibitors brought to bear on the wide variety of capacities to perceive, feel, think, or act, will vary based on the neurocognitive demands of the processes (McCloskey, Perkins, & Diviner, 2009).

Within the broad classification of speed, fluency, and efficiency of processing facilitators/inhibitors four second-order classifications were created: (1) performance fluency, (2) retrieval fluency, (3) acquired knowledge fluency, and (4) fluency and accuracy. Measures of performance fluency do not require any memory retrieval and principally are designed to measure automaticity of processing. Performance fluency has five third-order classifications: (1) psychomotor fluency, (2) perceptual fluency, (3) figural fluency, (4) naming fluency, and (5) oral motor fluency. These constructs are described in greater detail in Chapter 15.

Measures of retrieval fluency were reclassified from a second-order classification under the broad classification of learning and memory to a second-order classification under the broad classification of speed, fluency, and efficiency of processing facilitators/inhibitors. The principle focus of retrieval fluency is not the memory demand per se, but the fluency of the retrieval from memory.

Academic fluency measures such as reading fluency, writing fluency, and mathematics fluency were all reclassified from their respective academic acquired knowledge areas to the second-order classification of acquired knowledge fluency within the broad classification of speed, fluency, and efficiency of processing facilitators/inhibitors.

The classification of working memory within CHC theory or the SNP model remains debatable. Schneider and McGrew (2012) pointed out that "many of us use the term 'working memory capacity' to refer to the superordinate category of *Gsm*, whereas others use it to refer to a narrow ability within *Gsm*" (p. 116). Working memory tasks involve processes of attentional control and memory functions working together to help facilitate other cognitive processes and acquired knowledge. In the Integrated SNP/CHC Model, Miller reclassified working memory from a second-order classification under the broad classification of learning and memory to a broad classification of working memory facilitators/inhibitors (see Chapter 14 for further discussion).

Here are six additional examples of further CHC theory integration into the SNP Model:

1. Reclassifying psychomotor speed and accuracy as an example of psychomotor fluency (third-order classification) within the second-order classification of performance fluency, which is a part of the broad classification of speed, fluency, and efficiency of processing facilitators/inhibitors (Schneider & McGrew, 2012).

2. Reclassifying oral and receptive language skills from the broad classification of language functions, an implied cognitive process, to a new broad classification of language abilities, a part of acquired knowledge (Mather & Wendling, 2012).

3. Reclassifying semantic memory from the learning and memory broad classification to a broad classification called acculturation knowledge (a term used by Horn & Blankson, 2012, to refer to *Gc*), part of acquired knowledge.

4. Expanding the construct of speed and efficiency of processing modeled, in part, on McGrew's hypothesized speed hierarchy (McGrew & Evans, 2004; Schneider & McGrew, 2012). Further discussion of the cognitive facilitator called *speed and efficiency of processing* and the related second- and third-order classifications are presented in Chapter 15.

5. Including planning, inductive reasoning, sequential reasoning, and quantitative reasoning as second-order classifications of executive functions (Schneider & McGrew, 2012).

6. Reclassifying shifting attention form attentional processes to executive functions, specifically with a second-order classification called *cognitive flexibility* or *set shifting.*

The broad classifications and second- and third-order subclassifications of the Integrated SNP/CHC Model are presented in Rapid Reference 5.3. The corresponding CHC broad and narrow abilities are cross-referenced to the SNP model classifications in Rapid Reference 5.3 based on the current CHC classifications referenced in Horn and Blankson (2012) and Schneider and McGrew (2012). Current CHC theory still does not adequately classify all of the basic neuropsychological constructs. Recent expansion of the CHC theory by Schneider and McGrew (2012) has included narrow abilities for sensorimotor functions such as tactile abilities (*Gh*), kinesthetic abilities (*Gk*), and olfactory abilities (*OM*). Narrow abilities have also been identified for fine motor functions such as finger dexterity (*P2*), and manual dexterity (*PI*); and for gross motor functions such as gross motor equilibrium (*P4*) and control precision (*P8*). CHC theorists have not yet identified narrow abilities for visual-motor integration skills and visual scanning.

Rapid Reference 5.3

Integrated SNP/CHC Model Classifications

Broad Cassifications	**Second-Order Classifications**	**Third-Order Classifications**
	Basic Sensorimotor Functions	
Sensorimotor functions	• Lateral preference	
	• Sensory functions	• Auditory and visual acuity • Tactile sensation and perception (*Tactile abilities: Gh*) • Kinesthetic sensation and perception (*Kinesthetic abilities: Gk*) • Olfactory sensation and perception (*Olfactory memory: OM*)
	• Fine motor functions	• Coordinated finger/hand movements (*Finger dexterity: P2 and Manual dexterity: P1*)
	• Visual-motor integration skills	
	• Visual scanning	• Direct measures • Indirect measures • Qualitative behaviors
	• Gross motor functions (*Psychomotor abilities: Gp*)	• Balance (*Gross body equilibrium: P4*) • Coordination (*Control precision: P8*)
	• Qualitative behaviors	
	Cognitive Processes	

Broad Cassifications	**Second-Order Classifications**	**Third-Order Classifications**
Visuospatial processes (*Visual processing: Gv*)	• Visual spatial perception	• Visual discrimination and spatial localization (*Spatial orientation: S*) • Visual-motor constructions (*Visualization: Vz and Manual dexterity: P1*) • Qualitative behaviors
	• Visual spatial reasoning	• Recognizing spatial configurations (*Flexibility of closure: CF*) • Visual gestalt closure (*Closure speed: CS*) • Visuospatial analyses with and without mental rotations (*Speeded rotation: SR and Visualization: Vz*)
Auditory processes (*Auditory processing: Ga*)	Sound discrimination (*Speech sound discrimination: U3*)	
	Auditory/phonological processing (*Phonetic coding: PC*)	
Learning and memory processes (*Short-term memory: Gsm, and long-term memory: Glr*)	• Rate of new learning	• Verbal learning (*Free recall memory: M6*) • Visual learning (*Free recall memory: M6*) • Paired associative learning (*Associative Memory: Ma*)

Broad Cassifications	**Second-Order Classifications**	**Third-Order Classifications**
	• Immediate verbal memory (*Short-term memory: Gsm, and auditory processing: Ga*)	• Letter recall (no contextual cues) (*Memory span: MS*) • Number recall (no contextual cues) (*Memory span: MS*) • Word recall (no contextual cues) (*Memory span: MS*) • Sentence recall (contextual cues) (*Memory span: MS*) • Story recall (contextual cues) (*Meaningful memory: MM*)
	• Immediate visual memory (*Short-term memory: Gsm, and visual processing: Gv*)	• Abstract designs, spatial locations, or visual sequences with motor response (no contextual cues) • Faces, objects, or pictures with verbal or pointing response (no contextual cues) (*Visual memory: MV*) • Visual digit span with verbal response (no contextual cues) • Picture/symbolic (with contextual cues)
	• Delayed verbal memory (*Long-term storage and retrieval: Glr*)	• Free recall without contextual cues (*Free recall memory: M6*) • Free recall with contextual cues (*Meaningful memory: MM*) • Verbal recognition

Broad Cassifications	**Second-Order Classifications**	**Third-Order Classifications**
	• Delayed visual memory (*Long-term storage and retrieval: Glr*)	• Free recall without contextual cues (*Free recall memory: M6*) • Free recall with contextual cues (*Meaningful memory: MM*) • Visual recognition • Qualitative behaviors
	• Verbal-visual associative learning and recall (*Associative memory: MA*)	• Verbal-visual associative learning • Verbal-visual associative delayed recall
Executive processes (*Fluid reasoning: Gf*)	• Cognitive flexibility (set shifting)	• Verbal set shifting • Visual set shifting • Verbal and visual set shifting
	• Concept formation	• Concept recognition • Concept generation
	• Problem solving, planning, and reasoning	• Planning (*Spatial scanning: SS*) • Deductive and inductive reasoning (*Induction: I*) • Sequential reasoning (*General sequential reasoning: RG*) • Quantitative reasoning (*RQ*)
	• Response inhibition	• Verbal response inhibition • Motoric response inhibition
	• Qualitative behaviors	
	• Behavioral/emotional regulation	
	Facilitators and Inhibitors	

Broad Cassifications	**Second-Order Classifications**	**Third-Order Classifications**
Allocating and maintaining attention facilitators/inhibitors:	• Selective/focused attention	• Auditory selective/focused attention • Visual selective/focused attention
(Attention/Concentration: *AC*)	• Sustained attention	• Auditory sustained attention • Visual sustained attention • Auditory and visual sustained attention
	• Attentional capacity	• Memory for numbers, letters, or visual sequences (*Memory span: MS*) • Memory for words and sentences (*Memory span: MS*) • Memory for stories (*Meaningful memory: MM*)
	• Qualitative behaviors	
Working memory facilitators/inhibitors: (Attentional Control: *WM*)	• Verbal working memory • Visual working memory • Qualitative behaviors	

Broad Cassifications	**Second-Order Classifications**	**Third-Order Classifications**
Speed, fluency, and efficiency of processing facilitators/inhibitors	• Performance fluency (*Processing speed: Gs*)	• Psychomotor fluency (*Psychomotor speed: Gps and Movement time: MT*) • Perceptual fluency (*Perceptual speed: P*) • Figural fluency (*Figural fluency: FF*) • Naming fluency (*Naming facility: NA*) • Rate-of-test-taking fluency (*R9*) • Oral motor fluency (*Speed of articulation: PT and Movement time: MT*)
	• Retrieval fluency	• Word fluency (*Word fluency: FW and Ideational fluency: FI*) • Semantic fluency
	• Acquired knowledge fluency	• Reading fluency: Rapid phonological decoding (*Reading speed: RS*) • Reading fluency: Rapid morphological decoding • Writing fluency (*Writing speed: WS*) • Mathematics fluency (*Number facility: N*)
	• Fluency and accuracy	
	Acquired Knowledge (*Gc*)	

Broad Cassifications	**Second-Order Classifications**	**Third-Order Classifications**
Acculturation knowledge	• Semantic memory (*Comprehension-Knowledge: Gc*)	• Verbal comprehension (*Lexical knowledge: VL and Language development: LD*) • General information (*General verbal information: KO*) • Domain-specific knowledge (*Domain-specific knowledge: Gkn*)
Language abilities (*Language development: LD*)	• Oral expression (*Communication ability: CM*) • Qualitative behaviors	• Vocabulary knowledge (*Lexical knowledge: VL*)
	• Receptive language (*Listening ability: LS and auditory comprehension: ACV*) • Qualitative behaviors	• Receptive language with verbal response • Receptive language with nonverbal response
Reading achievement (*Reading and writing: Grw*)	• Basic reading decoding skills (*RD*)	• Phonological decoding (*Reading decoding: RD*) • Orthographic coding • Morphological/syntactic coding
	• Reading comprehension skills (*Reading comprehension: RC*)	
Written language achievement (*Reading and writing: Grw*)	• Written expression (*Writing ability: WA*) • Expository composition • Orthographic spelling (*Spelling ability: SG*) • Knowledge of mechanics of writing (*English usage: EU*) • Handwriting • Qualitative behaviors	

Broad Cassifications	**Second-Order Classifications**	**Third-Order Classifications**
Mathematics achievement (*Quantitative knowledge: Gq*)	• Oral counting • Fact retrieval • Mathematical calculations (*Mathematical achievement: A3*) • Mathematical reasoning (*Mathematical knowledge: KM and Quantitative reasoning: RQ*) • Quantitative knowledge (*Gq*) • Qualitative behaviors	

Note: The labels in parentheses relate to CHC broad or narrow abilities (Horn & Blankson, 2012; Schneider & McGrew, 2012).

Within the broad classification of learning and memory, CHC theory does not provide the specificity needed for classification. Specifically, within the neuropsychology realm, distinctions are made between free recall of information versus recognition. Recognition memory is not addressed in CHC theory. CHC theory also does not address in detail attention. From a neuropsychological point of view, it is important to determine the type of attentional processing difficulty a student may be experiencing such as selective/focused, sustained, shifting, or attentional capacity. In the *Woodcock-Johnson III Tests of Cognitive Abilities* (Woodcock, McGrew, & Mather, 2001, 2007a) a clinical cluster score was included called *Broad Attention* and included a conceptualization of attention that mirrored the SNP Model. However, there are no narrow abilities identified for these attentional facilitators and inhibitors.

Finally, CHC theory does not define narrow abilities for several written language achievement skills such as expository composition and handwriting that are operationalized by Berninger (2007) on the *Process Assessment for the Learner—Second Edition: Diagnostics for Reading and Writing*. Nor does CHC theory define narrow abilities for several mathematics achievement skills such as oral counting and fact retrieval that are operationalized by Berninger (2007) on the *Process Assessment for the Learner—Second Edition: Diagnostics for Math*.

Each of the areas within the Integrated SNP/CHC Model will be further defined and refined in other chapters; however, a brief overview is provided here. *Sensorimotor functions* 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, visual scanning, and balance and coordination. An examiner does not want to attribute a poor performance on a higher order cognitive task to a cognitive process such as auditory short-term memory, if the true reason for the poor performance is poor auditory acuity. Chapter 10 reviews sensory-motor functions.

The cognitive processes considered next in the SNP model are *visuospatial* and *auditory processes*. Visual-spatial skills are subdivided into the following areas: visual-spatial perception and visual spatial reasoning. *Auditory processes* are subdivided into the following areas: sound discrimination and auditory/phonological processing. Chapter 11 reviews both visuospatial and auditory processes.

Learning and memory is dependent on sensory-motor functions, attentional processes, visuospatial processing, and auditory processes. In Chapter 12, learning and memory will be conceptually divided into four major classifications: rate of learning, immediate memory, long-term (delayed) memory, and associative memory and learning.

Executive processes serve as the command and control center for the other cognitive processes. In Chapter 13, executive functions are classified into the broad classifications of cognitive flexibility or set shifting, concept formation, problem solving or reasoning, response inhibition, qualitative behaviors, and behavioral and emotional regulation.

In Chapter 14, the attention and working memory facilitators/inhibitors are discussed. 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, and attentional capacity components. Working memory can be subdivided into verbal working memory and visual working memory.

In Chapter 15, the speed, fluency, and efficiency of processing facilitators/inhibitors is discussed. This cognitive facilitator is subdivided into five second-order classifications: performance fluency, retrieval fluency, acquired knowledge fluency, the influence of fluency on performance accuracy, and qualitative behaviors that relate to speed and efficiency of processing.

In Chapter 16, the broad classifications of acculturation knowledge and language abilities that are part of acquired knowledge are discussed. In Chapter 17, the other achievement areas with acquired knowledge, such as reading, writing, and mathematics, are discussed.

The final consideration that must be made in interpreting any assessment results with the SNP Model are the contributions made by the student's social-emotional, environmental, and cultural factors. It is imperative that a learning difficulty or behavioral problem not be attributable to a processing disorder if one or more of these other factors (e.g., social-emotional, environmental, or cultural) are deemed to be the root cause of the student's current difficulties.

Chapter Summary

In this chapter several school neuropsychology conceptual models are reviewed. A comprehensive model for school neuropsychological assessment is presented with a rationale for each component of the model. In subsequent chapters of this book, each of the major processing areas of the school neuropsychological model is examined in greater detail.

Test Yourself

1. The basic tenets of which model are: 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 and 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. School neuropsychology conceptual model.

d. None of the above.

2. Which of the theoretical models combines two approaches: (1) individual psychoeducational assessment and (2) 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. School neuropsychology conceptual model.

d. None of the above.

3. A key component of the CHT model is the analysis of the neurocognitive demands required to perform a given task. This is called:

a. Conducting a factorial analysis.

b. Conducting a behavioral analysis.

c. Conducting a demand analysis.

d. Conducting a task analysis.

4. One of the major changes to the Integrated SNP/CHC Model is the inclusion of what broad classification(s)?

a. Cognitive facilitators for attention.

b. Cognitive facilitators for working memory.

c. Cognitive facilitators for speed and efficiency of processing.

d. All of the above.

5. According to the SNP Model, 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. The SNP Model is heavily influenced by all of the following except one. Which one?

a. A process-oriented approach to assessment.

b. A cognitive-behavioral approach to assessment.

c. Cross-battery assessment.

d. CHC Theory.

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

Chapter Six

School Neuropsychology Report Writing

In Chapter 5 a model for school neuropsychological assessment is presented and Chapters 10 through 17 define and operationalize each of the subcomponents of the conceptual model. This chapter illustrates how the assessment model can be integrated into a school neuropsychological report. Some principles of neuropsychological assessment and report writing are presented first in this chapter. Secondly, the essential elements of a comprehensive neuropsychological report are reviewed (e.g., identifying information, reason for referral, background information). Please note that not all children require a comprehensive school neuropsychological assessment. The actual neuropsychological domains measured in a particular evaluation varies based on the referral question(s) and the history of the student. However, in this chapter, the components of the entire model are illustrated for instructional purposes.

Basic Principles of School Neuropsychological Assessment and Report Writing

Writing a useful school neuropsychological assessment report takes practice. This section of the chapter reviews a set of basic principles for writing a school neuropsychological report.

Why are School Neuropsychological Evaluations Lengthy?

Traditional psychoeducational or psychological reports are not as comprehensive as neuropsychological reports. Rapid Reference 6.1 presents the common components of psychoeducational, psychological, and neuropsychological assessments. Psychoeducational assessment typically includes measures of cognitive 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). Because 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.

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.

Rapid Reference 6.1

Typical Components Across Psychoeducational, Psychological, and Neuropsychological Assessments

	Psychoeducational	Psychological	Neuropsychological
Record review	X	X	X
Developmental history	X	X	X
Clinical interviews	O	X	X
Intellectual	X	X	X
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

X: typically used; O: optional; —: not typically used

Neuropsychological evaluations are more comprehensive and may include assessments of sensorimotor 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) suggest 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 et al. (2001) suggest 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 do's and don'ts for neuropsychological report writing is presented in Rapid Reference 6.2. The rationale for these best practices and poor practices are discussed in the remainder of this chapter. Keep in mind that the ultimate goal of a good neuropsychological evaluation is to identify the student's neurocognitive strengths and weaknesses and to link that information to prescriptive interventions that maximize the student's learning potential.

Rapid Reference 6.2

Tips for School Neuropsychological Report Writing

Neuropsychological Report “Do's”	**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 evidence-based, prescriptive interventions. • Always provide educational recommendations for the home and school, and, where applicable, the student and outside agency personnel.	• Ignore the referral question. • Overtest 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 do not put it in the context of the student's developmental, social-emotional, cultural, and environmental background. • 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 student.

Neuropsychological Report “Do's”	Neuropsychological Report “Don'ts”
• Hierarchically arrange the recommendations from the most important first to the least important last.	

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.

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 student 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” who constantly searches for clues in the test results to build a case that best explains the student's academic or behavioral difficulties. Likewise, if a student performs poorly on a test that measures attention, 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.

> **Caution**
>
> Avoid using medical and educational jargon in a report. A teacher might find the statement that "Johnny suffered a subarachnoid hemorrhage" interesting but not know what to do with the information to better educate Johnny.

However, it is then imperative that the school neuropsychologist defines, in lay terms, that medical jargon. For example, a 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 example above, 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 et al., 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 their 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 from 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 a 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.

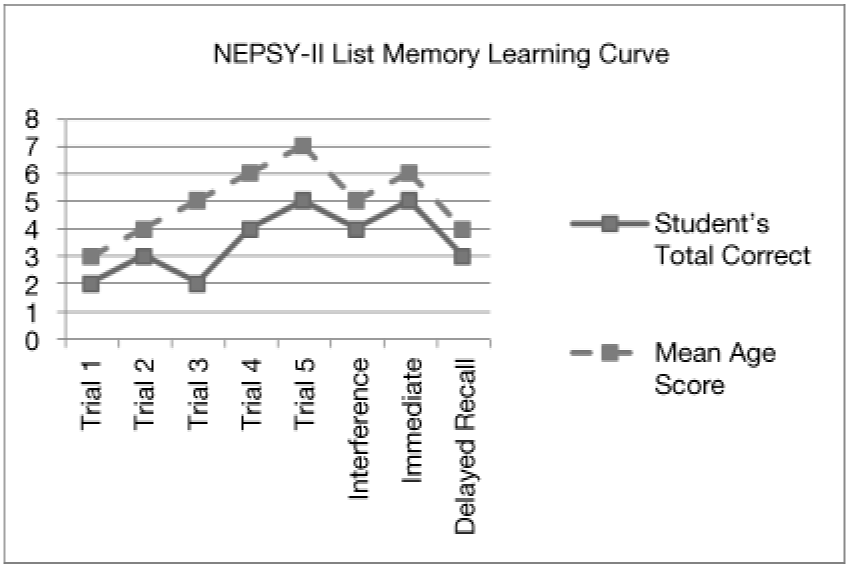
Charts that present data that share a common construct, but come from different test batteries, can be a useful method (see example in Figure 6.1). Graphs can also be useful in presenting data that can illustrate strengths and weaknesses clearly. Figure 6.2 illustrates to the report reader how a student's learning curve compares to his or her same-age peers.

Figure 6.1 An Example of Charting Data

Note: Dean-Woodcock Sensory Motor Battery (DWSMB) W scores can be translated into standard scores using the free scoring software that may be downloaded from this site: http://www.woodcock-munoz-foundation.org/press/dwnr.html — note that the standard score conversion is a truncated distribution of scores and average scores are designated as a standard score of 100+.

Fine-Motor Functions							
Instrument – Subtest: Description	Well Below Expected Level	Below Expected Level	Slightly Below Expected Level	At Expected Level	Slightly Above Expected Level	Above Expected Level	Well Above Expected Level
Coordinated Finger/Hand Movements							
DWSMB – Mime Movements: Following commands (e.g., "Show me how you would brush your teeth").				105			
KABC-II – Hand Movements: Producing a sequence of motor acts with dominant hand.				100			
WRAVMA – Pegboard: Inserting as many pegs as possible, within 90 seconds, into a waffled pegboard.				95			

Figure 6.2 Example of a Report Graph



Describing the Child's Performance, Not Just Test Scores

An occupational hazard that occurs when new professionals are learning how to write up a school neuropsychological evaluation is an overfocus on what the tests are measuring and an underfocus on describing the student's performance on tests. In an effort to minimize the description of every test administered in the narrative of the written report, it is recommended that when the test data is reported in the table, include a brief description of what the test was designed to measure (see Figure 6.1 for an example). By reporting your test results in a tabular format with test descriptions this will minimize the need to describe in the narrative what the test was designed to measure. Rather, the narrative should focus on how the student approached the tests, why particular tests were easier than others, and why particular tests were more difficult than others.

When it is obvious that a student used an uncommon strategy or process to complete a particular test, that unique behavior should be mentioned in the report narrative. For example, if a test was designed to measure verbal working memory yet the student only used immediate verbal memory, the overall results of the test could change and not be measuring what the test was designed to measure. Also when several tests are administered to a student and all of the tests are designed to measure a similar neurocognitive process, yet the results are variable; the school neuropsychologist must attempt to explain the disparity in the scores. Conducting demand analyses of the tasks (e.g., the input, processing, and output) will help generate hypotheses about why the student's performance was variable. Sometimes non-neuropsychological factors such as fatigue, motivation, or poor attitude may explain the variability in test performance as well.

Figure 6.3 presents an example of the sensorimotor section of a report. This is a good example of how the school neuropsychologist brings to life for the reader how the child performed these tasks and most importantly what would be the instructional implications for the pattern of these strengths and weaknesses.

Figure 6.3 An Example of a Well-Written Sensorimotor Section of a Report

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

Written Report Narrative: The majority of Peter's scores on tasks measuring fine-motor coordination were at an expected level for his age. Basic coordination through finger tapping was adequate and equal in both hands. On increasingly more complex imitation of motor sequences, Peter's performance was slightly below an expected level. On this task, he sometimes struggled to initially coordinate the movement, so he slowed his pace to obtain accuracy. At other times, he had difficulty with maintaining the sequence of movements in a repetitive manner. Complex coordination can impact daily tasks, such as buttoning and using eating utensils, which are reported by his parents as challenging for Peter. When asked to imitate hand positions, Peter's performance was considerably stronger when using his dominant, right hand than when using his left hand, as he tended to transpose the position of his fingers on his left hand for the more complex items. When required to trace a path within a given visual framework, his completion time and accuracy were at an expected level for his age, but Peter frequently lifted his pencil in order to maintain accuracy to stay within the lines upon changing directions. He was highly determined to stay within the track and occasionally used his nondominant hand in an attempt to avoid lifting the pencil from the page (in order to follow the rules), while adjusting the grip of his dominant hand. Thus, pencil control for forming letters and maintaining alignment with handwriting is challenging. When asked to copy shapes (e.g., Design Copy and VMI), Peter demonstrated an excellent ability to perceive the overall design; however, fine-motor challenges with coordination impacted the precision of his designs, as he tended to overshoot forming corners and connections between shapes, as well as unintentionally made extraneous marks on the page. While considered adequate for his age, Peter's motor skills are a relative weakness for him. This can result in frustration, as Peter may have a specific vision for how he wants a design or letter to appear, but lacks advanced motor skills to reproduce the image on paper to his precise specifications.

Instrument – Subtest: Description	Well Below Expected Level	Below Expected Level	Slightly Below Expected Level	At Expected Level	Slightly Above Expected Level	Above Expected Level	Well Above Expected Level
Coordinated Finger/Hand Movements							
NEPSY-II – Fingertip Tapping Dominant Hand Combined: Dominant hand completion time for two fine-motor tasks.				(11)			
NEPSY-II – Fingertip Tapping Nondominant Hand Combined: Nondominant hand completion time for two fine-motor tasks.				(11)			
NEPSY-II – Imitating Hand Positions: Imitating hand positions shown by examiner.				(8)			
• With Dominant Hand						>75	
• With Nondominant Hand			*11–25*				
NEPSY-II – Visuomotor Precision Combined: Tracing a path from start to finish quickly and while trying to stay within the lines.				(10)			
• **Total Completion Time:** Slower completion time = lower scaled score				(8)			
• **Total Errors:** More errors = lower % rank				*51–75*			
• **Pencil Lift Total:** More lifts = lower % rank		*6–10*					

Visual-Motor Copying Skills							
Beery Visual Motor Integration Total: Copying simple to complex designs on paper.				96			
• **Visual Perception:** Visual perception aspects of the task.						117	
• **Motor Coordination:** Motor coordination aspects of the task.			87				
NEPSY-II – Design Copying General Score: Copying simple to complex designs on paper.					>75		
• **Design Copying Process Motor:** This score represents the motor output portion of the overall score.				(10)			

Relate the Child's Test Performance to Real-World Examples

The goal of any school neuropsychological assessment should not only be to report a set of test scores and come up with a diagnosis. The goal of a school neuropsychological assessment is to take samples of behavior to determine a student's functional strengths and weaknesses and relate that information to actual classroom behaviors. Reporting to the classroom teacher that “Johnny has a fine-motor weakness” will probably not do Johnny any good. However, reporting that Johnny has difficulty copying and producing shapes and letters on paper due to an identified fine-motor coordination deficiency would help the teacher understand how a processing deficit would manifest itself in the classroom. The final step in the process would be to provide evidence-based remediation strategies to improve Johnny's fine-motor coordination difficulties and/or to develop some compensatory strategies to bypass Johnny's processing difficulties. Figure 6.3 presents a school neuropsychological report narrative for the sensorimotor section of the report and is an example of relating the student's test performance to real classroom behaviors.

Don't Forget

The goal of a school neuropsychological assessment is to take samples of behavior to determine a child's functional strengths and weaknesses and to relate that information to actual classroom behaviors.

Components of a School Neuropsychological Report

This section of the chapter will review the components of a school neuropsychological report. Organizing a report into sections will aid the clinician in explaining and the report recipient in understanding the results of neuropsychological findings.

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.

Organizing the Report

Rapid Reference 6.3 presents a suggested list of major report headers for a school neuropsychological report. The rationale for each of these report sections is 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:

- Name of student
- Date of birth and age of student
- School name and grade placement of student
- Name of parents/guardians
- Primary language spoken at home
- Name of examiner
- Dates of testing
- Date of report

> Rapid Reference 6.3
>
> Suggested Overall Organization of the School Neuropsychology Report
>
> - Identifying information
> - Reason for referral
> - Background information
> - Current assessment instruments and procedures
> - Test observations and related assessment validity
> - Evaluation results
> - Summary
> - Diagnostic impressions
> - Intervention strategies and recommendations

This identifying information is important to establish the child about whom this report is written, when in the life of the student the evaluation was conducted, and by whom the evaluation was conducted.

Reason for Referral

One of the most important sections of a school neuropsychological 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, or 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 student to have reading problems and what interventions would work best for this particular student? is much better than a referral question that states: Is the student 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 two sources: (1) a review of the student's educational records and (2) clinical interviews with the parent(s)/guardian(s), the student's current teacher(s), and the student, as age appropriate. A student'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) suggests that the student'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 or diagnoses that the student might have received in the past.

A thorough clinical interview with the student's parent(s)/guardian(s) is crucial to fully understanding the student. Potential explanations or insights into the causal factors of the student's current presenting problems may often be found in the student's background information. The time spent in reviewing the student's educational records and interviewing the student's parent(s)/guardian(s) and teacher(s) is as important as assessing the student 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 student live?
    - How many brothers and sisters does the student have?
    - Is the student adopted or living with a stepparent or other relative?
    - What is the principle language spoken at home?
    - What cultural factors in this student's life play a role in the student's achievement and behavior at school, in the home, and in the community?

- Have there been any major family stressors in the past year?
- Are the parents/guardians employed and if so, in what occupations?
- Does the family have any major socioecomomic limitations that could impede following the report recommendations?

- Birth and developmental history
  - Was the student exposed to any prenatal toxins (e.g., alcohol, lead)?
  - Did the mother receive adequate prenatal care?
  - Was the pregnancy carried full term?
  - What was the birth weight of the student?
  - Were there any complications during pregnancy or delivery?
  - Did the student achieve developmental milestones within normal age limits?
- Health history
  - Does the student have a history of any major illnesses?
  - What is the status of the student's weight, height, sight, and hearing?
  - Has the student experienced any ear infections or hearing problems?
  - Has the student taken any medications, and if so, name of drug and dosage?
  - Is there a history of neurological problems (e.g., seizures, head injury, high fever)?
  - Is there a positive family history on either or both sides of the biological family for health-related problems?
  - Is the student right- or left-handed?
  - How many days of school has the student missed each year, on average?
- Social history
  - In which social activities does the student engage?
  - Does this student have many friends?

  - Describe the types of friends this student has and the activities in which they engage.
  - Does this student engage in any organized sporting activities?
- Educational history
  - How many schools has the student attended?
  - Has the student been retained?
  - Has the student received any special education services?
  - What is the history of the student's educational performance? Have there been any dramatic changes in the student's school performance in the past year?
  - Does the student like school?
  - What are the student's best subjects in school?
  - What school subjects are the most challenging for this student?
  - What specific academic or behavioral interventions has the student received?
- 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 lists 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 is 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: Reynolds & Kamphaus, 2009).

By listing the name of a test in this section, it implies that the examiner administered the test in its entirety. If only a portion of the test was administered put “Selected Subtests” after the name of the test. Also if the examiner did not administer the test him/herself put “as administered by...” after the name of the test. For example, it is common practice to integrate the results of a speech and language evaluation that was administered by the speech and language pathologist into a school neuropsychological report; however, credit must be given to the person who administered the test for legal and ethical reasons.

Related to the Do's and Don'ts of Neuropsychological Report Writing presented in Rapid Reference 6.2, 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). *The Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition* (D. Miller, 2012; see supplemental CD) may be used to select the assessment tools needed to address the identified areas of concern. 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.

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!

To have this flexible battery approach to assessment, the examiner needs 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, 2001, 2007), 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., *Wide Range Assessment of Memory and Learning—Second Edition*: 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 best practice.

Test Observations and Related Assessment Validity

In this section of the report, the examiner reports 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 et al., 2001, 2007). In addition, any overt pathognomonic signs, such as excessively large or excessively small handwriting, are reported.

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, or is distracted during the examination. Armengol et al. (2001) suggested numerous factors that could compromise the test validity and reliability, including:

> [D]iminished 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)

When the validity of the assessment results is in question, the examiner includes 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 makes a statement such as “these results appear to be an accurate reflection of that [name of student's] current levels of functioning.”

Another useful statement to add to a school neuropsychological assessment report that uses a variety of assessment techniques is:

> The reader is reminded that these results are compiled from tests that were not normed from the same sample; however, test results have been integrated with data from other sources including review of records, interview, observations, other test results and work samples to ensure ecological validity. Standardization was followed for all administrations. No single test or procedure was used as the sole determining criteria for eligibility or educational planning. Unless otherwise noted these results are considered a valid estimate of [insert student's name] demonstrated skills and abilities at this point in time (D. Miller, 2012b).

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 is tests that use a truncated t-score distribution to indicate psychopathology (e.g., BASC-II scores). 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 mentioned above, be reported according to the scale shown in Figure 6.4.

Figure 6.4 Standardized Test Score Descriptors

Standard Score	Scaled Score	Percentile Rank	Normative Classification
> 129	> 15	> 98%	Superior
121–129	15	92–98	Well Above Expected
111–120	13–14	76–91	Above Expected
90–110	8–12	25–75	At Expected
80–89	6–7	9–24	Slightly Below Expected
70–79	4–5	2–8	Below Expected
< 70	1–3	< 2	Well Below Expected

If the NESPY-II is administered as part of the assessment battery, use the scale as shown in Figure 6.5 to account for the differences in how the NEPSY-II test results are classified.

Figure 6.5 Standardized Test Score Descriptors If the NEPSY-II Is Administered

Standard Score	Scaled Score	% Rank	Normative Classification	Proficiency Classification	NEPSY-II Scaled Score	NEPSY-II % Rank	Normative Classification	Proficiency Classification
> 129	> 15	> 98%	Superior	Markedly Advanced	13–19	> 75	Above Expected	Very Proficient to Markedly Advanced
121–129	15	92–98	Well Above Expected	Advanced				
111–120	13–14	76–91	Above Expected	Very Proficient				
90–110	8–12	25–75	At Expected	Proficient	8–12	26–75	At Expected	Proficient
80–89	6–7	9–24	Slightly Below Expected	Inefficient	6–7	11–25	Slightly Below Expected	Inefficient
70–79	4–5	2–8	Below Expected	Deficient	4–5	3–10	Below Expected	Deficient
< 70	1–3	< 2	Well Below Expected	Markedly Deficient	1–3	≤2	Well Below Expected	Markedly Deficient

Rapid Reference 6.4

Suggested Report Headers for the Evaluation Results Section of a School Neuropsychological Report

I. Classroom Observations

II. Basic Sensorimotor Functions

III. Cognitive Processes: Visuospatial

IV. Cognitive Processes: Auditory/Phonological

V. Cognitive Processes: Learning and Memory

VI. Cognitive Processes: Executive

VII. Facilitators/Inhibitors: Allocating and Maintaining Attention

VIII. Facilitators/Inhibitors: Working Memory

IX. Facilitators/Inhibitors: Speed, Fluency, and Efficiency of Processing

X. Acquired Knowledge: Acculturation Knowledge

XI. Acquired Knowledge: Language Abilities

XII. Acquired Knowledge: Reading Achievement

XIII. Acquired Knowledge: Written Language Achievement

XIV. Acquired Knowledge: Mathematics Achievement

XV. Social-Emotional Functioning and Adaptive Behaviors

Notice that the classification ranges in Figures 6.4 and 6.5 are not based on the standard deviation unit of 15 with an average standard score falling within the range of 85 to 115. The classification ranges were based initially on those used by the NEPSY-II, which reflect better precision for those scores that fall below the mean.

Organizing the evaluation results section of the report. Rapid Reference 6.4 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 Chapter 5. Lichtenberger, Mather, Kaufman, and Kaufman (2004) refer to this type of organization as an “ability by ability” way to organize a report.

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 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 de-emphasizing the subcomponents of cognitive processing such as attention, memory, and executive functions. 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 section, it is suggested that the remaining sections be further subdivided into three areas:

1. *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 one or more teachers, depending on the student's age.

2. *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 6.5).

3. *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 gathers information regarding the current presenting concerns about the student. The presenting concerns information are ideally obtained from both a teacher and the student's parent(s)/guardian(s). On the supplemental CD, there is a checklist that can be used to gather information on the presenting concerns. The checklist is called the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth—Third Edition* (NPCC-3: D. Miller, 2012a). The NPCC-3 is available in English and Spanish. The checklist was designed to mirror the areas assessed in the school neuropsychological conceptual model that are presented in this book. See Figure 6.6 for an example of a completed NPCC-3 rating form completed by a Mother (M) and a Teacher (T) for the Attention Problems section of the scale.

Figure 6.6 An Example of a Completed NPCC-3 by a Mother (M) and a Teacher (T) for the Attention Problems Section of the Scale

Attention Problems	Mild	Moderate	Severe
Selective or Sustained Attention Difficulties			
• Seems to get overwhelmed with difficult tasks.		M, T	
• Difficulty paying attention for a long period of time.	M	T	
• Seems to lose place in an academic task (e.g., reading, writing, math).	M	T	
• Mind appears to go blank or loses train of thought.		M, T	
• Inattentive to details or makes careless mistakes.		M	T
Shifting or Divided Attention Difficulties			
• Gets stuck on one activity (e.g., playing video games).		M, T	
• Does not seem to hear anything else while watching TV.		M	T
• Difficulty transitioning from one activity to another.	M	T	

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 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.

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 on the referral question(s). Rapid Reference 6.5 provides a more detailed list of the subcomponents that can be considered for inclusion in the report. These subcomponents reflect the second-order classifications within the school neuropsychology assessment model (see Chapter 5). 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 behaviors are reported last.

Rapid Reference 6.5

Expanded Report Headers for the Evaluation Results Section of a School Neuropsychological Report

I. Classroom Observations

II. Basic Sensorimotor Functions

- **1.** Presenting concerns
- **2.** Current levels of functioning
    - Lateral preference
    - Sensory functions
        - Auditory and visual acuity
        - Tactile sensation and perception
        - Kinesthetic sensation and perception
        - Olfactory sensation and perception
    - Fine-motor functions
        - Coordinated finger/hand movements
    - Visual-motor integration skills
    - Visual scanning
        - Direct measures
        - Indirect measures
        - Qualitative behaviors
    - Gross motor functions
        - Balance
        - Coordination
    - Qualitative behaviors
- **3.** Summary of sensorimotor functions

Cognitive Processes

III. Visuospatial Processes

- **1.** Presenting concerns
- **2.** Current levels of functioning
    - Visual spatial perception
        - Visual discrimination and spatial location
        - Visual-motor constructions
        - Qualitative behaviors
    - Visual spatial reasoning
        - Recognizing spatial configurations
        - Visual gestalt closure
        - Visuospatial analyses with and without mental rotations
- **3.** Summary of visuomotor processes

IV. Auditory Processes

1. Presenting concerns
2. Current levels of functioning
    - Sound discrimination
    - Auditory/phonological processing
3. Summary of auditory processes

V. Learning and Memory Processes

1. Presenting concerns
2. Current levels of functioning
    - Overall learning and memory index scores
    - Rate of learning
        - Verbal learning
        - Visual learning
        - Paired associative learning
    - Verbal immediate versus visual immediate memory
        - Immediate verbal memory
            - Letter or number recall (no contextual cues)
            - Word recall (no contextual cues)
            - Sentence recall (contextual cues)
            - Story recall (contextual cues)
        - Immediate visual memory
            - Abstract designs with motor response (no contextual cues)
            - Abstract designs with verbal response (no contextual cues)
            - Faces with verbal or pointing response (no contextual cues)
            - Objects or pictures with verbal or pointing responses (no contextual cues)
            - Spatial locations with motor response (no contextual cues)
            - Visual digit span with verbal response (no contextual cues)
            - Visual sequences imitation with motor response (no contextual cues)
            - Picture or symbolic (with contextual cues)
    - Delayed memory: Recall versus recognition
        - Delayed verbal memory
            - Delayed verbal recall (without context)
            - Delayed verbal recall (with context)
            - Delayed verbal recognition (without context)
            - Delayed verbal recognition (with context)
        - Delayed visual memory
            - Delayed visual recall (without context)
            - Delayed visual recall (with context)
            - Delayed visual recognition (without context)
            - Delayed visual recognition (with context)

- ▫ Qualitative behaviors
- Verbal-visual associative learning and recall
  - Verbal-visual associative learning
  - Verbal-visual delayed associative memory

3. Summary of learning and memory processes

VI. Executive Functions

1. Presenting concerns

2. Current levels of functioning

- Cognitive flexibility or set shifting
  - Verbal set shifting
  - Visual set shifting
  - Verbal and visual set shifting
- Concept formation
  - Concept recognition
  - Concept generation
- Planning
- Deductive and inductive reasoning
- Sequential reasoning
- Quantitative reasoning
- Response inhibition
  - Verbal response inhibition
  - Visual response inhibition
- Qualitative behaviors
- Behavioral and emotional regulation

3. Summary of executive functions

Facilitators/Inhibitors

VII. Allocating and Maintaining Attentional Resources Facilitators/Inhibitors

1. Presenting concerns

2. Current levels of functioning

- Selective/focused and sustained attention
  - Auditory selective/focused and sustained attention
  - Visual selective/focused and sustained attention
- Attentional capacity
  - Attentional capacity for numbers or letters with verbal response
  - Attentional capacity for visual sequential patterns with motor response
  - Attentional capacity for words and sentences (increased meaning) with verbal response
  - Attentional capacity for stories (even more contextual meaning) with verbal response
  - Qualitative behaviors of attention

        - Behavioral ratings of attention and hyperactivity

3. Summary of attentional facilitators/inhibitors

VIII. Working Memory Facilitators/Inhibitors

1. Presenting concerns

2. Current levels of functioning

- Verbal working memory
- Visual working memory

3. Summary of working memory processes

IX Speed, Fluency, and Efficiency of Processing Facilitators/Inhibitors

1. Presenting concerns

2. Current levels of functioning

- Performance fluency
    - Psychomotor fluency
    - Perceptual fluency
    - Figural fluency
    - Naming fluency
- Retrieval fluency
    - Word fluency
    - Semantic fluency
- Acquired knowledge fluency
    - Reading fluency: Rapid phonological decoding
    - Reading fluency: Rapid morphological decoding
    - Writing fluency
    - Mathematics fluency
- Fluency and accuracy
- Qualitative behaviors

3. Summary of speed and efficiency of processing

Acquired Knowledge

X. Acculturation Knowledge

1. Presenting concerns

2. Current levels of functioning

- Semantic memory
    - Verbal comprehension
    - General information

3. Summary of acculturation knowledge

XI. Language Abilities

1. Presenting concerns

2. Current levels of functioning

- Oral expression
    - Oral motor production

        - Vocabulary knowledge
        - Qualitative behaviors
    - Receptive language
        - Receptive language with a verbal response
        - Receptive language with a nonverbal response
        - Qualitative behaviors
  3. Summary of language abilities

XII. Reading Achievement

1. Presenting concerns
2. Current levels of functioning
    - Basic reading skills
        - Phonological decoding
        - Orthographic coding
        - Morphological/syntactic coding
    - Reading comprehension skills
3. Summary of reading achievement abilities

XIII. Written Language Achievement

1. Presenting concerns
2. Current levels of functioning
    - Written expression
    - Expository composition
    - Orthographic spelling
    - Handwriting skills
    - Qualitative behaviors
3. Summary of written language achievement abilities

XIV. Mathematics Achievement

1. Presenting concerns
2. Current levels of functioning
    - Oral counting
    - Fact retrieval
    - Mathematical calculations
    - Mathematical reasoning
    - Qualitative behaviors
3. Summary of mathematics achievement abilities

XV. Social-Emotional Functioning and Adaptive Behaviors

1. Presenting concerns
2. Current levels of functioning
    - Social-emotional rating scales
    - Social-emotional test results
    - Social-emotional qualitative behaviors
    - Adaptive behavior rating scales
    - Processing concerns checklists

3. Summary of social-emotional functioning

Summary Section

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 et al., 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 de-emphasizing 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.

Don't Forget

When writing the summary section of the report, lead with the child's strengths before presenting the areas of concern.

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 proclaim diagnostic statements such as “Johnny has a right parietal lesion.” Although Johnny's teacher might find that diagnosis fascinating, she or he probably does not know what to do to better educate Johnny based on that information. Statements like that also scare the parent(s) senselessly. It is best if the clinical/school neuropsychologist describes the constellations of deficits and/or strengths associated with a right parietal lobe dysfunction and then in 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 TR* 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 TR* diagnosis) (Lichtenberger et al., 2004). The school neuropsychologist must still use the language of IDEA to determine eligibility for special education services. A *DSM-IV TR* 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 TR* 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 to work to improve the student's weaknesses. A dubious practice that is used by some practitioners is to provide a long list of recommendations and not have them listed in any organized manner. Parents and teachers want to prioritize the top interventions they can provide to help the student. Too many recommendations in a report overwhelm the reader and it runs the risk that none of the recommendations are 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 et al. (2004) suggests that the reasons that recommendations are not followed are because:

> [T]he 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 is entitled “Recommendations for the Outside Consultant or Agency.” This section contains recommendations for agency or private mental health professionals, educational consultants, or physicians who end up reading the report.

Each of the recommendations sections are 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, student (if applicable), 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 can 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 an intervention lasts 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 about the length and the methods of the intervention 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 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 are organized and prioritized to aid the reader. Recommendations are based on intervention strategies that have a research base of effectiveness. And finally, recommendations are tailored in such a way that the student's strengths help compensate for their weaknesses. School neuropsychological evaluations can provide educators and parents a wealth of information that can be used to improve educational quality for students.

Chapter Summary

In this chapter, a model for a school neuropsychological report is presented that follows the school neuropsychological assessment model. As a reminder, not every school neuropsychological assessment is as thorough as the school neuropsychological report outline implies. The referral question and the student's profile of strengths and weaknesses, and the available clinician's time all dictate the thoroughness of the report.

Test Yourself

1. True or False? The comprehensive model described in this chapter needs to be used for each student who needs a school neuropsychological evaluation.

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. True or False? If a school neuropsychologist must use jargon in a report, it is best practice to define the jargon in terms a lay person understands.

4. School neuropsychologists should consider using a *DSM-IV* diagnosis in their reports when:

a. School neuropsychologists should never use a *DSM-IV* diagnosis in their report.

b. If the school neuropsychologist wants to qualify the student as Severe 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. True or False? Introducing new information into the summary section of the report is acceptable practice.

6. Which of the referral questions below 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 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

Chapter Seven

Major School Neuropsychological Test Batteries for Children

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 2. Currently there are three major test batteries designed to assess neuropsychological functioning in school-age children: the NEPSY-II, the WISC-IV Integrated and the Delis-Kaplan Executive Functions System (D-KEFS). This chapter provides an overview of these three test batteries.

NEPSY-II: A Developmental Neuropsychological Assessment

The NEPSY (Korkman, Kirk, & Kemp, 1997) 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-II is based on Lurian theory and has a strong process-oriented approach embedded in the tests. Data obtained from the NEPSY-II are interpreted in both a quantitative and qualitative manner.

The NEPSY-II tests have four purposes:

1. To assess the effects of damage to the brain regardless of whether the reasons for that damage are known or not.

2. To use in long-term follow-up of children with acquired or congenital brain damage or dysfunction.

3. To identify patterns of deficiencies in children that are consistent with the research on neurodevelopmental disorders.

4. To identify strengths and weaknesses that can be directly linked to prescriptive interventions. (Kemp & Korkman, 2010)

The NEPSY-II batteries assess six functional domains: Attention/Executive Functions, Language, Sensorimotor, Visuospatial, Memory and Learning, and Social Perception. Rapid Reference 7.1 shows the NEPSY-II subtests for each of the six functional domains.

Rapid Reference 7.1

NEPSY-II Subtests by Domain

Source: Adapted from Kemp and Korkman (2010).

Subtest	**Age Range**	**Description**
Measures of Attention/Executive Functioning		
Animal sorting	7–16	Assesses the ability to formulate basic concepts, sort those concepts into categories, and shift set from between categories.
Auditory attention and response set	Part 1: 5–16 Part 2: 7–16	The subtest has two parts. The first part, Auditory Attention, assesses selective and sustained auditory attention. The second part, Response Set, maintains the selective and sustained attention requirements of Part 1 and adds a shifting attention component.
Clocks	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 a random array.
Inhibition	5–16	A timed test that assesses the ability to inhibit automatic responses in favor of novel responses.
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 production.
Phonological processing	3–16	The test has two parts; Part 1, Word Segment Recognition, requires identifying words from segments. Part 2, Phonological Segmentation, requires reorganization of phonemes to form new words.
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.
Word generation	3–16	Assesses the ability to generate words within specific semantic or phonemic categories.
Measures of Memory and Learning		
List memory, list memory delayed	7–12	Assesses immediate and delayed recall, rate of learning, the role of interference, and retention after interference.
Memory for designs, memory for designs delayed	Immediate: 3–16 Delayed: 5–16	Assesses immediate and delayed spatial memory for novel visual material.
Memory for faces, memory for faces delayed	5–16	Assesses immediate and delayed visual memory of facial features, as well as face discrimination and recognition.
Memory for names, memory for names delayed	5–16	Assesses verbal-visual associative immediate learning and delayed recall.
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	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		

Subtest	Age Range	Description
Affect recognition	3–16	Assesses the ability to recognize emotional affect from photographs of children's faces.
Theory of mind	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 3-dimensional constructions from models or 2-dimensional drawings.
Design copying	3–16	Assesses the ability to copy 2-dimensional geometric figures.
Geometric puzzles	3–6	Assesses mental rotation, visuospatial analysis, and attention to detail.
Picture puzzles	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.

Administration Choices with the NEPSY-II

It should be first pointed out that not all of the NEPSY-II tests are suitable for all ages between 3 and 16 years. There are two record forms that may be used: one for children ages 3 to 4, and the other for children ages 5 to 16. The NEPSY-II tests in each protocol are alphabetically arranged by test name but should not be administered in sequential order like other tests.

Don't Forget

The NEPSY-II has four types of assessment batteries:

1. Full Assessment
2. General Referral Battery
3. Diagnostic Referral Battery
4. Selective Assessment

There are four types of assessment batteries that an examiner can choose from: a full assessment of all age appropriate tests; (1) a general referral battery; (2) a diagnostic referral battery; or (3) selective assessment.

Full Assessment

The full assessment uses all of the subtests that are age appropriate across all six domains. When time permits and a thorough neuropsychological assessment is warranted, the full assessment battery may be chosen as the administration option. Students who may warrant the full assessment battery option would be those with:

- Severe brain damage or dysfunction.
- Notable neurodevelopmental risk factors such as prenatal exposure to drugs or alcohol.
- A severe learning or behavioral problem that has been monitored for multiple years.
- Severe medical treatments that may effect the central nervous system such as radiation treatments for cancer, or neurosurgeries to treat seizure disorders.

For all of the conditions above, the purpose of the full assessment is to establish a comprehensive profile of the student's neurocognitive strengths and weaknesses and use that information to tailor evidence-based interventions (Kemp & Korkman, 2010).

Rapid Reference 7.2

NEPSY-II Tests in the General Referral Battery

Source: Adapted from Korkman, Kirk, and Kemp (2007).

Domain	**Ages 3–4**	**Ages 5–16**
Attention/executive functions	Statue	Statue (ages 5–6) Auditory attention and response set inhibition
Language	Comprehension of instructions Speeded naming	Comprehension of instructions Speeded naming
Sensorimotor	Visuomotor precision	Visuomotor precision (ages 5–12)
Visuospatial	Design copying Geometric puzzles	Design copying Geometric puzzles
Memory/learning	Narrative memory	Narrative memory Memory for faces/memory for faces delayed Word list interference (ages 7–16)

General Referral Battery

The general referral battery is a subset of all of the NEPSY-II tests but it still taps into five of the six core domains (see Rapid Reference 7.2). The general referral battery does not include subtests from the Social Perception domain, which is typically reserved for suspected autism disorders. The general referral battery is often recommended as the starting point for most school-based referrals, particularly when the referral questions are unclear or when multiple problems are cited (Kemp & Korkman, 2010).

Diagnostic Referral Batteries

The NEPSY-II introduced eight Diagnostic Referral Batteries designed to address specific presenting problems (Korkman, Kirk, & Kemp, 2007). The subtests selected in these batteries were selected based on: (a) the largest effect sizes in scores within a clinical group as compared to a matched normative sample; and (b) clinical experience and the known neurocognitive deficits associated with these clinical groups based on the literature (Kemp & Korkman, 2010). Rapid Reference 7.3 shows the eight diagnostic referral batteries.

Rapid Reference 7.3

NEPSY-II Diagnostic Referral Batteries

1. Learning Differences—Reading
2. Learning Differences—Mathematics
3. Attention/Concentration
4. Behavior Management
5. Language Delays/Disorders
6. Perceptual-Motor Delays/Disorders
7. Social Perception
8. School Readiness

The compilation of NEPSY-II subtests contained within each Diagnostic Referral Battery are different because they reflect which neurocognitive processes are predictive of specific types of clinical syndromes. The neurocognitive processes that predict, or are related to, a student with a reading disorder will be different from those neurocognitive processing deficits associated with a student with social perception difficulties.

Rapid Reference 7.4 provides an example of how the NEPSY-II subtests change based on which Diagnostic Referral Battery is chosen. Use caution when selecting a specific Diagnostic Referral Battery and making the assumption that the presenting problems will fall within that single category. It is not uncommon for children to have multiple learning problems that will cut across these diagnostic categories. When in doubt, start with the General Referral Battery and add supplemental subtests that relate to the stated referral concerns.

Selective Assessment Batteries

Selected subtests from the NEPSY-II may also be used as part of a cross-battery assessment. Since the NEPSY-II tests are not subject to order effects, individual subtests may be selected for administration based on the referral question(s). The selection and interpretation of an individual NEPSY-II subtest or subtests as part of a broader comprehensive assessment battery depends on the knowledge and expertise of the school neuropsychologist. Kemp and Korkman (2010) pointed out that when only a few selected subtests from the NEPSY-II are added to a routine test of cognitive abilities that does not warrant being called a neuropsychological assessment.

Rapid Reference 7.4

An Example of NEPSY-II Tests Based on Two Different Diagnostic Referral Batteries

Source: Adapted from Korkman, Kirk, and Kemp (2007).

Domain	**Learning Differences—Reading**	**Perceptual-Motor Delays/Disorders**
Attention/executive functions	Auditory attention and response set (ages 5–16) Inhibition (ages 5–16) Statue (ages 3–6)	Auditory attention and response set (ages 5–16) Clocks (ages 7–16) Design fluency (ages 5–12) Statue (ages 3–6)
Language	Comprehension of instructions (ages 3–16) Oromotor sequences (ages 3–12) Phonological processing (ages 3–16) Speeded naming (ages 3–16)	Oromotor sequences (ages 3–12)
Sensorimotor	Manual motor sequences (ages 3–12)	Finger tapping (ages 5–16) Imitating hand positions (ages 3–12) Manual motor sequences (ages 3–12) Visuomotor precision (ages 3–12)
Visuospatial	Design copying (ages 3–16) Picture puzzles (ages 7–16)	Block construction (ages 3–16) Design copying (ages 3–16) Geometric puzzles (ages 3–16)
Memory/learning	Memory of names/delayed (ages 5–16) Word list interference (ages 7–16)	Memory for designs/memory for designs delayed (ages 3–16)
Social perception	Not applicable	Affect recognition (optional) (ages 3–16)

Order of Subtest Administration

Once an examiner has chosen which NEPSY-II subtests to administer, the order of the subtests must be determined. The order of the subtests is dependent on several factors including the ability of the child to sustain interest in the tasks, the time lapse between the immediate and delayed memory tasks must be accounted for, and some common sense principles such as not starting with subtests that will be especially difficult based on the referral questions should be considered. When planning the order of the subtest administration, do not take a break between the immediate and delayed memory subtests and do not intersperse other types of memory tests in the immediate to delayed recall interval to minimize any potential interference effects.

Types of Scores Generated

The sheer number of scores generated by the NEPSY-II can be at first overwhelming even for the most experienced school neuropsychologists. Rapid Reference 7.5 presents the types of scores generated by the NEPSY-II.

Rapid Reference 7.5

Scores Generated by the NEPSY-II

Scaled scores	These scores are normalized and corrected by age and have a mean of 10 with a standard deviation of 3.
Percentile rank ranges	These scores are normalized and corrected by age and are expressed as a percentile score. The NEPSY-II groups these percentile ranks into ranges that correspond to the following classifications: ≤ 2, well below expected level; 3–10, below expected; 11–25, slightly below expected; 26–75, at expected level; > 75 above expected level.
Cumulative percentages (base rates)	These scores represent the cumulative percentages of the standardization sample or one of the clinical validation groups used to construct the diagnostic referral batteries. They are descriptive base rates and are not actual percentile ranks. As an example, a base of 26 would be interpreted as "26% of the same-age children obtained the same score or lower."
Combined scores	The combined score integrates two standardized scores from the same subtest. For example, a combined score might be a synthesis of a completion time score and a score that reflects the number of correct items. Hooper (2010) questioned the clinical utility and validity of the combined scores and this author agrees. The combined score is only valid when there is no significant difference between the two scores that are used to form the combined score; otherwise, the individual scores must be interpreted in isolation.
Contrast scores	A contrast score takes the difference between two scores and creates a norm-based value to determine the statistical and clinical significance between the performance on those two measures.
Process scores	Process scores allow the clinician to evaluate subtle aspects of a student's performance on a particular task. For example, examining the number of novel sort and repeated sort errors made on the Animal Sorting test.
Qualitative behavioral observations	When a child engages in a qualitative behavior such as asking for repetitions on verbal tasks, occurrences or absence of these behaviors are recorded and base rates can be determined with comparisons made to the same age group within the standardization sample.

Reporting NEPSY-II Scores Within the SNP Model

As reported in Chapter 6, it is suggested that within a school neuropsychological assessment report, test results should not be reported in a pure linear fashion. The NEPSY-II is organized in such a way that it makes it easier to report the results based on the six functional domains. However, many of the NEPSY-II tests have subscores and process scores that may involve neurocognitive processes other than the principle processing domain in which the test is categorized. As an example, the Inhibition test has three conditions: (1) inhibition naming, (2) the inhibition portion of the test, and (3) a switching (shifting) attention portion of the test. The test is categorized as an Attention and Executive Functions test. Within the SNP Model, the first part of the test, the naming portion, is a simple task that requires the child to name shapes rapidly and this subscore is reported in the Speed, Fluency, and Efficiency of Processing Facilitator/Inhibitor (Broad Classification), Performance Fluency (second-order classification), and Naming Fluency (third-order classification) section of the school neuropsychological report.

The second part of the Inhibition test requires the child to inhibit the natural tendency to name the shape and requires the child to name an alternative shape, so a circle is called a *square* and a square is called a *circle.* This subscore from the test is reported under the Executive Process (Broad Classification)—Response Inhibition (second-order classification) —Verbal Response Inhibition (third-order classification) section of the school neuropsychological report.

The third part of the Inhibition test requires the child to name the actual shape for some items then switch to naming the alternate shape based on a prescribed rule. This subscore of the test is reported in the Executive Process (Broad Classification)—Cognitive Flexibility (second-order classification)—Verbal Cognitive Flexibility (third-order classification) section of the school neuropsychological report.

In Chapters 10 through 17, the NEPSY-II scores are reclassified according to the Broad Classification, second-order classifications, and third-order classifications of the SNP Model, as appropriate. The NEPSY-II is a valuable assessment tool for school neuropsychologists but the test requires practice to administer and score and requires careful consideration of how to interpret the wide variety of the scores that are generated.

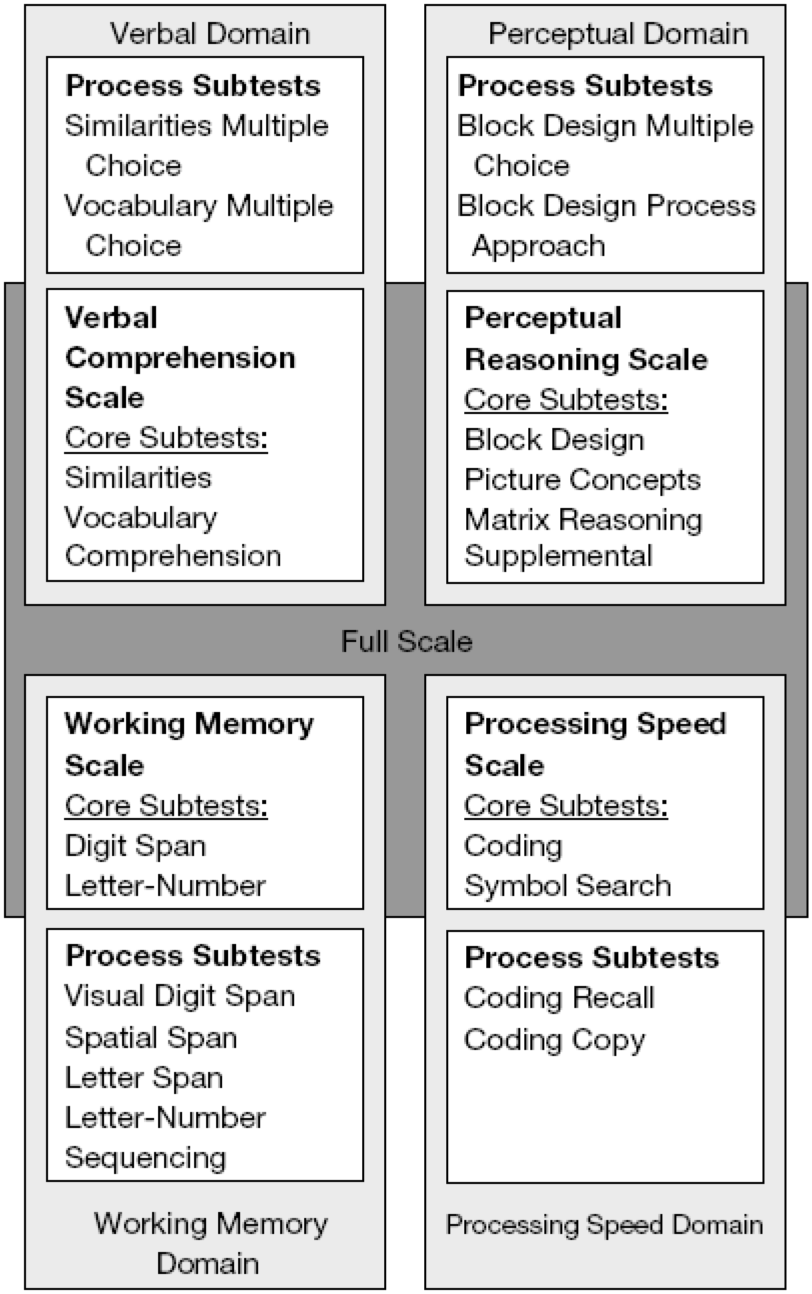
Wechsler Intelligence Scale for Children—Fourth Edition Integrated

The WISC-IV Integrated (Wechsler et al., 2004a) 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: Kaplan, Fein, Kramer, Delis, & Morris, 1999). Figure 7.1 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.

> ## 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 7.1 The WISC-IV Integrated Test Framework

Source: Adapted from Wechsler et al., 2004.



The WISC-IV Integrated may be purchased as a supplement to the stand-alone WISC-IV kit. 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 15 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 other 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 of supplemental WISC-IV tests (Elithorn Mazes, Visual Digit Span, Spatial Span, Letter Span, Letter-Number Sequencing Process Approach) (Flanagan & Kaufman, 2009). 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 7.1).

Verbal Comprehension Process Subtests

This section of the chapter reviews the WISC-IV Integrated subtests that are designed to measure verbal comprehension.

Similarities Multiple Choice, Vocabulary Multiple Choice, Picture Vocabulary Multiple Choice, Comprehension Multiple Choice, and Information Multiple Choice

Each of these subtests falls under the Verbal domain. These subtests use the same content as used on 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) 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 chooses 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.

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 2-dimensional picture of a block design and is asked to construct the design using 3-dimensional blocks. On the Block Design Multiple Choice subtest, the child is shown a 2-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 3-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. (Wechsler et al., 2004).

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 2-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 as 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 are 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 is 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). 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.).

Working Memory Process Subtests

This section of the chapter reviews the WISC-IV Integrated subtests, which are designed to measure working memory.

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).

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., 2004a). 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 paper and pencil to assist in calculations. The pairing of the visual–verbal presentation of items and the use of 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

This section of the chapter reviews the WISC-IV Integrated subtests which are designed to measure processing speed.

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 (Wechsler et al., 2004).

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 is 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. This subtest helps to isolate the contributions of graphomotor speed and accuracy to the overall Coding B performance (Wechsler et al., 2004).

Reporting WISC-IV Integrated Scores Within the SNP Model

Similar to the NEPSY-II test scores previously discussed in this chapter, the WISC-IV Integrated test scores should not be reported all together in one section of a school neuropsychological report, but should be reported within the SNP Model domains and subclassifications based on the principle neurocognitive demands of the tasks.

In Chapters 10 through 16, the WISC-IV Integrated scores are reclassified according to the Broad Classification, second-order classifications, and third-order classifications of the SNP Model, as appropriate. The WISC-IV Integrated is a valuable addition to the WISC-IV and affords school neuropsychologists the opportunity to systematically test the limits for low performing WISC-IV scores.

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, which can be administered to ages 16 to 89. The D-KEFS subtests are presented in Rapid Reference 7.6. Practitioners who are familiar with the neuropsychology field 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 originally designed by Simon (1975).

Rapid Reference 7.6

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

- *Trail-Making Test*—A visual-motor task designed to measure flexibility in thinking.
- *Verbal Fluency*—Assesses the ability to quickly produce verbal responses in accordance with a set of rules.
- *Design Fluency*—The production of as many differing designs as possible using a series of dots and rules as a guide within a delineated time period
- *Color-Word Interference Test*—Measures the inhibition of the natural inclination to respond in a certain way in order to respond in accordance with a set of defined rules.
- *Card Sorting Test*—Measures concept generation and recognition using a set of cards.
- *Word Context Test*—Requires the individual to discover the meanings of a made-up word based on its use in five clue sentences, which progressively provide more detailed information about the target word's meaning.
- *Twenty Questions*—Requires the individual to identify a target stimulus from an array of pictures by asking questions in a yes/no format.
- *Tower Test*—Measures visual attention, visual-spatial skills, spatial planning, rule learning, inhibition, and the establishment and maintenance of cognitive set.
- *Proverbs Test*—Assesses the ability to interpret pithy, concrete phrases that convey deeper, abstract meaning.

The fundamental differences and advantages of the D-KEFS over the previous versions of these tests are (1) the updated normative sample, and (2) 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 tests are stand-alone measures of different aspects of executive functions and are not interchangeable. The tests also measure other 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 the Chapter 8.

Reporting D-KEFS Scores Within the SNP Model

Similar to the NEPSY-II and WISC-IV Integrated test scores previously discussed in this chapter, the D-KEFS test scores should not be reported all together in one section of a school neuropsychological report, but should be reported within the SNP Model domains and subclassifications based on the principle neurocognitive demands of the tasks.

In Chapters 10 through 16, the D-KEFS scores will be reclassified according to the broad classification, second-order classification, and third-order classification of the SNP Model, as appropriate. The D-KEFS is a valuable assessment tool for school neuropsychologists but the test requires practice to administer and score and careful consideration of how to interpret the wide variety of the process-related scores that are generated.

Chapter Summary

In this chapter the NEPSY-II, WISC-IV Integrated, and D-KEFS used for school neuropsychological assessment are reviewed. These three tests are chosen for review because they often serve as part of a core assessment for school neuropsychologists.

Test Yourself

1. True or False? The NEPSY-II is standardized on a sample of children ages 3–0 to 16–11.

2. The Clocks test on the NEPSY-II is classified in what domain according to the test authors?

- **a.** Attention/Executive Functions
- **b.** Language Functions
- **c.** Sensorimotor Functions
- **d.** Visuospatial Processing

3. All of the following diagnostic referral batteries are part of the NEPSY-II except for one. Which one?

- **a.** Behavior Management
- **b.** Perceptual-Motor Delays/Disorders
- **c.** Traumatic Brain Injured
- **d.** School Readiness

4. On the WISC-IV Integrated, all of the tests below have a multiple-choice version of the WISC-IV test except for one. Which one?

- **a.** Similarities
- **b.** Vocabulary
- **c.** Block Design
- **d.** Coding

5. What WISC-IV Integrated test does not appear on the WISC-IV in an alternate form?

- **a.** Elithorn Mazes
- **b.** Similarities
- **c.** Vocabulary
- **d.** Coding

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. true; 2. b; 3. c; 4. d; 5. a; 6. d

Chapter 8

Clinical Interpretation Guidelines

In this chapter, a set of clinical interpretation guidelines for school neuropsychologists is presented. The chapter is divided into three sections. The first section presents some guidelines related to selecting a test or test battery. Topics in this first section include case conceptualization, 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 are discussed in this chapter are outlined in Rapid Reference 8.1.

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 prophecies, over- and underinterpretations 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

This section of the chapter reviews the basic principles of selecting a test or an assessment battery that relates to the referral question(s). Choosing a test or a set of tests starts with case conceptualization and ends with being knowledgeable of a wide variety of assessment instruments so a flexible test battery can be assembled.

Case Conceptualization

Ideally, the clinician does not want to overtest or undertest a student, but choose the optimal amount of assessment for the student. Advances in our knowledge base related to the known neuropsychological deficits associated with common neurodevelopmental disorders serve as a starting point when assembling test batteries. Test publishers and authors have done a better job of providing practitioners with suggested diagnostic batteries for various clinical groups based on validation studies (e.g., NEPSY-II).

Rapid Reference 8.1

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 undertesting.
- 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 underinterpretations and overinterpretations 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 interpretation model.

To improve efficiency and accuracy of assessment, it behooves the school neuropsychologist to be familiar with the known neuropsychological correlates of common childhood disorders, which helps the clinician assemble a targeted assessment battery. Books such as the *Handbook of Pediatric Neuropsychology* (Davis, 2011), *Essentials of School Neuropsychological Assessment: Guidelines for Effective Practice, Assessment, and Evidence-Based Interventions* (D. Miller, 2010), *Neuropsychological Assessment and Intervention for Childhood and Adolescent Disorders* (Riccio, Sullivan, & Cohen, 2010) all provide updated literature reviews on what neuropsychological processes are impaired and spared in childhood neurodevelopmental disorders. It is important for school neuropsychologists to continue to update their own knowledge base on the current research in the field of school and pediatric neuropsychology.

Don't Forget

The "art form" behind good clinical practice is knowing which assessment instruments to choose to ultimately answer referral questions and to provide useful information that helps guide prescriptive interventions.

Once a research-based test battery is administered, the patterns of student test performances are related back to the neuropsychological literature to determine if the patterns match the neurodevelopmental disorder(s) being assessed. School neuropsychologists need to have the cognitive flexibility to modify the assessment battery to address additional neuropsychological processing concerns that may not have been anticipated at the start of the evaluation but emerge as the initial test results are interpreted.

Relating the Assessment to the Referral Question(s)

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 one assessment battery to answer all referral questions. Practitioners need to be trained to administer a wide variety of assessment instruments or components of instruments and ideally should have access to those instruments within the schools.

Caution

Some assessment specialists only rely on 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).

Adopting a Flexible Approach to Assessment

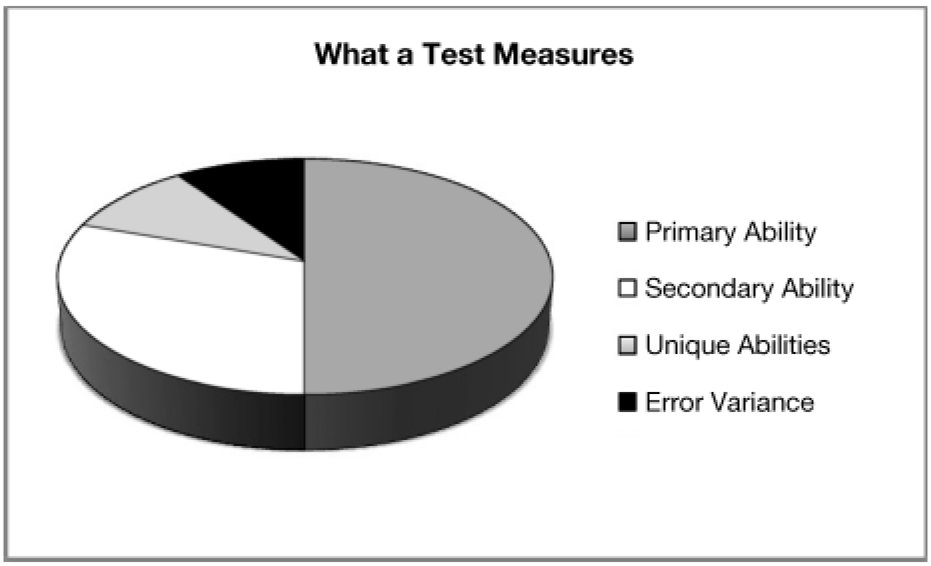
Assessment specialists (e.g., school neuropsychologists, school psychologists, educational diagnosticians, psychometrists) should be flexible during the assessment process itself. In the example earlier, the referral question is: “Why can't Johnny read?” An assessment specialist could plan an evaluation 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 children during testing or based on samples of their 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 here as primary and secondary abilities. An example would be the WJIII-COG Numbers Reversed Test (Woodcock, McGrew, & Mather, 2001, 2007a) that requires attentional capacity and working memory.

Figure 8.1 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 test score. If students achieve a low score on the WISC-IV Block Design (Wechsler, 2003) subtest because they were 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.

Figure 8.1 Conceptual Variables Measures by Any Test



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 aide 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.

Tests Reporting to Measure the Same Construct Sometimes Measure Something Different

A common misconception of practitioners is to assume that two tests that have the same process or skill in their title must measure the same construct. For example, on the surface it would make sense that the WISC-IV Processing Speed Index (Wechsler, 2003) and the WJIII-COG Processing Speed Cluster scores 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 the 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 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.

> **Caution**
>
> Brief measures of intelligence, achievement, or behavioral constructs should be viewed as screeners only and are not substitutes for a more comprehensive test battery.

In Chapter 2, the Single Test Approach characterizing the early neuropsychology practice is reviewed. Remember 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 decreased 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. Some students may only need the screener, while other students need more in-depth assessment.

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 the parent(s) or teacher(s) evaluation of the student. 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 student'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 parent's endorsement of a child's working memory problems. 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 only as 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.

> **Caution**
>
> 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.

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 working memory. The school neuropsychologist, administers Jerome a subtest that measures his memory for digits backward. Jerome achieved an average score on this subtest so Alicia concludes that Jerome has no working memory problems. What is wrong with this example?

In the example, the school neuropsychologist does not have enough assessment data to determine whether Jerome has a working memory problem. Jerome may have achieved an average score on a memory for digits backward task because of the small chucks of information to be manipulated in memory. Jerome may have difficulties with visual working memory, or with working memory of more complicated verbal stimuli. In Chapters 10 through 17, the basic cognitive processes and achievement areas are 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 two tests that purport to measure the same suspected deficit area as a means of verifying the deficit.

Historically in the practice of neuropsychology it was common to administer a single measure, such as the drawing of a Greek Cross, and to 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 visuospatial processing to validate the hypothesis of poor visuospatial constructive skills. Additional guidelines for data interpretation and analyses are presented in the next section. A final point must be made about overassessment. Assessment for the sake of assessment is never 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).

Don't Forget

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

This section of the chapter details the best practices in data analyses and clinical interpretations. Both quantitative and qualitative data are important to consider in the overall clinical picture of the student.

Ask How the Child Approached the Tasks

In Chapter 2, Historical Influences of Clinical Neuropsychology and School Psychology, 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 student 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 student, 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 student. After administering a test to a student in a standardized manner, ask the student what was easy and what was hard for the student to perform. Ask the student what could have been done to make harder tasks easier, and vice versa. Students 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” to best answer the referral questions.

> **Don't Forget**
>
> Too often assessment specialists are so concerned about administering a test in a standardized manner that they forget that a student 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 current school neuropsychologist explained the demands of the task, calmed Tonika by listening to her concerns, and told her to try her best on the task. Tonika performed the task and achieved an average score.

What does the vignette above tell us? Tonika had convinced herself, or had been convinced by a previous examiner, that she could not perform verbal memory tasks. Sometimes students 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 student, 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 student as a partner in discovering his or her neurocognitive strengths and weaknesses. Students need to be debriefed by the examiner at the conclusion of the evaluation about the results. Too frequently, students referred for a school neuropsychological evaluation have been told for years that they did not do well, discounting their strengths and developmental changes. Students need to be told about their neurocognitive strengths and taught methods to use those strengths to work around their neurocognitive limitations.

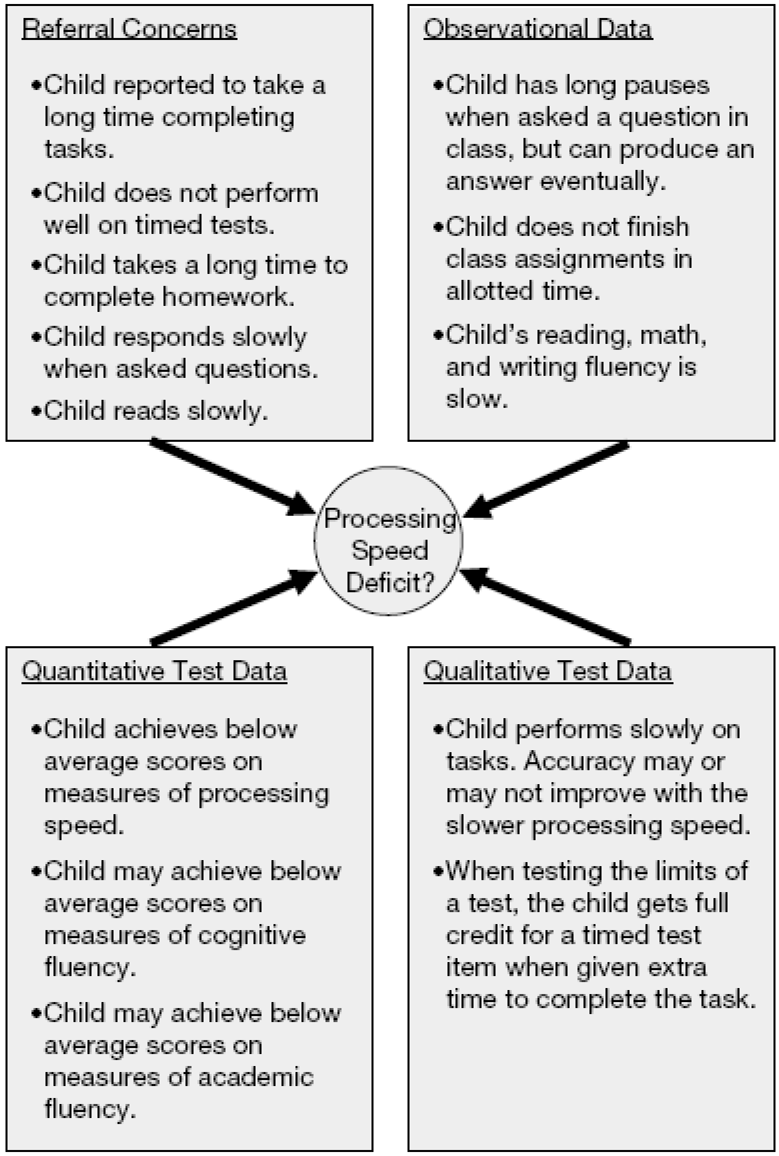
Integrating Reported Problems with Observable Behavior and Assessment Data

How often have assessment specialists (e.g., educational diagnosticians, school psychologists, school neuropsychologists) been relegated to a confined space (e.g., a supply closet, or 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 concerns of parents and teachers about the child's learning should be integrated within the current assessment findings. The *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth—Third Edition* (Miller, 2012, see the supplemental CD), 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 8.2 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.

Figure 8.2 A Vector Analysis Model for Clinical Interpretation



In the example presented in Figure 8.2, the data from the four sources converge 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 that 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 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.

As mentioned in the previous section, the school neuropsychologist must look for confirming trends in the data. In the earlier example there is not 100% 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 earlier example. When doing a task analysis of the tests administered, one reading test in which the child 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 Underinterpretation of 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 example above, Clifford may have memory problems that relate to long-term memory rather than working memory. As discussed in Chapter 12, Learning and Memory Cognitive Processes, 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 underinterpretation of the data.

Depth of Processing Interpretation Model

It is proposed that school neuropsychologists use a *depth of processing model* (see Figure 8.3) 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 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. 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. The first clinical interpretation case example provided in the next section illustrates why using only Level I interpretations 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). 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 be able 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.

Figure 8.3 Levels of Processing Interpretative Model for School Neuropsychologists

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 intra-subtest variability)	• Incidence of intra-subtest 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.

→ Consideration of noncognitive factors (e.g., motivation, fatigue), environmental, cultural factors that contribute to performance as each level.

→ Evidence-based interventions

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.

Rapid Reference 8.2

NEPSY-II Auditory Attention and Response Set Interpretative Examples

Test Scores	1	2	3	4	5
Part 1: Measures of Selective/Focused and Sustained Attention					
Auditory attention combined total: Selectively responding to auditory target words while ignoring auditory nontarget words over time.	(8)	(6)	(4)	(10)	(6)
Total commission errors: Responding to nontarget words that were to be ignored (more errors = lower % rank).	*3–10*	*26–75*	*≤ 2*	*26–75*	*26–75*
Total correct: Responding correctly to target words (more correct = higher scaled score).	(10)	(5)	(5)	(10)	(7)
Total omission errors: Missing target words (more errors = lower % rank).	*25–75*	*3–10*	*3–10*	*26–75*	*3–10*
Total inhibitory errors: Ignoring distracter words (more errors = lower % rank).	*3–10*	*26–75*	*26–75*	*26–75*	*3–10*
Part 2: Measures of Selective/Focused, Sustained, and Shifting Attention					
Response set combined total: Added shifting of attention while selectively responding to auditory target words while ignoring auditory nontarget words over time.	(9)	(7)	(5)	(6)	(10)
Total commission errors: Responding to nontarget words that were to be ignored (more errors = lower % rank).	*11–25*	*26–75*	*3–10*	*26–75*	*26–75*
Total correct: Responding correctly to target words (more correct = higher scaled score).	(11)	(6)	(6)	(7)	(10)
Total omission errors: Missing target words (more errors = lower % rank).	*25–75*	*3–10*	*3–10*	*3–10*	*26–75*
Total inhibitory errors: Ignoring distracter words (more errors = lower % rank).	*11–25*	*26–75*	*26–75*	*3–10*	*26–75*
Qualitative Behaviors					
Inattentive/distracted off-task behaviors	No	Yes *23%*	No	No	No
Out of seat/physical movement in seat off-task behaviors	No	Yes *14%*	No	No	No

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 two examples of data from case studies are presented to illustrate either the Levels of Processing Interpretative Model for School Neuropsychologists or the multiple causes of test behaviors.

Clinical Interpretation Examples

In Rapid Reference 8.2, five sets of test scores are presented from the NEPSY-II's (Korkman, Kirk, & Kemp, 2007) Auditory Attention and Response Set (AARS) test. This test is presented as an example to illustrate that reporting only one test score may not be enough to fully explain a student's performance on a test. For the reader not familiar with the AARS test, a quick review is needed. The AARS test is divided into two parts: (1) Auditory Attention, and (2) Response Set. For each part of the test, the student has a stimulus booklet page in front of them with four colored circles: black, red, yellow, and blue. After a brief practice period for each part, the student listens to a CD recording of an examiner reading one word per second over an extended period of time.

On the Auditory Attention part of the test, the student is instructed to touch, as quickly as possible, the red circle on the page after the word “red” is spoken. The student is taught to ignore all other color words. On the Response Set part of the test, the task becomes more difficult because the student is instructed to touch, as quickly as possible, the yellow circle when the word “red” is spoken, touch the red circle when the word “yellow” is spoken, and touch the blue circle when the word “blue” is spoken. The “red” and “yellow” word prompts require students to switch their cognitive set while the “blue” word prompt requires students to maintain an expected cognitive set.

For a correct response to a stimulus word to occur, the student has 2 seconds to touch the correct circle. A Combined Total score is calculated based on the total number of commission errors and total number of correct responses. The total number of omission errors (not touching the red circle within 2 seconds) and inhibitory errors (touching another color circle in response to the corresponding color word when instructed not to) are also recorded.

AARS Example 1—Too Many Commission and Inhibitory Errors Across Both Parts of the Test

The different levels of interpretation are illustrated in this first example.

Level 1 Analysis—Interpreting Global Scores

In this example, the student achieved a scaled score of 8 (10 is average with a standard deviation of 3) on the Auditory Attention Combined Score and a scaled score of 9 on the Response Set portion of the test. Some inexperienced clinicians may only present these two scores in a report and draw the incorrect diagnostic conclusion that the student did not have any performance difficulties on this task.

Level 2 Analysis—Interpreting Subtest Scores

The interaction between the four AARS test scores, total correct, commission errors, omission errors, and inhibitory errors, for each part of the test must be interpreted to fully understand how a student performed on this test. In this example on the Auditory Attention part of the test, the student achieved an average score for the total number correct (scaled score = 10) and paid attention throughout the tasks as reflected by an average score for the total omission errors (average percentile rank range of 25% to 75%). However, the student made many commission and inhibitory errors on the Auditory Attention part of the test. The student achieved below expected level percentile rank range scores (3% to 10%) for both the number of commission and inhibitory errors. These low scores reflect an impulsive response style without paying attention to the specific rules of the task; in this case, only touching the red circle in response to the word "red" while ignoring all other stimuli. This same impulsive style of responding while not maintaining the rules of the task was also evident in the Response Set portion of the test.

Level 3 Analysis—Interpreting Qualitative Behaviors

The AARS test yields two qualitative behaviors: (1) the number of times the student was inattentive/distracted or engaging in off-task behaviors, and (2) the number of times the student was out of the seat, or engaged in extraneous physical movements and was off task. In this first example, while the student did show an impulsive response style, no qualitative behaviors were noted. If the qualitative behaviors were noted in this first example, a diagnosis of ADHD Predominantly Hyperactive-Impulsive Type could be considered. Since these qualitative behaviors were not exhibited in this example, the clinician would want to rule out that the student fully understood the task (receptive language issues) or that the student was being oppositional or overly compliant (a behavioral issue), or that the student lost the cognitive set of what the task directions were (an executive dysfunction).

Level 4 Analysis—Error Analysis and Integration with Other Assessment Data

The student's performance on the AARS must be interpreted in light of the referral question, background information, formal and informal observations, and other assessment data. Determining if the student's impulsive response style was due to receptive language, behavioral issues, or executive dysfunction requires the clinician to integrate informal and formal data about the student (the vector analyses previously discussed in this chapter).

Level 5 Analyses—Understanding the Neurocognitive Demands of the Test

The Auditory Attention portion of the AARS requires the student to selectively focus attention on target stimuli while selectively ignoring nontarget stimuli. This portion of the test also requires sustaining attention over a prolonged period of time and response inhibition. The Response Set portion of the AARS requires all of these same attentional processes and the additional component of shifting attention or cognitive flexibility (e.g., touching the red circle in response to the word “yellow” or vice versa). Beyond these primary neurocognitive processes that are required to successfully perform this task, the test also requires, receptive language input and minimal fine motor coordination output. Non-neurocognitive factors of the student such as motivation, fatigue, and attitude may also factor into the overall test performance.

AARS Example 2—Student Distracted During the Test Causing Many Omission Errors, Few Correct, and Few Commission Errors

For the Example 2 AARS scores, the student achieved an Auditory Attention Combined Total scaled score of 6 on the Auditory Attention portion of the test and a scaled score of 7 on the Response Set portion of the test, both of which are in the slightly below average range of functioning (Level 1 analysis). For both portions of the test, the student had a low number of correct responses, a high number of omissions, and few commission errors. Behaviorally, the student frequently became distracted throughout each section of the test and did not respond to the stimuli items, which resulted in the low number correct and the high number of omissions. Commission errors were low because the student was not responding to anything including making errors (Level 2 analysis). The student did have both qualitative behaviors present: inattentive and hyperactive behaviors. The NEPSY-II provides base rates for these qualitative behaviors. In this example, only 23% of children the same age exhibited the same amount of inattentive/distracted off-task behaviors and only 14% of the children the same age exhibited the same amount of out of seat hyperactive behaviors (Level 3 analysis). The scores alone do not provide enough detail about the student's behavior during the test. The examiner would need to report the child's distractibility during the test in order to appropriately interpret the test results and integrate those results in light of the other case study data (Level 4 analyses). The neurocognitive demands of the test remain the same as outlined in Example 1 (Level 5 analyses).

AARS Example 3—Student with Slow Processing Speed Resulting in Many Omission Errors, Few Correct, and a High Number of Commission Errors

On the AARS test, the student has 2 seconds to touch a color circle in response to a stimulus prompt. Children with slow processing speed correctly touch the correct colored circle in response to the corresponding prompt but they do so outside of the 2-second window. As a result of this time delay in responding, the number of correct items is low and since the correct responses occurred late they count as commission errors. Students with this type of score pattern will not necessarily have the qualitative behaviors of inattention or hyperactivity, but rather just a slow response time. The clinician in these types of cases should look for confirmatory evidence of slow processing speed in other parts of the assessment.

AARS Example 4—Average Performance on Auditory Attention but Weaker Performance on Response Set

In this example, the addition of the shifting attention requirement is most probably the cause of the weaker performance on the Response Set portion of the test. The clinician should look for other evidence of a shifting attention deficit in the student from other assessment data, background information, and behavioral observations.

AARS Example 5—Weaker Performance of Auditory Attention and Stronger Performance on Response Set

In this example, the student performed better on the more challenging Response Set portion of the test. When this profile emerges it usually is indicative that the student was bored on the first part of the test and did not put forth good effort. However, when the task became more challenging, and perhaps more interesting, the student was able to marshal the cognitive resources needed to complete the task. Again, the clinician should look for other confirmatory evidence of this type of response style across other samples of behavior.

A danger in interpretation of any assessment data is not fully interpreting the results. In these AARS examples, if a clinician were to stop interpreting the test data at the first level, the full picture of how the student performed the tasks would be lost. Test authors and publishers have included supplemental and qualitative behaviors as part of their test batteries to reveal a more complete clinical picture of the student's performance.

In the next case study example, test data from the D-KEFS Trail-Making Test (Delis, Kaplan, & Kramer, 2001) is 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 14, Attention and Working Memory Facilitators/Inhibitors, 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 et al., 2001) sought to address some of these interpretative limitations by including five conditions (see Rapid Reference 8.3).

In Rapid Reference 8.3, the primary and secondary constructs for each of the D-KEFS trail-making test scores are presented. For example, in Condition 1—Visual Scanning, visual scanning and visual attention are the principle 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 principle construct being measured. Condition 4—Number-Letter Switching represents the major part of the test. All of the other conditions and contrast scores were designed to help interpret the child's performance on the number-letter switching condition. Figure 8.4 illustrates the contribution of conditions and contrast scores to the understanding of the number-letter switching condition.

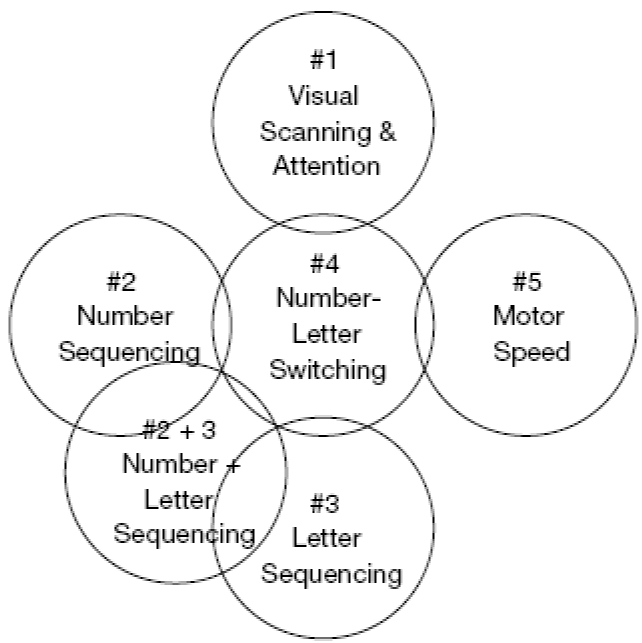
Rapid Reference 8.3

The D-KEFS Trail-Making Test Scores

Score	**Primary Measure Conditions**	**Secondary Measures**
Condition 1—Visual scanning	• Visual scanning • Visual attention	• Motor functions
Condition 2—Number sequencing	• Basic numeric sequential processing	• Visual scanning • Visual attention • Motor functions
Condition 3—Letter sequencing	• Letter sequential processing	• Visual scanning • Visual attention • Motor functions
Condition 4—Number-letter sequencing	• Shifting attention/cognitive flexibility/divided attention	• Visual scanning • Visual attention • Motor functions • Sequential processing
Condition 5—Motor speed	• Motor functions	• Visual scanning • Visual attention
Contrast Scores		
Condition 4 versus Condition 1	Contribution of visual scanning and attention to the performance on Condition 4.	
Condition 4 versus Condition 2	Contribution of number sequencing to the performance on Condition 4.	

Score	Primary Measure Conditions	Secondary Measures
Condition 4 versus Condition 3	Contribution of letter sequencing to the performance on Condition 4.	
Condition 4 versus Condition 2 + 3	Contribution of sequential processing in general to the performance on Condition 4.	
Condition 4 versus Condition 5	Contribution of motor output to the performance on Condition 4.	

Figure 8.4 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



The D-KEFS Condition 4 is considered a classic measure of executive functioning; however, as shown in Rapid Reference 8.4 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-TMT 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.
- Look to other measures to confirm motor impairment (e.g., Dean-Woodcock Neuropsychological Battery, WISC-IV Coding, NEPSY Visual-Motor Precision, WRAVMA Pegboard). See Rapid References 10.5 to 10.10 for a list of other measures of sensorimotor functions.

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, 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. See Rapid References 14.4 to 14.8 for a list of other measures of attentional facilitators/inhibitors.

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.

- Examine the D-KEFS-TMT Condition 1—Visual Scanning to determine if that is a significantly low score.
- Examine the Condition 4 (Number-Letter Switching) versus Condition 1 (Visual Scanning) contrast score.
- Examine other measures to confirm visual scanning deficits (see Rapid Reference 10.9 for a list of comparison tests).

Rapid Reference 8.4

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)	√	√	√	√	√

Language Deficits

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 16.9 for a list of other measures of receptive language.

Learning and Memory 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 14.9 for a list of other measures of working memory.

Executive Function Deficits

Condition 4 of the D-KEFS-TMT requires the student 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 student is exhibiting disproportionate impairment in cognitive flexibility relative to the other four baseline conditions (Delis et al., 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 13.10 to 13.11 for a list of other measures of executive functioning.

Speed and Efficiency of Cognitive Processing Deficits

Because 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 15.3 to 15.10 for a list of other measures of speed and efficiency of cognitive processing.

Intellectual/Academic Deficits

If students have 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 needs to verify this hypothesis by reviewing the results of measures of cognitive processing.

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, medications) 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 student 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 student, 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 student's teacher(s) and parent(s). Look for clues related to the noncognitive factors that could explain poor test performance. A student that has been diagnosed with major depression and has been prescribed an antidepression medication may appear lethargic and undermotivated. The psychological state of the student 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 4.6).

Environmental factors (e.g., Maslow's 1943 Hierarchy of Needs—A student who is hungry or fearing for his or her safety will not perform well on testing). If noncognitive factors are causing poor performance consider invaliding 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 them aware of the multiple explanations for human behavior. The sciences of psychology, school psychology, and school neuropsychology are still relatively young with 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 student's profile of neurocognitive strengths and weaknesses.

Chapter Summary

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 underinterpretations of the results, integrating reported problems with observation and assessment data, and the introduction of a *Levels of Processing Interpretative Model for School Neuropsychologists.*

Test Yourself

1. True or False? Most assessment specialists (e.g., school psychologists, educational diagnosticians, psychometrists) within the schools will stop at Level IV in their data analyses.

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 is related to analyzing?

a. Error analysis, informal samples, testing the limits, and so on.

b. Qualitative performance data, supplemental scores, process data, and so on.

c. Global Index/Factor Scores Only

d. Neuropsychological interpretation of the data

4. True or False? 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.

5. In the case study Example #2, poor performance on the D-KEFS Trail-Making Test, 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 is related to analyzing?

a. Error analysis, informal samples, testing the limits, and so on.

b. Qualitative performance data, supplemental scores, process data, and so on.

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 is related to analyzing?

a. Error analysis, informal samples, testing the limits, and so on.

b. Qualitative performance data, supplemental scores, process data, and so on.

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

Chapter 9

Case Study Illustration

In this chapter a comprehensive school neuropsychological report is presented, which illustrates the component parts of the Integrated SNP/CHC Model. The case study is of a 16-year 7-month old male in high school who is being diagnosed with a nonverbal learning disability as a result of this evaluation.

School Neuropsychological Evaluation

Identifying Information

Name of Student: John Doe	Date of Birth: 05/02/1999
Age: 16 years 7 mos.	Ethnicity of Student: Caucasian
School: No Name High School	Grade: 10
Parents: Mr. and Mrs. John Doe	Home Language: English

Reason for Referral

John's current language arts teacher expressed concerns regarding John's reading progress and difficulties with understanding and following certain directions/instructions. John struggles with reading words and understanding content, despite a strong work ethic and good effort. The special education teachers have followed up with skills testing using the READ 180 and Wilson Reading programs. Scores on these measures were very low, with John earning a 0% on the READ 180 Skills Survey. The teacher indicated that she has never had a student score a 0%. John's grades are very good, but are not reflective of having met grade level standards. Given John's continuing struggles with progressing academically, further investigation into possible neuropsychological contributors was deemed warranted.

Background Information

Family History

John is an only child living with both biological parents. The family has always lived in the surrounding metropolitan area. Mr. Doe is a plumber for an independent contractor with 2 years of college. Mrs. Doe earned her GED and she reported receiving special education services through junior high for difficulties with reading. Mrs. Doe has been a cafeteria worker for the school district for a number of years. The family is reportedly well adjusted with both parents and John confirmed a close relationship. According to his parents, John is rarely a discipline problem at home. His strengths are his level of patience and his willingness to try hard. Parents perceive his areas of difficulty being his lack of concentration and fine motor skills related to school. Parents also reported that John's mind frequently seems to wander.

Birth and Developmental History

John was born 1 month premature with low birth weight (4 lbs. 7oz.) and was jaundiced. He spent his first 10 days in the hospital due to an undeveloped sucking reflex and being fed with a tube, which continued for 4 days after going home. He crawled at 8 and a half months, walked at 13 months and was potty trained by 3 years of age. Parents reported that he had good gross motor skills, but experienced difficulties with fine motor skills, especially handwriting.

Health History

John suffered from high fevers (at times 104 degrees) as a toddler, and had ear infections and sinus headaches as a child. The frequency of the high fevers was not reported. No other illnesses were reported. John is nearsighted and has been wearing glasses since second grade. He takes no medications. There is a family history of diabetes, heart problems, and cancer.

Educational History

John has attended school in the No Name School District since beginning kindergarten. He attended one elementary school for grades Kindergarten through third grade, including a third grade retention. He was enrolled at a different elementary school in the district in fourth grade. The usual progression of schools through fifth and sixth grades and junior high was achieved. He received special education services beginning in first grade in the resource room for language arts and math. In junior high and high school, a special education study skills class was added. He also received speech/language therapy and occupational therapy until these services were discontinued in upper elementary grades. Currently four of seven of John's classes are in special education. Historically, teachers have reported that John has a tendency to become frustrated and will shut down for extended periods of time when he is upset. He is, and has been, a conscientious student, attempting to do his best. John typically seems to rush through tasks, appearing to be unaware of the quality of his work. This also is descriptive of his current approach to completing tasks when he does not know answers or is unsure as to how to proceed. His performance is much improved when he slows down with teacher-assisted cueing. John is intent on obtaining the credits needed to graduate with a regular high school diploma.

Educational Interventions (Response to Interventions)

John has been receiving special education services. These were READ 180 in eighth grade, Language Exclamation in ninth grade, repeating Level C of READ 180 during the first semester of the school year, and is currently placed in Wilson Reading and Step-Up-To-Writing programs. He is currently receiving math instruction in a Basic Math Class in the resource room, which addresses skills at a third to fourth grade equivalent. READ 180 was discontinued after achievement testing was conducted and indicated that the program did not match his auditory/verbal learning strengths. Even in special education, students progress through a predetermined schedule of classes, even if the grade is 1 percentage point above failing. If a class is failed, the student repeats that class. John has received accommodations from his regular education classes, which include extended time for assignment completion and test taking, having tests read aloud in a separate, quiet location such as the resource room, frequent comprehension checks, and the provision of class notes after effort has been demonstrated.

Previous Testing Results

A comprehensive school evaluation was last conducted when John was 9 years 8 months old and in his second year of thirdgrade. The evaluation consisted of ability, achievement, speech/language, and perceptual motor assessment. Cognitive assessment yielded a significant difference between verbal and nonverbal ability on the *Wechsler Intelligence Scale for Children—Third Edition* (Verbal Comprehension Index = 92; Perceptual Organization Index = 56; Freedom from Distractibility = 72). Achievement testing with the *Woodcock Johnson Test of Achievement-III* showed academic skills to approximate grade expectancies in word identification, math calculation, and spelling. Areas of difficulty included reading comprehension, written expression, and math word problem solving. After results of this evaluation were obtained, additional assessment in reading was requested by John's parents. The reading subtests of the *Wechsler Individual Achievement Test-II* (WIAT-II) yielded scores significantly below grade expectancies and were deemed to be an underestimate of his true skill levels because he reportedly did not try as hard as he could have. Both receptive and expressive language skills were significantly delayed, as were fine motor skills. It was hypothesized that his performance was better on novel language tasks because his attention was more focused. The Child Study Committee (CSC) determined that additional information was needed to assist in determining eligibility for special education.

A neuropsychological evaluation by a clinical neuropsychologist was subsequently contracted for and conducted a few months later while John was still 9 years old. The NEPSY (first edition) yielded the following categorical results: Attention SS = 70; Language SS = 60; Sensorimotor SS = 57; Visual Spatial SS = 52; Memory SS = 61. Scores reflected his struggle with visual-spatial information, as well as difficulty dealing with complex verbal information. The clinical neuropsychologist made the following *DSM-IV* diagnoses:

Axis I	ADHD—Inattentive type
Learning	Disorder associated with nonverbal learning disability
Axis II	Borderline intellectual functioning
Axis III	History of ear infections, high fevers
Axis IV	Learning problems

Current Assessment Instruments and Procedures

- Record Review, Parent Interview, Teacher Reports, Student Interview, & Classroom Observations.
- Conners Comprehensive Behavior Rating Scales (Conner's CBRS)
- Delis-Kaplan Executive Function System (D-KEFS)—Selected Subtests
- Developmental Test of Neuropsychological Assessment—Second Edition (NEPSY-2)
- Neuropsychological Processing Concerns Checklist for School Age Children and Youth—Second Edition (NPCC-2)
- Test of Memory and Learning—Second Edition (TOMAL-2)
- Woodcock-Johnson III, Tests of Achievement (WJIII-ACH) Normative Update
- Woodcock-Johnson III, Tests of Cognitive Abilities (WJIII-COG) Normative Update

Assessment Validity

At one point during the administration of the WJIII-ACH, testing was discontinued because it appeared that John was not putting forth optimal effort. This was based on his consistent approach to problem solving where he would rush through all items appearing not to give any thought to answers he provided. He was able to answer the beginning items of subtests; however, his rapid pace of responding did not vary as items increased in difficulty, answering all items without regard to whether his responses were related to the test items. It was explained to him that testing would resume later and the reason for stopping was to attempt to obtain valid results. He was informed that in no way was this meant to be punitive. Teachers and parent reported that John was upset about this for the entire day, remaining upset after he came home from school. On checking with teachers it was revealed that John frequently rushes through work and will slow down only when prompted, which does not consistently result in improved performance. After resuming testing the following day, John made an initial attempt to be more reflective, but this did not last throughout the remainder of testing. It appeared that John placed more value on rapidly completing the entirety of a task, rather than risking not completing a task by taking his time and examining his responses. Given the input from teachers, his behavior is not likely to have adversely affected test results.

Evaluation Results

Performance levels for all tests administered will be reported according to the following scale:

I. Classroom Observations

John was observed in his U.S. History class. It is a full class that includes the classroom teacher, the English Language Learner (ELL) teacher, a special education aide, and two ELL aides. There was much talking and commotion in the class, as well as a great deal of off-task behavior from several students. The CNN Student News Clip was shown at the beginning of the class. John, sitting in the front desk of one of five short rows facing the center of the room, was scribbling, coloring on paper, and only occasionally watching the clip when something appeared to spark his interest. He did not immediately begin working on his map, as directed by the teacher, after the clip ended, but neither did most of the other students. John accomplished little during the class period, because he spent the majority of the time soliciting help from both the teacher and the special education aide. He did attempt to complete a part of his map for a few minutes immediately following each individualized explanation. John frequently rubbed his head and eyes in apparent frustration and confusion. At one point he talked with his teacher about leaving out part of the assignment and was told that he would receive only partial credit, but also that the information would be needed for the upcoming test the following week. Class notes were disseminated to several students, including John who mentioned to the teacher and the aide that he had lost previous notes.

Table 9.1

STANDARD SCORE	SCALED SCORE	% RANK	NORMATIVE CLASSIFICATION	PROFICIENCY CLASSIFICATION	NEPSY-II SCALED SCORE	NEPSY–II % RANK	NORMATIVE CLASSIFICATION	PROFICIENCY CLASSIFICATION
> 129	> 16	> 98%	Superior	Markedly advanced	13–19	> 75	Above expected	Very proficient to markedly advanced
121–129	15	92–98	Well above expected	Advanced				
111–120	13–14	76–91	Above expected	Very proficient				
90–110	8–12	25–75	At expected	Proficient	8–12	26–75	At expected	Proficient
80–89	6–7	9–24	Slightly below expected	Inefficient	6–7	11–25	Slightly below expected	Inefficient

The teacher indicated that John does not understand concepts and needs everything to be explained to him. If it were not for the special education aide, he would be totally lost. John does leave the room to take tests and to have them read aloud for him. John expressed great frustration with the noise level in the class and how it interferes with his concentration. He mostly does not understand the information that is presented.

II. Basic Sensorimotor Functions

Sensory functions encompass our ability to process visual, auditory, kinesthetic, and olfactory information. Dysfunction in any single sensory system can have a dramatic effect on a student's learning capabilities and behavioral regulation. **Motor functions** encompass both fine motor skills (e.g., picking up or manipulating small objects, holding a pencil correctly, buttoning a button) and gross motor skills (e.g., walking in a balanced and coordinated manner, running, jumping, riding a bike).

Presenting concerns. The *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth—Second Edition* (NPCC-2) was completed by Mr. Doe [parent] and John's special education teacher. Current Sensory presenting concerns on the NPCC were as follows (T = teacher, P = parent):

Table 9.2

Sensorimotor Functions	Mild	Moderate	Severe
Auditory Functioning			
• Does not like loud noises.	P	T	
Motor Functions	**Mild**	**Moderate**	**Severe**
Motor functioning **Circle right (R), left (L) or both right and left (B) as applicable**			
• Poor fine motor skills (e.g., using a pencil). (L)		P T	

John's teacher reported that he will isolate himself from peers in the classroom when working independently, especially when there is much chatter and commotion occurring. Mr. Doe noted that John has fewer noise interferences at home. John enjoys hunting and is around guns frequently, which reportedly does not bother him. It is only when he needs to concentrate on academic tasks that he requires less noise according to his father. Both parent and teacher perceive fine motor skills, especially as related to handwriting, to be a moderate difficulty.

Current Levels of Functioning On the NEPSY-II Design Copying subtest John was asked to copy a number of increasingly more detailed and complex designs in a box beneath each design. He drew each design rapidly appearing not to take particular care as to the appearance of the designs. The low Design Copying Process Motor score indicates that difficulties with motor control interfere with accuracy of drawing. Poor fine motor coordination also adversely affects the accuracy of his graphomotor output. John commented that copying the designs was hard, especially as the designs became more detailed. He appeared to have little concern for the quality of his drawings as evidenced by lines that were not straight and crowding of details within the boundaries of designs. This impulsive approach to task completion has been noted on other tasks, as well as for completion of assignments in the classroom. Although he was able to recognize the overall configuration of the designs his difficulties with fine motor skills appear to impact his ability to correctly reproduce them. He did not consistently connect lines within designs and shapes were disproportionately drawn with regard to dimension and location indicating poor visuospatial ability. His speed of production may also have negatively impacted the quality of his drawings. These results have implications for his poor handwriting skills in relation to letter formation and spacing between letters and words. Consequently, copying from the board or book to paper will likely be difficult, as will expressing his thoughts or ideas on paper.

Table 9.3 Sensorimotor Functions.

Instrument—Subtest: Description	**Well Below Expected Level**	**Below Expected Level**	**Slightly Below Expected Level**	**At Expected Level**	**Above Expected Level**	**Well Above Expected Level**	**Superior**
Visual-Motor Integration Skills							
NEPSY-II—Design copying general score: Copying simple to complex designs on paper.		*2–5*					
NEPSY-II—Design copy process total: The fine motor contribution to the overall visual-motor task.	(1)						
• **Design copying process motor:** This score represents the motor output portion of the overall score.	(3)						
• **Design copying process global:** Ability to recognize the overall configuration of the design.	(1)						
• **Design copying process local:** Ability to recognize details of the design.	(3)						
Visual Scanning/Tracking: Direct Measure							
D-KEFS—Trail making condition 1 (visual scanning): Marking all the Number 3s on a page as quickly as possible.				(10)			
Visual Scanning/Tracking: Indirect Measures							
NEPSY-II—Picture puzzles total: A large picture divided by a grid with four smaller pictures taken from sections of the larger picture is presented. The student identifies the location on the grid of the larger picture from which each of the smaller pictures was taken.	(1)						

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

John does well when there are limited stimuli for which he needs to perform an operation, such as in Trail Making Condition 1. However, as detail and spatial orientation are added, visual scanning becomes far more difficult, and his ability to discern detail becomes impaired. In the classroom, finding information in passages with small print, or completing many math problems on a page could be overwhelming for John.

Sensorimotor functioning summary. John's father and the resource room teacher noted that noise interferences for John are directly proportional to the amount of work completion evidenced. Handwriting is an area of concern for both parties. Test results substantiate these concerns with regard to the speed and accuracy of motor output. As the complexity and amount of material increases the accuracy of his reproductions decreases. Legibility of handwriting or production of maps, for example, will be adversely affected with the increase of material required to be written or drawn. He will also require more time to complete tasks requiring increased amount of material. John will perform better when auditory distractions are minimized or when he is able to work in a quiet location away from noise in the regular classroom environment.

III. Cognitive Processes: Visuospatial Processes

For the purposes of this report, visual-spatial processes include *visual spatial perception* and *visual spatial reasoning*.

Presenting concerns. On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth—Second Edition* (NPCC-2) John's father and teacher reported the following concerns. John's father has ongoing concerns regarding John's handwriting, which the father relates to his perception that John experiences difficulty in copying notes from the board. He indicated that John tries to copy notes from the board quickly, which interferes with legibility. John's teacher sees mild difficulties here, primarily because he is given copies of notes allowing him to copy notes from the board at a more comfortable pace and reducing any stress related to being able to get down everything he needs to copy. Drawing and activities with puzzles are not a priority at school and thus are not observed. Both parent and teacher have concerns with handwriting legibility.

Table 9.4 Visuospatial Perception.

Instrument—Subtest: Description	Well Below Expected Level	Below Expected Level	Slightly Below Expected Level	At Expected Level	Above Expected Level	Well Above Expected Level	Superior
Visual Discrimination and Spatial Localization							
NEPSY-II—Arrows total: Two arrows from many are chosen by letter label, which are thought to point to the center of the target.	(1)						
NEPSY-II—Picture puzzles total: A large picture divided by a grid with four smaller pictures taken from sections of the larger picture is presented. The student identifies the location on the grid of the larger picture from which each of the smaller pictures was taken.	(1)						

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile rank ranges appear in *italics*.

Current Levels of Functioning John required repetition of the directions for the Arrows task, and even after three repetitions, he demonstrated limited reflection responding almost immediately with each presentation. He was required to find two lines from an array of lines, which pointed to the middle of a circle. Despite his seemingly impulsive approach, he was generally able to accurately identify one of the two lines. His low score does suggest poor visuospatial skills in judging line orientation. John's struggle with identifying geometric shapes requiring some degree of mental rotation is a weakness. Again, he was generally able to identify one of two required responses, despite demonstrating little reflection. Sustained attention and attentional capacity were problematic, since he quickly lost interest in this task. Part/whole visual perception and separating figure from ground within pictures is problematic. This was evidenced by his low score on Picture Puzzles where he was shown pictures of objects and landscapes then asked to correctly position specified parts of these on a grid. John did not enjoy this task, and as the details within the pictures increased he began to indiscriminately and inaccurately choose places on the grid. His performance here appears to be related to difficulties with attentional capacity as well as cognitive overload. John does experience difficulty in perceiving connections between parts when removed from a whole.

Table 9.5 Visuospatial Reasoning.

Instrument—Subtest: Description	**Well Below Expected Level**	**Below Expected Level**	**Slightly Below Expected Level**	**At Expected Level**	**Above Expected Level**	**Well Above Expected Level**	**Superior**
Recognizing Spatial Configurations							
WJIII-COG—Spatial relations: Identify two or more pieces that go together to form a complete target shape.	60						
Visuospatial Analyses with and without Mental Rotations							
NEPSY-II—Geometric puzzles total: A picture of a large grid containing several shapes is presented, then the student matches two shapes outside of the grid to two shapes within the grid.	(1)						

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile rank ranges appear in *italics*.

Summary of visual-spatial functioning. Visual perception appears to be intact for John; however, as visual complexities increase he experiences difficulty in perceiving and recalling details, which ultimately leads to problems with correct spatial positioning. Although he strives to maintain speed, the degree of accuracy suffers. There was little difference between his visual perception with and without motor involvement, although the fact that he was often able to recognize one of the required two correct responses on subtests requiring this, suggests that perceptual flexibility may be limited. Difficulties with spatial positioning may be influential here, which has implications for his difficulties in recreating details within designs. Not only will legibility of handwriting be problematic due to incorrect letter formation, but reading comprehension and written expression will likely be adversely affected, as well. John will have difficulties finding information in text to answer questions. The act of handwriting will become laborious causing him to focus more effort on putting words on paper, rather than on the content of what he writes.

Table 9.6 Auditory/Phonological Processing.

Instrument—Subtest: Description	**Well Below Expected Level**	**Below Expected Level**	**Slightly Below Expected Level**	**At Expected Level**	**Above Expected Level**	**Well Above Expected Level**	**Superior**
WJIII-ACH NU—Sound awareness: Rhyming, deletion, substitution, and reversal of phonemes.						124	
WJIII-COG NU—Incomplete words: Listening to a word with one or more missing phonemes and then identifying the whole word.				103			
WJIII-COG NU—Sound blending: Blending sounds to form a whole word.					118		

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile rank ranges appear in *italics*.

III. Cognitive Processes: Auditory Processing

We live in a highly verbal society; therefore, language skills are necessary for successful academic and behavioral functioning in school-age children.

Presenting concerns. On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth—Second Edition* (NPCC-2) John's father and teacher did not report any concerns in this area.

Current Levels of Functioning John's major strength is his knowledge of letter sounds and letter combinations for forming whole words. His skills are above expected level in these areas. John does prefer to read aloud, or whisper to himself as he reads because he recognizes words more readily if he hears that his pronunciations sound like words he knows. Allowing him to do this in the classroom by providing a study carrel or seating at a distance away from other students will facilitate more accurate reading of passages.

Summary of language functioning. Phonological processing is an outstanding strength for John, especially for sound awareness and sound blending.

Table 9.7 Memory and Learning Functions.

	Mild	Moderate	Severe
General learning efficiency			
• Difficulty learning verbal information.		T	P
• Difficulty learning visual information.	T		
• Difficulty integrating verbal and visual information.	T		
Long-term memory difficulties			
• Forgets where personal items or school work were left.	T		
• Forgets to turn in homework assignments.	T P		
• Forgets what happened days or weeks ago.			T

III. Cognitive Processes: Learning and Memory

Presenting concerns. On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth—Second Edition* (NPCC-2) John's father and teacher reported significant concerns regarding Memory and Learning functions.

Many concerns were noted by John's teachers regarding memory and learning functions, with fewer, although severe concerns, also noted by John's father. Difficulties with long-term memory impact his recollection of math facts and procedures, forgetting details of events, which occurred in the past, and forgetting to turn in assignments. Although he is noted to have difficulty with both, John's teacher indicates that he struggles more with learning verbal information than with visual information. Integrating verbal and visual information is mildly difficult for John according to his teacher.

Current Levels of Functioning

1. ***Overall memory index scores.*** The assessment data indicates that there is a similar development between verbal and nonverbal memory indices. John is better able to recall information immediately after presentation, than he is able to recall the same information after a time delay. This suggests that many verbal repetitions and information presented in sequence will facilitate recall. This requires a higher order of cognitive processing and integration. Associative memory is a relative strength for John and helps to explain how he remembers any type of information. Associations provide a cognitive link, whether visual or verbal that aids in retrieval. In contrast, the Free Recall Index represents his struggle to consolidate information into memory when there are no links provided. Because memory is a pervasive weakness for John, his Learning Index is below expected level. He will require the presentation of smaller chunks of information over an extended period of time.

Table 9.8 TOMAL-2 Memory Indices.

Index	Well Below Expected Level	Below Expected Level	Slightly Below Expected Level	At Expected Level	Above Expected Level	Well Above Expected Level	Superior
Verbal memory index		76					
Nonverbal memory index		74					
Verbal delayed recall index	66						
Composite memory index		75					
Supplemental indices							
Sequential recall index			83				
Free recall index	58						
Associative recall index			82				
Learning index		70					

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile rank ran.es appear in *italics*.

2. ***Rate of learning***

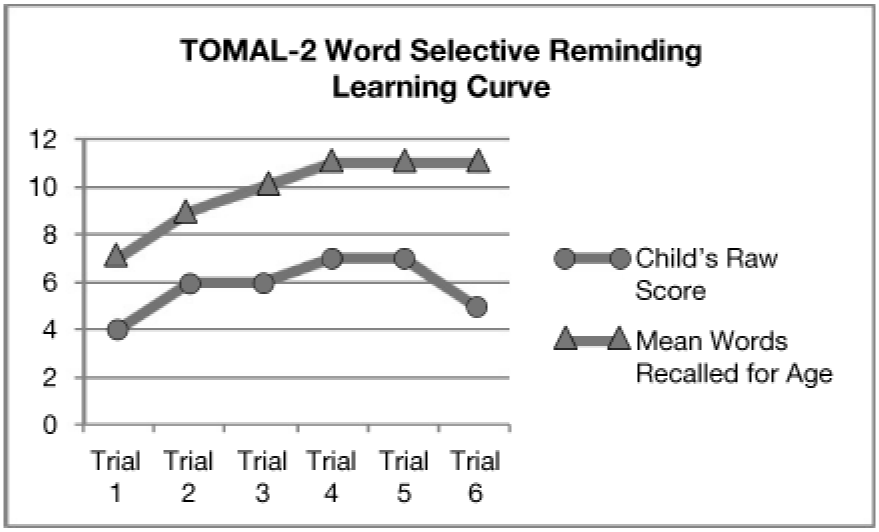
Figure 9.1 illustrates the benefit that John received from verbal reminders of words he forgot when recalling a list of twelve words over eight trials. He did not recall as many words as subjects in the normative sample for his age. His rate of learning was relatively comparable to that for the normative sample with a gradual upward slope, indicating benefit from reminders. By Trial 6 John had reached attentional capacity and he was able to recall only one more word without reminders as he had for Trial 1. His learning rate is slow, but steady until he reaches cognitive overload at which point his learning rate decreases. John demonstrates this in the classroom when he can encode information to a certain point, then reaches his limits. Frequent breaks may refresh his ability to benefit from instruction over an extended period of time.

Table 9.9 Rate of Learning.

Instrument—Subtest: Description	**Well Below Expected Level**	**Below Expected Level**	**Slightly Below Expected Level**	**At Expected Level**	**Above Expected Level**	**Well Above Expected Level**	**Superior**
Verbal Learning							
TOMAL-2—Word selective reminding: Learning a list of words then repeating it, and then only reminded of words left out.		(5)					

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile rank ranges appear in *italics*.

Figure 9.1 TOMAL-2 Word Selective Reminding Learning Curve



3. ***Verbal immediate versus visual immediate memory***. John struggles with both verbal and visual immediate memory, with or without context. Recalling factual information appears to be more problematic than fictional information, perhaps due to the interest level, or to the ability to better comprehend that which is presented. The more information presented the less he seems able to recall. The combination of visual, verbal, and motor associations may account for his average score for manual imitation. In the classroom, information to be remembered should be presented in smaller chunks. Using a multisensory presentation and presenting information in more than one way may also facilitate immediate memory.

Table 9.10 Immediate Verbal Memory.

Instrument—Subtest: Description	Well Below Expected Level	Below Expected Level	Slightly Below Expected Level	At Expected Level	Above Expected Level	Well Above Expected Level	Superior
Letter Recall (No Contextual Cues)							
TOMAL-2—Letters forward: Repeating a string of letters spoken by the examiner.			(7)				
Number Recall (No Contextual Cues)							
TOMAL-2—Digits forward: Repeating a string of digits spoken by the examiner.		(5)					
Word Recall (No Contextual Cues)							
TOMAL-2—Word selective reminding: Learning a list of words then repeating it, and then only reminded of words left out.		(5)					
Story Recall (With Contextual Cues)							
NEPSY-II—Narrative memory free recall: Details recalled from verbally presented stories.	(2)						
• **NEPSY-II—Narrative memory recognition:** Details recognized from verbally presented stories.		(4)					
• **NEPSY-II—Narrative memory free and cued recall:** Details recalled freely and with cues from verbally presented stories.		(4)					
TOMAL-2—Memory for stories: Details recalled from verbally presented stories.			(7)				

WJIII-ACH—Story recall: Details recalled from verbally presented stories.		79					
Immediate Visual Memory							
Abstract Designs With Verbal Response (No Contextual Cues)							
TOMAL-2—Abstract visual memory: Recalling geometric designs when order is not important.	(1)						
TOMAL-2—Visual sequential memory: Recalling a sequence of geometric designs.		(6)					
Faces with Verbal or Pointing Response (No Contextual Cues)							
TOMAL-2—Facial memory: Recognition and identification of faces.		(4)					
Spatial Locations with Motor Response (No Contextual Cues)							
TOMAL-2—Memory for locations: Remembering the locations of dots on a page.		(6)					
TOMAL-2—Visual selective reminding: Learning a pattern of dots then repeating it, and then only reminded of the dots left out.		(6)					
Visual Sequences Imitation with Motor Response (No Contextual Cues)							
TOMAL-2—Manual imitations: Copying the examiner's precise sequence of taps on the table.				(9)			

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

4. ***Delayed memory: Recall versus recognition***.

There is little difference between verbal immediate and delayed memory recall. A strength was demonstrated when John imitated hand movements presented by the examiner. The auditory association of the hand movements tapped on the table with the presence of gross motor functioning may provide an association for recall. Abstract visual immediate memory is well below expected level suggesting that he may be better able to recall more concrete information. He does not benefit from added context, placement of objects on a page, or sequenced information. Recall is facilitated when John needs to recall smaller chunks of information. Delayed memory is below expected level. Neither consistently provided reminders, nor added context, assist with information retrieval. Immediate and delayed memory deficits will be most noticeable when John takes tests requiring him to recall greater amounts of information presented over time. Performance will be enhanced if smaller chunks of material are presented over a shorter amount of time.

Table 9.11 Delayed Memory.

Instrument—Subtest: Description	Well Below Expected Level	Below Expected Level	Slightly Below Expected Level	At Expected Level	Above Expected Level	Well Above Expected Level	Superior
Verbal Delayed Recall (Without Context)							
TOMAL-2—Word selective reminding delayed: Delayed recall of the words learned in the Word selective reminding task.		(5)					
Verbal Delayed Recall (With Context)							
TOMAL-2—Memory for stories delayed: Delayed recall of story details.		(3)					

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

5. *Verbal-visual associative learning and recall.* John struggled with associating symbols for words in the absence of seeing the words to “read” sentences. He required many reminders of the words that the symbols represented as he progressed from sentence to sentence. The repetition did not appear to be of benefit. He performed somewhat better when there was a resemblance of the symbol to the word, such as for horse. His ability to recall the associated words with the symbols diminished as sentences increased in length. Combining visual and verbal associations appears to create confusion for John. There were numerous errors on delayed recall as well, but he did remember many of the “words” representing the symbols. He may have difficulty with reading words that are spelled differently, but sound the same. Recalling phonetically irregular words may be difficult, as well.

Table 9.12 Verbal-Visual Associative Learning and Recall.

Instrument—Subtest: Description	Well Below Expected Level	Below Expected Level	Slightly Below Expected Level	At Expected Level	Above Expected Level	Well Above Expected Level	Superior
Verbal Delayed Recall (Without Context)							
TOMAL-2—Word selective reminding delayed: Delayed recall of the words learned in the Word selective reminding task.		(5)					
Verbal Delayed Recall (With Context)							
TOMAL-2—Memory for stories delayed: Delayed recall of story details.		(3)					

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

Summary of memory functioning. These results present a comparison between the contributing factors of verbal and visual associations for assisting John with understanding information presented to best consolidate that information into memory. He appears to be better able to attach meaning through words than through visuospatial processing. John is very much aware of difficulties with memory as evidenced by the following analogy which he volunteered: “I can't hardly remember the information ... it's there for a few seconds ... it's like the nickel with the dot in front of the zero in front of the five. That's how long it lasts then it's gone.” This suggests that John is unable to remember information long enough to progress academically in any area at the same rate as his peers. Each aspect of memory assessed is below expected level and will significantly impact his ability to progress at a traditional rate to acquire credits for graduation. Teacher and parent concerns emphasize his need for repetition and reminders. He has trouble remembering multiple steps for problem solving and forgets details of past events. They do agree that verbal memory is stronger than visual memory.

IV. Cognitive Processes: Executive Functions

Executive functioning can be conceptualized into four broad areas: concept formation, problem solving and reasoning, qualitative behaviors, and behavioral/emotional regulation. Each of these broad areas has some relationship to the frontal lobes of the brain.

Presenting concerns. On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth—Second Edition* (NPCC-2) John's father and teacher noted the following behaviors:

Many concerns are noted by John's teacher regarding his difficulties with learning new concepts, learning from prior mistakes, organizational skills, time management, task initiation, impulsivity, irritability when frustrated and lack of common sense. John's father noted fewer concerns, but indicated that at home John has a set routine, and has parental guidance for most activities. John's ability to shift attention from one activity to another, although less problematic, has implications for difficulties in learning from prior experience.

Current Levels of Functioning

1. Cognitive Flexibility or Set Shifting

On the D-KEFS Verbal Fluency test, John was able to produce only a few words that switched between two semantic categories, but he was able to switch the limited words he did produce. On the NEPSY-II Inhibition test, John was not able to switch between the natural inclination to name a circle a “circle” rather than call it a “square” and vice versa. On the D-KEFS Trail-Making test, his ability to switch between letters and numbers was poor due to limited letter sequencing abilities and limited motor output fluency.

The low score for response set total correct reflects poor sustained attention during high cognitive load and multitasking in working memory. This suggests greater difficulties with the ability to shift attentional focus. As the cognitive requirements increase, John becomes more impulsive with his responding and attends less to stimulus content. John experiences difficulty with more complex mental processes. John will benefit from explicit instruction for one concept at a time.

2. Problem Solving and Reasoning

John's ability to identify, categorize, and determine rules for problem solving (inductive reasoning) and to analyze puzzles using symbolic formulations to determine missing parts (deductive reasoning) was very poor. John did not appear to understand the nature of Analysis/Synthesis and he impulsively provided any response. John tends to sacrifice accuracy for speed resulting in inefficient processing of information. Despite completing academic tasks rapidly, John will likely exhibit a lack understanding for content.

Table 9.13 Executive Functions.

	Mild	Moderate	Severe
Shifting or divided attention difficulties			
• Gets stuck on one activity (e.g., playing video games).	T		
• Difficulty transitioning from one activity to another.	T		
Planning difficulties			
• Difficulty making plans.	T		
• Quickly becomes frustrated and gives up easily.			T
• Difficulty sticking to a plan of action.	T		
Problem solving and organizing difficulties			
• Difficulty solving problems that a younger child can do.	T		
• Difficulty learning new concepts or activities.	P	T	
• Makes the same kinds of errors over and over, even after corrections.	P	T	
Behavioral/emotional regulation			
• Demonstrates signs of overactivity (hyperactivity).	T		
• Does not seem to think before acting.	P T		
• Difficulty following rules.	T		
• Demonstrates signs of irritability.	P	T	
• Lack of common sense or judgment.	T		

3. Response Inhibition

John was focused primarily on showing how quickly he could complete the inhibition tasks. He commented that the tasks would be easy, because he did not have to read anything. His low scores are generally reflective of uncorrected errors. It was as if he had built up a momentum and just "plowed through" as quickly as he could. On the Inhibition tasks he self-corrected only two errors. He made considerably more errors when required to switch between naming shapes/arrow directions to indicating the opposite of these. He demonstrated impulsive responding, and poor self-monitoring. His performance was better on the Color-Word Naming Inhibition task, seeming to be more focused on the accuracy of his responses. Cognitive flexibility appears to be an area of difficulty. John's teacher and observations during testing indicate that John has a tendency to rush through tasks often, which does result in incorrect answers and limited understanding of concepts.

Table 9.14 Shifting Attention.

Instrument—Subtest: Description	**Well Below Expected Level**	**Below Expected Level**	**Slightly Below Expected Level**	**At Expected Level**	**Above Expected Level**	**Well Above Expected Level**	**Superior**
Verbal Shifting Attention							
D-KEFS—Color-word interference condition 4—Inhibition/switching: Child switches back and forth between naming the dissonant ink colors and reading the words.			(7)				
D-KEFS—Verbal fluency condition 3—Category switching: Total correct responses: Switching between verbalizing fruits and pieces of furniture.		(6)					
• **Verbal fluency condition 3—Category switching total switching accuracy:** The correct number of switches between verbal categories.						100	
NEPSY-II—Inhibition: Switching combined: Rapidly and accurately name shapes while switching cognitive sets.	(3)						
• **Switching total completion time:** How quickly the task was completed (slower time = lower scaled score).		(4)					
• **Switching total errors:** Total errors made on the task (more errors = lower % rank).		*2–5*					
• **Switching uncorrected errors:** Errors with no attempt to correct (more errors = lower % rank).	*< 2*						
• **Switching self-corrected errors:** Errors that were self-corrected (more self-corrections = lower % rank).				*51–75*			

Visual Shifting Attention							
D-KEFS—Trails condition 4—Number-letter switching: A psychomotor task which requires switching between number and letter sequences (e.g., 1-A-2-B . . .).	(2)						
• **Trail-making condition 1 (visual scanning):** All of the number 3s on a page are marked as quickly as possible.				(10)			
• **Trail-making condition 2 (number sequencing):** Quickly connecting lines between consecutive numbers.				(11)			
• **Trail-making condition 3 (letter sequencing):** Quickly connecting lines between sequential letters.	(1)						
• **Trail-making conditions 2 and 3 combined:** Time taken across number and letter trials.		(6)					
• **Trail making condition 5—Motor speed:** Tracing a dotted line as quickly as possible.		(6)					
Verbal and Visual Shifting Attention							
NEPSY-II—AARS—Response set combined score: Added shifting of attention while selectively responding to auditory target words while ignoring auditory nontarget words over time.		(5)					
• **Response set total commission errors:** Responding to nontarget words that were to be ignored.			*11–25*				
• **Response set total correct:** Responding correctly to target words.		*2–5*					
• **Response set total omission errors:** Missing target words.			*11–25*				
• **Response set total inhibitory errors:** Ignoring distracter words.				*26–50*			

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

Table 9.15 Problem Solving, Planning, and Reasoning.

Instrument—Subtest: Description	Well Below Expected Level	Below Expected Level	Slightly Below Expected Level	At Expected Level	Above Expected Level	Well Above Expected Level	Superior
Inductive Reasoning							
WJIII-COG—Concept formation: Categorical reasoning and inductive logic.		71					
Sequential Reasoning							
WJIII-COG—Analysis/synthesis: General sequential (deductive) reasoning.	53						

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

Summary of executive functioning. John appears to be more reflective and takes more time to examine components of tasks when there are fewer cognitive demands. He responds rapidly and impulsively when overwhelmed with complex tasks, causing him to rush through things just to be done. He is more concerned with finishing an activity without regard to how well it is completed or whether he has understood how to do it or what knowledge can be gained. He does not take the time to plan strategies for problem solving and quickly becomes frustrated when expected to think things through. Visual and auditory distracters interfere with remembering directions once he encounters difficulty, which also inhibits retrieval of information from memory. He does not learn from previous errors, such that he cannot generate different strategies for solving the same problem. His mind tends to wander, as indicated by parents as being historically problematic. He has trouble organizing his thoughts and his time in relation to developing a plan for completing tasks with accuracy. John would benefit from being taught self- monitoring techniques to include more focus on information processing speed rather than task completion speed.

Table 9.16 Response Inhibition.

Instrument—Subtest: Description	Well Below Expected Level	Below Expected Level	Slightly Below Expected Level	At Expected Level	Above Expected Level	Well Above Expected Level	Superior
Verbal Response Inhibition							
D-KEFS—Color-word naming condition 3 (inhibition): Rapidly naming the color of the ink a color word ("red") is printed in. An inhibitory task.			(7)				
NEPSY-II—Inhibition combined: Rapidly and accurately naming the opposite names of shapes (e.g., "circle" for "square").	(3)						
• **Inhibition total completion time:** How quickly the task was completed.	(3)						
• **Inhibition total errors:** Total errors made on the task.	(3)						
• **Inhibition uncorrected errors:** Errors with no attempt to correct.	*< 2*						
• **Inhibition self-corrected errors:** Errors that were self-corrected.			*11–25*				

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

V. Cognitive Facilitators: Allocating and Maintaining Attention

Attention is a complex and multifaceted construct used when an individual must focus on certain stimuli for information processing. 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 a facilitator for all other higher-order processing. In other words, if attention is compromised it can adversely affect the other cognitive processes of language, memory, visuospatial skills, and so on. Attention can be divided into four subareas: selective/focused attention, shifting 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 ability to pay attention to relevant information while ignoring irrelevant 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. ***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. ***Sustained attention*** refers to the ability to maintain an attention span over a prolonged period of time. ***Attentional capacity*** refers to the child's ability to recall information ranging from small chunks (e.g., a string of numbers or letters), to larger chunks of information (e.g., list of unrelated words or sentences of increasing length and complexity), and to even larger semantically complex chunks of information (e.g., memory for stories).

Presenting concerns. The *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth—Second Edition* (NPCC-2) John's father and his special education teacher reported that John experiences difficulties with all aspects of attention. Perceptions of the degree of difficulty that John experiences are illustrated in the chart below.

Table 9.17 Attention Problems.

	Mild	Moderate	Severe
Selective or sustained attention difficulties			
• Seems to get overwhelmed with difficult tasks.		T	P
• Difficulty paying attention for a long period of time.	P	T	
• Seems to lose place in an academic task (e.g., reading, writing, math).		T	
• Mind appears to go blank or loses train of thought.		T P	
• Inattentive to details or makes careless mistakes.		P T	

John's teacher appears to have more concerns regarding all aspects of attention as defined in the introduction to this section. Each aspect of attention is required for academic and social success. John is perceived to be distracted by environmental sensory stimuli. This was particularly evident during the classroom observation in his history class. He demonstrates a short attention span and loses track of what is being discussed or may not know where to read when called on. Only John's teacher noted moderate concerns with his ability to pay attention to more than one thing at a time, such as taking notes while listening for key concepts as teachers lecture. Finally, attentional capacity is viewed by both parent and teacher as being a significant area of difficulty. He becomes tired and overwhelmed when information to be learned or retrieved from memory requires effort. As John commented in relation to completing certain tasks during testing, “my brain hurts.”

Current Levels of Functioning

1. *Selective/focused and sustained attention.*

John did appear to enjoy the tasks comprising each of these subtests. Auditory selective and sustained attention appears to be a relative strength for John when the tasks are reduced to one or two requirements. He needed to point to color shapes in a specified sequence presented verbally. He did well despite the addition of distracters added to the directions. He performed similarly on a task requiring him to peruse a number of small pictures on a page and to circle as many of a particular pair of pictures as he could find within a time limit. With both tasks the objective was clear; the motor output was minimal, requiring only pointing and circling pictures with a pencil. There was minimal environmental noise to interfere with concentration. John made few errors and only twice looked up from the auditory attention tasks on the NEPSY II. The novelty of the Auditory Attention task was interesting and challenging for him contributing to his ability to focus and sustain attention for a limited amount of time.

His performance on the Pair Cancellation subtest where he was required to circle as quickly as possible, all of the pairs of a ball and a puppy occurring together did contain several errors. John finished three seconds before the three minutes allotted was concluded, but he had five omission errors. There were no incorrect pairs circled.

Table 9.18 Selective/Focused and Sustained Attention.

Instrument—Subtest: Description	Selective	Sustained	Well Below Expected Level	Below Expected Level	Slightly Below Expected Level	At Expected Level	Above Expected Level	Well Above Expected Level	Superior
Auditory Selective/Focused and Sustained Attention									
NEPSY-II—Auditory attention combined: Selectively responding to auditory target words while ignoring auditory nontarget words over time.	X	X				(8)			
• **Auditory attention commission errors:** Responding to nontarget words that were to be ignored.	X	X				*26–50*			
• **Auditory attention total correct:** Responding correctly to target words.	X	X			*11–25*				
• **Auditory attention total omission errors:** Missing target words.	X	X			*11–25*				
• **Auditory attention total inhibitory errors:** Ignoring distracter words.	X					*26–50*			
Visual Selective/Focused and Sustained Attention									
WJIII-COG—Pair cancellation: Matching target stimuli from a large visual array under time constraints.		X			82				

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

2. *Attentional capacity.*

John's attentional capacity is diminished as the cognitive load increases. The addition of more information that needs to be retrieved appears to interfere with his ability to recall details. As noted by his parents and teacher, he tends to become overwhelmed with tasks containing too many details. He consequently avoids tasks that require a great deal of mental effort. Analogies or stories provided to assist with recalling information may be more interfering for him unless the content is brief and specifically related to the information. He will require much repetition to consolidate information into memory.

Summary of the cognitive facilitator of attentional processing. Auditory attention is an area of strength for John as long as environmental distractions and motor output are minimized. His speed and accuracy of responses is average to slightly below average given these conditions. The visual attention required for pair cancellation demonstrates a relative strength in focused and selective attention when auditory distracters are eliminated. Auditory working memory is also a relative strength in the absence of distracters, although as the cognitive load increases he makes more errors. As John reaches his attentional capacity limits, his focused, selective, and sustained attention diminishes. These factors relate to parent and teacher concerns regarding the increase of errors when auditory distractions increase, as well as difficulties in paying attention for long periods of time when cognitive load increases. The hyperactive behaviors noted by his parent and teacher are related to cognitive inattention more so than an acting out behavioral inattention. John will tend to rush through tasks in an effort to “fake good.” He will do this to look like he has understood what is required, but he has difficulty sustaining attention due to stretching his attentional capacity. His ability to retrieve information will be impaired as well.

Table 9.19 Attentional Capacity.

Instrument—Subtest: Description	Well Below Expected Level	Below Expected Level	Slightly Below Expected Level	At Expected Level	Above Expected Level	Well Above Expected Level	Superior
Memory for Numbers, Letters, or Visual Sequences							
TOMAL-2—Digits forward: Repeating auditorially presented digits of increasing length.		(5)					
TOMAL-2—Letters forward: Repeating auditorially presented letters of increasing length.			(8)				
Attentional Capacity for Stories (With Contextual Meaning)							
NEPSY-II—Narrative memory free recall: Recalling verbally presented story details.	(2)						
TOMAL-2—Memory for stories: Recalling verbally presented story details.		(5)					
WJIII-ACH—Story recall: Recalling verbally presented story details.		79					

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

VI. Cognitive Facilitators: Working Memory

Working memory is the active manipulation of information that is being held in immediate memory or information recalled from long-term memory. Working memory is classified as a cognitive facilitator because it is used frequently to help process higher order cognitive and academic tasks. Working memory can be measured using verbal or visual stimuli.

Presenting concerns. On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth—Second Edition* (NPCC-2) John's father and teacher reported significant concerns regarding Memory and Learning functions.

With regard to working memory, John requires many repetitions to follow directions, forgets information right after being presented, and has trouble remembering multistep directions. He does not remember steps involved with completing tasks, such as solving a math problem, and has trouble with summarizing narrative information.

Current Levels of Functioning

Summary of the cognitive facilitator of working memory. John was less engaged in the tasks for the TOMAL-2. By this time he was beginning to tire of being tested. He immediately responded with a string of numbers after hearing them, but generally the numbers did not include the actual numbers. Consequently, results of the TOMAL-2 are not a valid measure of his verbal working memory. He was more attentive for the WJIII-COG: Numbers Reversed, but errors began when a series of five numbers was presented for recall. He could only recall four numbers out of sequence. In contrast, despite the increased cognitive load, John's attention was well focused for Auditory Working Memory. He was able to separate the words from the numbers and to repeat them backward in sequence. His performance was sporadic, in that he would correctly repeat the words, not the numbers or would miss two items of a shorter series of numbers and correctly repeat a longer series. This suggests that there may be some kind of association that is unique to John to assist with recalling numbers and words in reverse order. This may be due to focused and sustained attention. When presented with vocabulary words, or states and capitals to be remembered, his working memory would be facilitated if unique references are also provided, or if a mnemonic approach to memory is employed.

Table 9.20 Learning and Memory Functions.

	Mild	Moderate	Severe
Working memory difficulties			
• Frequently asks for repetitions of instructions/explanations.		T	
• Trouble following multiple step directions.		P	T
• Loses track of steps/forgets what they are doing amid task.			T P
• Loses place in the middle of solving a math problem.		P	T
• Loses train of thought while writing.	P		T
• Trouble summarizing narrative or text material.			T P

Table 9.21 Working Memory.

Instrument—Subtest: Description	**Well Below Expected Level**	**Below Expected Level**	**Slightly Below Expected Level**	**At Expected Level**	**Above Expected Level**	**Well Above Expected Level**	**Superior**
Verbal Working Memory							
TOMAL-2—Digits backward: Repeating number strings in reverse order that were spoken by the examiner.		(5)					
TOMAL-2—Letters backward: Repeating letter strings in reverse order that were spoken by the examiner.		(4)					
WJIII-COG—Numbers reversed: Repeating number strings in reverse order that were spoken by the examiner.			82				
WJIII-COG—Auditory working memory: Repeating the name of the objects in sequential order, followed by the numbers in sequential order, after listening to an audio recording of a series of names of both objects and digits.			86				

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

VII. Cognitive Facilitators: Speed, Fluency, and Efficiency of Processing

Another cognitive facilitator that is frequently utilized in cognitive processes that are more automatic is speed, fluency, and efficiency of cognitive processing. This cognitive facilitator can be subdivided into four subcomponents: performance fluency (automatic processing of stimuli with no memory requirement), retrieval fluency (efficiency of memory retrieval), acquired knowledge fluency (rapid reading, writing, and math), and accuracy as a function of fluency or processing speed.

Presenting concerns. On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth—Second Edition* (NPCC-2), John's father and teacher reported significant concerns regarding Memory and Learning functions.

Table 9.22 Speed and Efficiency of Cognitive Processing.

	Mild	Moderate	Severe
Processing speed and fluency difficulties			
• Takes longer to complete tasks than others the same age.		T P	
• Slow reading that makes comprehension difficult.		P	T
• Homework takes too long to complete.		T	
• Requires extra time to complete tests.			T P
• Responds slowly when asked questions.	P	T	
Processing speed with accuracy difficulties			
• Does well on timed tests.			T
• Difficulty recalling information accurately and quickly.		T	P
Academic fluency			
• Slow and deliberate reader.		T	
• Takes a long time to write.	T		

John's father and teacher have significant concerns regarding the extended amount of time that John requires to complete assignments when effort is applied. He requires extra time for test taking, especially since he wants to do well. He is perceived as having a great deal of difficulty with reading, stumbling over words and needing to reread passages due to not getting the gist of what he reads the first time. Answers are not readily available when asked questions and he needs extra "think time." Parent concern is mostly that he needs the extra time in order to obtain good grades.

Current Levels of Functioning

1. ***Performance fluency*****.**

Results for the verbal fluency section are consistent with John's tendency to rush through tasks while being unaware of errors. Automaticity of naming letters and colors in isolation is a relative strength, however, when inhibitory and switching conditions are added his cognitive efficiency is slowed and error rates significantly increase. His speed of task completion slowed significantly when cognitive load increased, such that there appears to be difficulty with processing speed, which adversely affects verbal fluency. John's attention was well focused during these subtests, with good adherence to following directions. John may have difficulty with math computation of mixed problems on a given assignment due to difficulties in noticing a change in signs. He will require extended time when new concepts are introduced which requires the assimilation of new information with previously learned information.

2. ***Retrieval fluency*****.**

John demonstrates relative strengths for both verbal and nonverbal retrieval. As noted in his performance on other tasks, he tends to do well when he is provided with limited amounts of information, as in generating lists of words beginning with a specified letter or category or in generating designs based on only one type of dot.

His slightly lower score on Verbal Fluency Condition 2 may reflect a higher order thinking process in that he needed to cluster words into a category as opposed to just naming unrelated words beginning with a designated letter. Nonetheless, there was little difference between his ability to quickly produce words and designs. It is also apparent, however, that his speed of production slows when he is required to focus on a task when distracters are added. An example of this in the classroom might be when he is performing a math fluency task. He will likely perform better on a page of all addition problems than on a page with mixed operations.

John showed little forethought in completing the fluency tasks; however, this appears to have been a benefit since he was able to more rapidly complete the task. On the Decision Speed test, John made no errors while matching two pictures within a row belonging to a category; however, he completion speed was slow.

Table 9.23 Performance Fluency.

Instrument—Subtest: Description	**Well Below Expected Level**	**Below Expected Level**	**Slightly Below Expected Level**	**At Expected Level**	**Above Expected Level**	**Well Above Expected Level**	**Superior**
Perceptual Fluency							
WJIII-COG—Visual matching: Rapidly matching two numbers on a row.		73					
Figural Fluency							
D-KEFS—Design fluency condition 1 (filled dots): Connects filled dots to create as many different designs as possible in 60 seconds.			(6)				
D-KEFS—Design fluency condition 2 (empty dots): Connects empty dots to create as many different designs as possible in 60 seconds.				(8)			
• Design fluency structured array			(7)				
• Design fluency random array		(5)					
Naming Fluency (Rapid Automatized Naming)							
D-KEFS—Color-word interference condition 1 (color naming): Naming the color of colored squares rapidly.			(7)				
D-KEFS—Color-word interference condition 2 (word reading): Naming color words (e.g., "red") rapidly.			(8)				
NEPSY-II—Inhibition: Naming combined: Rapidly and accurately name shapes.	(2)						

• **Naming total completion time:** How quickly the task was completed.	(3)				
• **Naming total errors:** Total errors made on the task.		*2–5*			
• **Naming uncorrected errors:** Errors with no attempt to correct.	*< 2*				
• **Naming self-corrected errors:** Errors that were self-corrected.				*51–75*	
NEPSY-II—Speeded naming combined scaled: Rapidly naming attributes of objects or a series of numbers and letters.		(5)			
• **Speeded naming total completion time:** How quickly the task was completed.			(7)		
• **Speeded naming total correct:** How accurately the task was completed.		*2–5*			
• **Speeded naming total self-corrected errors:** Awareness of errors made on the task with self-correction.				*51–75*	
WJIII-COG—Rapid picture naming: Rapidly naming common pictures.		73			

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics.*

3. ***Acquired knowledge fluency.***

All of the acquired knowledge fluency measures were below expected level for a student his age. Writing fluency was low in part because he did not apply capitalization or punctuation consistently in his sentences. Many items were not complete sentences and words were incorrectly utilized to form sentences.

4. ***Accuracy as a function of fluency***.

Completion time scores by themselves are not always accurate predictors of processing speed because sometime a student slows down to improve accuracy. The number of errors in combination with the task completion time must be interpreted in tandem. Despite John's slowing down, his accuracy did not improve across multiple measures, which is usually indicative of low ability in the tested area.

Table 9.24 Retrieval Fluency.

Instrument—Subtest: Description	**Well Below Expected Level**	**Below Expected Level**	**Slightly Below Expected Level**	**At Expected Level**	**Above Expected Level**	**Well Above Expected Level**	**Superior**
Word Fluency							
D-KEFS—Verbal Fluency—Condition 1 (letter fluency): Naming as many words within a time limit that start with a specific letter.				(9)			
Semantic Fluency							
D-KEFS—Verbal Fluency—Condition 2 (category fluency): Naming as many words within a time limit that all fall in the same category (e.g., fruits).			(7)				
WJIII-COG—Decision speed: Rapidly matching two pictures in a row that belong in the same category.		76					

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

Summary of speed, fluency, and efficiency of cognitive processing. Processing speed is an area of difficulty for John regardless of the academic or cognitive task; however, it would appear that when the cognitive load increases cognitive efficiency becomes significantly impaired. This would be apparent in his need for extended time in taking tests and completing assignments, as well as in utilizing short-term memory to respond to questions about material just reviewed.

VIII. Acquired Knowledge

Acquired knowledge is different from cognitive processes or cognitive facilitators. Acquired knowledge is the learning of useful information (acculturation knowledge), development of language abilities, especially vocabulary, and learning academic skills associated with reading, writing, and mathematics.

Table 9.25 Acquired Knowledge Fluency.

Instrument—Subtest: Decription	**RPI**	**Well Below Expected Level**	**Below Expected Level**	**Slightly Below Expected Level**	**At Expected Level**	**Above Expected Level**	**Well Above Expected Level**	**Superior**
Reading fluency: Rapidly reading short, simple sentences and circles yes or no if they make sense over a 3-minute interval.	25/90		71					
Writing fluency: Producing, in writing, simple sentences that are legible.	17/90	61						
Math fluency: Solving simple math problems quickly.	57/90	68						

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

Current Levels of Functioning

1. ***Acculturation knowledge***.

Retrieval of encyclopedic information is low due to initial problems with encoding the information. The score for Verbal Comprehensions is elevated due to John's more accurate performance on the Picture Vocabulary subtest (one of four components of the subtest). His knowledge of synonyms, antonyms, and verbal analogies was weak. His approach to providing answers for General Information was rushed, with answers frequently unrelated to the items. He provided an answer to each item, but accuracy was poor. It is apparent that this is an area of difficulty.

2. ***Language abilities***.

On each one of these subtests John did well on initial items. Based on this performance he did understand the directions and maintained cognitive set throughout for both the Understanding Directions and the Comprehension of Instructions subtests. Understanding Directions required John to point to pictured objects in a given order delivered orally on a cassette recording. He made increasingly more errors as the number of pictures to which he was required to point in sequence increased. He was unable to remember each of the directions. He did well with understanding and following directions on Comprehension of Instructions. There were fewer directions to recall, as in the former subtest, which contributed to more accurate performance. Two errors appeared to be due to vocabulary interference. In one item he was directed to “point to the shape that is diagonal to...” and in another item directions were to “point to a shape adjacent to...”. He did not appear to know the meanings of diagonal or adjacent. Another error was due to starting on the left rather than the right as stipulated in the directions, although he accurately followed the remainder of the directions. With Oral Comprehension he again started out well, but as the difficulty of items increased he began to give any answer, many of which were unrelated to the specific item. He was unable to retrieve the appropriate word to complete passages, which were read to him. Both parent and teacher noted difficulties with John finding the right words, and in having trouble understanding verbal directions. These results indicate that as long as John has few directions to follow containing vocabulary that he understands, he will do well.

Table 9.26 Semantic Memory.

Instrument—Subtest: Description	Well Below Expected Level	Below Expected Level	Slightly Below Expected Level	At Expected Level	Above Expected Level	Well Above Expected Level	Superior
Verbal Comprehension							
WJIII-COG—Verbal comprehension: Four parts (picture vocabulary, synonyms, antonyms, and verbal analogies) that measures semantic memory.			82				
General Information							
WJIII-COG—General information: Depth of verbal knowledge based on "where" and "what" questions.		72					

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

3. ***Academic achievement*.**

***Presenting concerns*.** On the *Neuropsychological Processing Concerns Checklist for School-Aged Children & Youth—Second Edition* (NPCC-2) John's father and teacher reported significant concerns regarding academic achievement. Many concerns in all aspects of John's academic functioning were noted by both parents and teachers, but concerns were most severe related to John's understanding of math concepts. He often overlooks signs in math problems, does not know math facts, and "forgets" how to do basic borrowing and carrying. He seems unable to make sense of story problems. Handwriting is frequently difficult to decipher, especially when John is distracted or disinterested. Letter formation is large with excessive spacing between words. Vocabulary, spelling and grammar are significant areas of difficulty. John has trouble transferring his thoughts to paper. John's teacher reports that spelling is a relative strength for familiar words. John dislikes reading due to struggles with understanding what he reads and recalling detail from passages read. He also has difficulty with word identification, which causes reading to be slow and laborious.

Table 9.27 Language Abilities.

Instrument—Subtest: Description	Well Below Expected Level	Below Expected Level	Slightly Below Expected Level	At Expected Level	Above Expected Level	Well Above Expected Level	Superior
Vocabulary Knowledge							
WJIII-ACH—Picture vocabulary: Naming pictured objects.		80					
Receptive Language							
NEPSY-II—Comprehension of instructions total: Respond quickly to verbal instructions of increasing complexity.				(8)			
WJIII-ACH—Oral comprehension: Listening to passages and then orally providing a one-word response to fill in a missing last word.		78					
WJIII-ACH—Understanding directions: Pointing to various objects in a picture after listening to a sequence of recorded instructions.		77					

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

Table 9.28 Academic Functions: Reading.

	Mild	Moderate	Severe
Reading decoding difficulties			
• Over relies on sounding out most words when reading, even familiar words.		T	P
Reading comprehension difficulties			
• Difficulty understanding what is read.			T P
• Difficulty identifying main elements of a story.			P
• Appears distracted while reading.	P	T	
• Misses important details while reading.		P	T
Reading: Attitudinal issues			
• Avoids reading activities.	P	T	
• Appears anxious/uptight/nervous while reading.	P	T	
• Shows no interest in reading for information or pleasure.		T	P

Current Levels of Functioning

Summary of acquired knowledge. John's acculturation knowledge is weak for someone his age. He is having difficulty storing new long-term memories into his encyclopedic knowledge. John also has some difficulties with oral expression and receptive language skills. John struggles in all aspects of achievement. Although below expected level, he has relative strengths in sounding out letter combinations and in reading words in isolation. Reading fluency is similarly developed. He relied heavily on his fingers and touch-point math for figuring problems on the math calculation subtest. Effort did not appear to be focused with some opposition observed when he refused to show his work despite several requests for him to do so. He wrote words rapidly on the spelling subtest and did not finish several words because he was uncertain of the correct spelling. John's handwriting was difficult to read with large letter formation and inconsistent spacing between words. He wrote very rapidly. Oral reading consisted of omitted words and miscalled words. He did not pay attention to punctuation within sentences while reading. When queried about incorrect responses for providing missing words within sentences, he would not admit that his answers did not make sense, and made no attempt to provide a different answer.

Table 9.29 Academic Functions: Writing.

	Mild	Moderate	Severe
Writing: Spatial production difficulties			
• Demonstrates uneven spacing between words and letters.	P		T
• Trouble staying on the lines.			T
• Others have difficulty reading what the child has written.			T
• Trouble forming letters and words.	T	P	
• Writes overly large letters and words.			T
Writing: Expressive language difficulties			
• Limited vocabulary for age; uses lots of easy words.	P		T
• Difficulty putting ideas into words.	P	T	
• Uses simple sentence structure and lacks variety.			T
• Produces poor spelling in writing.			T P
• Poor grammar in writing.			T P
Writing: Graphomotor output difficulties			
• Difficulty holding the pencil or pen correctly.	T		
• Presses too soft with the pencil/pen while writing.	T		
• Shows preference for printing over cursive writing.			T
• Has trouble coming up with topics to write about.	T		
Writing: Attitudinal issues			
• Avoids writing activities.		T	P
• Appears anxious/uptight/nervous while writing.	T P		

IX. Social-Emotional Functioning and Adaptive Behaviors

Presenting concerns. John's language arts teacher from the previous school year expressed concerns about the lack of progress that John had demonstrated in reading. This was corroborated by the READ 180 skill testing on which he earned a 0%. Parents were less concerned about this because his grades were very good due to his excellent effort. John's parents and teacher have noted difficulties with math concepts. Again, his grades are good because of his good work ethic and placement in a special education math class. Parent noted, however, that John tends to internalize anything he perceives as criticism and worries excessively about this for extended periods of time. His current resource room teacher has noted that John has a tendency to "wear his heart on his sleeve."

Table 9.30 Academic Functions: Mathematics.

	Mild	Moderate	Severe
Mathematical computational and procedural difficulties			
• Forgets what steps to take when solving math problems (e.g., carrying in addition or borrowing in subtraction).			T P
• Makes careless mistakes while solving math problems.			T P
• Does not always pay attention to the math problem signs.			T
Mathematics: Verbal difficulties			
• Difficulty with retrieval of basic math facts.			T P
• Difficulty solving story problems.			T
Attitudes toward mathematics			
• Appears anxious/uptight/nervous when working with math.	T		
• Avoids math activities.	T		

Current levels of functioning. Each *Conner's Comprehensive Behavior Rating Scales* (CBRS) was rated with four responses (not true at all, just a little true, pretty much true, and very much true). Raw scores obtained are converted to T-Scores for interpretation. T-Scores have a mean (average) of 50. In general, higher T-Scores are associated with a greater number and/or frequency of reported problems. Caution: Please note that T-score cutoffs are guidelines only and may vary depending on the context of assessment. T-scores from 57 to 63 should be considered borderline and of special note because the assessor must decide (based on other information and knowledge of the youth) whether the concerns in the associated area warrant clinical intervention.

1. CBRS Content Scales: Detailed Scores

The following tables summarize the results of the teacher's and parent's assessment (F = father and T = teacher).

The Response Scale Analysis revealed no overly positive or negative response styles, nor was there an indication of an inconsistent response style, thus substantiating the validity of these results. Both parent and teacher ratings on the CBRS Rating Scales concurred regarding significant problems with learning and understanding material specific to reading, written expression and math. Both raters also had scores in the high average range for social anxiety. This is mainly in relation to the anxiety experienced as a result of excessive and prolonged worrying when he perceives certain events as criticism. This adversely affects concentration until he resolves the issue for himself. John's teacher's perception is that John is somewhat shy, becoming quiet and reserved during interactions around those with whom he does not yet feel comfortable. Mr. Doe's high average score for hyperactivity/impulsivity is mostly related to John's worrying tendencies and the fact that he will often impulsively make comments not appropriate to the situation when he feels anxious. There are no physical manifestations such as fidgeting or moving around in his seat.

Table 9.31 Academic Achievement.

Instrument—Subtest: Description	RPI	Well Below Expected Level	Below Expected Level	Slightly Below Expected Level	At Expected Level	Above Expected Level	Well Above Expected Level	Superior
Basic Reading Skills								
WJIII-ACH—Letter-word identification: Reading words in isolation.	22/90			81				
WJIII-ACH—Word attack: Reading phonetically regular nonsense words orally.	37/90			81				
Reading Comprehension								
WJIII-ACH—Passage comprehension: Reading a passage silently and provides the missing word.	27/90	66						
WJIII-ACH—Reading vocabulary: Orally producing synonyms, antonyms, or verbal analogies	10/90	63						
Written Expression								
WJIII-ACH—Writing samples: Producing meaningful written sentences.	33/90	62						
Mathematical Calculations								
WJIII-ACH—Calculations: Performing a variety of math calculations.	7/90	57						
Mathematical Reasoning								
WJIII-ACH—Applied problems: Analyzing and solving practical math problems.	0/90	45						

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

Table 9.32

T-Score	Guideline

T-Score	Guideline
70+	Very elevated score (Many more concerns than are typically reported)
60–69	High average score (Slightly more concerns than are typically reported)
40–59	Average score (Typical levels of concern)
< 40	Low score (Fewer concerns than are typically reported)

2. DSM-IV-TR Symptom Scales

The following table summarizes the results of the parent's and teacher's assessment with respect to the *DSM-IV-TR* symptom scales (other than the ADHD scales reported in the Attention section of this chapter), and provides general information about how he compares to the normative group.

John's parent and teacher ratings indicate no problems with conduct disorder or oppositional defiant disorder. John's father does indicate that John can be stubborn at home. It is sometimes difficult to convince him to look at situations from another point of view. After time and persuasion, John can be convinced to change his perceptions or to go forth without judgment. His teacher also notes a degree of stubbornness in John, but she describes him as cooperative, hardworking, striving to do his best.

These results indicate that John's teacher has observed significantly more behaviors related to ADHD Inattentive Type than has either John or his father. The behavioral raters noted that John had difficulties with failure to pay attention to details or with making careless mistakes. Parent and teacher ratings agreed that John often has difficulty organizing tasks and activities. Teacher ratings further endorsed John's difficulties with sustaining attention to task, often appearing not to listen when spoken to directly; often has difficulty with organizing tasks; is distracted by outside stimuli and forgetful in daily activities. The teacher also observes that John avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework). Parent and teacher ratings yield scores in the high average range specific to fidgeting or squirming in his seat, he appears to be restless or to act impulsively. Perception of the teacher was that John often interrupts or intrudes on others as in butting into conversations.

Table 9.33 Conners Comprehensive Behavior Rating Scales (CBRS)

Content Scales	Low Score <40 T	Average Score 40–59 T	High Average Score 60–69 T	Very Elevated Score 70 T+
Hyperactivity/impulsivity: High activity levels, may be restless, may have difficulty being quiet.			F, T	
Emotional distress: Worries a lot (including possible social and/or separation anxieties), may show signs of depression or may have physical complaints; may have rumination.		F, T		
Upsetting thoughts/physical symptoms (ED subscale): Has upsetting thoughts and/or ruminations. May complain about physical symptoms; may show signs of depression.		F, T		
Worrying (CRBS-P) (ED subscale): Worries a lot, including anticipatory and social worries. May experience inappropriate guilt.			T	F
Social problems: Socially awkward, may be shy; may have difficulty with friendships, poor social connections, limited conversational skills; may have poor social reciprocity.		F	T	
Social anxiety (CRBS-T) (ED subscale): Worries about social and performance situations; worries about what others think.			F, T	
Defiant/aggressive behaviors: May be argumentative; may defy requests from adults; may have poor control of anger or may lose temper; may be physically and/or verbally aggressive; may show violence, bullying, and destructive tendencies; may seem uncaring.	F	T		
Academic difficulties (AD): Total: Problems with learning and/or understanding academic material. Poor academic performance.				F, T

Language (AD subscale): Problems with reading, writing, and/or language skills.				F, T
Math (AD subscale): Problems with math.				F, T
Hyperactivity/impulsivity: High activity levels, may be restless, may have difficulty being quiet.		T	F	
Perfectionistic and compulsive behaviors: Rigid, inflexible. Has repetitive behaviors. May become "stuck" on a behavior or idea at times. May be overly concerned with cleanliness.	F	T		
Violence potential: At risk for acting violently.	F, T			
Physical symptoms: Complains about aches, pains, or feeling sick; may have sleep or weight/appetite issues.	F	T		

John's low scores suggest significant deficits in social perception. Deficits in Theory of Mind reflect problems with taking the perspective of others into account or understanding the intentions of others. As a result, he may misinterpret remarks or comments from others intended to be joking or playful, attaching a negative connotation instead. Misperceptions here likely contribute to his feelings of anxiety and worry when he believes that he has been criticized or discounted. Both parent and teacher have noted his stubbornness in letting go of perceived slights. John put little thought into his answers on this subtest, and at times responded according to aspects in the pictures associated with the items. Reflection related to the feelings of the characters in the pictures appeared to be somewhat lacking.

Table 9.34 Conners Comprehensive Behavior Rating Scales (CBRS): *DSM-IV TR* Symptom Scales.

DSM-IV-TR **Symptom Scales**	**Low Score < 40 T**	**Average Score 40–59 T**	**High Average Score 60–69 T**	**Very Elevated Score 70 T+**
Conduct disorder	T	F (2)		
Oppositional defiant disorder		F, T		
ADHD predominantly inattentive type			F (2), T (4)	

Table 9.35 Social Perception.

Instrument—Subtest: Description	**Well Below Expected Level**	**Below Expected Level**	**Slightly Below Expected Level**	**At Expected Level**	**Above Expected Level**	**Well Above Expected Level**	**Superior**
NEPSY-II—Affect recognition total	2						
• Total happy errors			*11–25*				
• Total sad errors			*11–25*				
• Total neutral errors		*6–10*					
• Total fear errors		*2–5*					
• Total angry errors	*>2*						
• Total disgust errors	*<2*						
NEPSY-II—Theory of mind total	*<2*						

Note: Standard scores appear in normal font. Scaled scores appear in (parentheses). Percentile ranks of any kind appear in *italics*.

John was less than enthusiastic about completing this subtest, but complied nonetheless. He indicated that it was difficult to see much of a difference between many of the pictures. This was particularly true of the pictures portraying neutral expressions. He tended to attribute “sad” or “disgust” to these, expressing some confusion about what a neutral expression should look like. His ability to identify the expressions of anger, fear, and disgust was poor. These results are indicative of his tendencies to misinterpret the motives of others for which he often holds grudges for extended periods of time. Support is given to the teacher's concern that John exhibits some social anxiety and difficulties with social reciprocity. The Total Affect Recognition Score does not, however, represent the variance among all scores, nor does it reflect the relative strength for recognizing happy and sad expressions.

Summary of social-emotional functioning. John's parents and his teacher acknowledge and praise John's conscientious work ethic. He is, in general, as well behaved as other students his age and in some instances more so. Concerns from both parent and teacher primarily involve John's struggles with learning and understanding academic material, especially in relation to reading and math. He does tend to worry excessively and for extended periods of time when he perceives that he has been criticized or slighted. Both parent and teacher note that he can be stubborn, but after a period of time can be dissuaded from his original perception. John does have some difficulty with taking the perspective of others into account and may often misunderstand the intent of comments or actions of others. Accurate identification of the emotions and expressions of others is also problematic.

Summary

A neuropsychological evaluation was conducted in 2003 during John's second year in third grade after completion of a comprehensive school reevaluation. Results at that time showed verbal ability to be significantly stronger than nonverbal ability. Academic strengths included word calling, spelling, and math calculation, with reading comprehension, written expression, and math word problem solving being areas of difficulty. Receptive and expressive language skills and visual motor skills were also areas of difficulty. NEPSY results from the 2003 neuropsychological evaluation confirmed deficits in language, sensorimotor, visual spatial abilities, memory, and attention areas.

Based on the current assessment results, John's overall relative strengths include above expected levels for processing of limited units of letters, numbers, and words with accompanying limited numbers of operations to be performed when information is presented verbally. Phonological processing skills are well above expected levels. Reading comprehension and spelling (based on work samples and teacher report) are relative strengths at slightly below expected levels. Working memory for smaller chunks of information is also a relative strength.

There are major interferences of cognitive inattention, especially for sustained attention and attentional capacity. Cognitive overload resulting from visuospatial difficulties and executive functioning problems interfere with acquiring and remembering information. Memory is a significant weakness with areas of difficulty indicated for both immediate and delayed memory. John has difficulty processing complex verbal and visual information, resulting in slow processing speed. Weaknesses in each of these areas contribute to inconsistent progress in reading comprehension. Verbal immediate memory is stronger, which allows John to use his strong phonological processing skills for reading words, but does not contribute to knowledge of word meanings within the context of passages read. His struggles with visual/spatial information and dealing with complex verbal information interfere with consistent progress in reading. John demonstrates difficulties with perspective taking and accurately interpreting the emotional intent of others.

Diagnostic Impressions

Assessment results indicate that John's attention processes are impaired in relation to his ability to focus and sustain attention when cognitive overload is reached. Although he appears to be able to shift attention between categories of information or activities, he has great difficulty in processing the information presented for learning. Visual spatial processing is a significant weakness. Memory is a pervasive weakness that adversely affects the acquisition and learning of new material, as well as the retrieval and application of new concepts. Processing speed and cognitive efficiency are below expected levels.

John's pattern of performance is characteristic of many aspects of a Nonverbal Learning Disability (NVLD) and ADHD—Inattentive Type. The description of John's strengths and weaknesses are characteristics of NVLD. Deficits in selective, sustained attention, shifting attention and attentional capacity are problematic relative to ADHD. Educational eligibility for special education services does not include a NVLD; however, John will continue to meet criteria for a learning disability in reading, math and written expression, as well as for an Attention Deficit Disorder.

Intervention Strategies and Recommendations

Recommendations for Instruction at School

Understanding and Following Directions

1. John requires multiple steps in moving from simple to complex instruction. He will learn best by a verbal step-by-step presentation.

2. Use language to clarify questions, and to explain and interpret written information.

3. Due to his difficulties with visualizing and integrating information, he may be more successful when he attempts to memorize verbatim small chunks of verbally presented material.

4. Stress smaller chunks of information to be learned rather than everything at once.

5. Avoid jargon, double meaning words, sarcasm, and nicknames and teasing.

Strategies for Improving Attention

1. Assist John in developing coping skills to deal with attentional capacity. Noise levels in a confined area have proven to be extremely distracting for him, consider placement in another class, or allow a change in seating arrangements.

2. Allow John to take open book tests and evaluate him on the basis of portfolios and other alternative means of assessing knowledge and skill.

3. Attempt to avoid visual distractions in the classroom.

4. John could be allowed to wear headphones to reduce or eliminate noise in the classroom when he is trying to focus.

Math Accommodations

1. It would be beneficial to capitalize on John's stronger verbal skills in teaching math rules and operations. Write out rules for a particular operation, and allow him to use this “cheat sheet” as a reference to solve problems.

2. For math, use real-life examples with extensive verbal explanations, and hands-on experiences.

3. For computational math difficulties have John write out math problems on graph paper or ruled leaf paper held sideways to form columns to provide spatial structure.

Ways to Lessen John's Anxiety

1. Students with NVLD are frequently prone to anxiety. Individual counseling would be helpful to teach John some anxiety management techniques.

2. Students with NVLD often have poor social skills due to difficulties with recognizing nonverbal communication cues. John would benefit from some social skills training to help him lessen his social anxiety.

Recommendations for Instruction at Home

Assisting With Academic Progress

1. Establish proper working conditions and timing arrangements for optimal consolidation of information into memory (e.g., try to pick a study place that is used consistently).

2. It would be beneficial for John if parents would review homework completed, pointing out errors and encouraging John to correct these errors before turning in the assignments.

Increase Self-Awareness

1. Parents could make sure that John receives any counseling, therapies, and/or medications that may be needed to treat any other problems or medical conditions he may have.

2. Reassure John that he is valued for who he is. It may be tricky to help him improve social skills, while at the same time nurturing his confidence to hold on to his unique individuality.

Recommendations for the Student

1. John should engage in intermittent self-testing and self-monitoring using checklists to indicate stages of completion.

2. John should liberally use underlining and rereading of underlined material.

3. John should acquire the habit of maintaining “to do lists” and assignment books, checking off completed items.

4. John should review material for a test just before sleeping, and then engage in morning self-testing (perhaps with the assistance of parents) before going to school.

5. With teacher guidance, John should break down lengthy assignments into smaller chunks.

6. John should engage in self-talk (verbal mediation) to compensate for visual spatial difficulties.

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Comments from the Author

This was an actual case study. The names and background information have been modified to protect the identity of the student. The diagnoses of NVLD and ADHD-Inattentive Type seem appropriate; however, there is an established set of known neuropsychological deficits associated with NVLD and to be more thorough, the case study could have included some additional assessments (see Rapid Reference 9.1).

Rapid Reference 9.1

Verified Known NVLD Symptoms in the Case Study Illustration

Known NVLD Deficit Area	**Verified in Case Study**	**Possible Additional Assessment**
• Bilateral tactile-perceptual deficits	No	NEPSY-II Manual Motor Sequences or equivalent
• Complex psychomotor deficits	Yes	
• Poor visual attention	Partially	CAS Number Detection and Receptive Attention
• Poor prosody and pragmatics	Partially through observation	Complete speech and language evaluation
• Poor visual memory and memory in general	Yes	
• Poor nonverbal problem solving	Yes	
• Poor concept formation	Yes	
• Poor social judgment	Yes	
• Poor social perception	Partially	NEPSY II: Affect Recognition
• Internalizing problems	Yes	
• Poor comprehension/better decoding	Yes	
• Good spelling skills	No	Spelling test from an achievement battery

Known NVLD Deficit Area	**Verified in Case Study**	**Possible Additional Assessment**
• Poor handwriting	Yes	
• Poor math calculations	Yes	
• Poor processing speed	Yes	

Chapter Ten

Sensorimotor Functions

One of the unique components of a school neuropsychological evaluation compared to a psychoeducational evaluation is the inclusion of the assessment of sensory-perceptual and motor functions. In the school neuropsychological conceptual model, the sensory-motor functions serve as a baseline 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 sensorimotor problems. In this chapter, sensory and motor functions are defined, the neuroanatomy of each is described, and the common tests used to assess sensorimotor functions are presented.

Sensory Functions

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 dysfunction.

Definitions

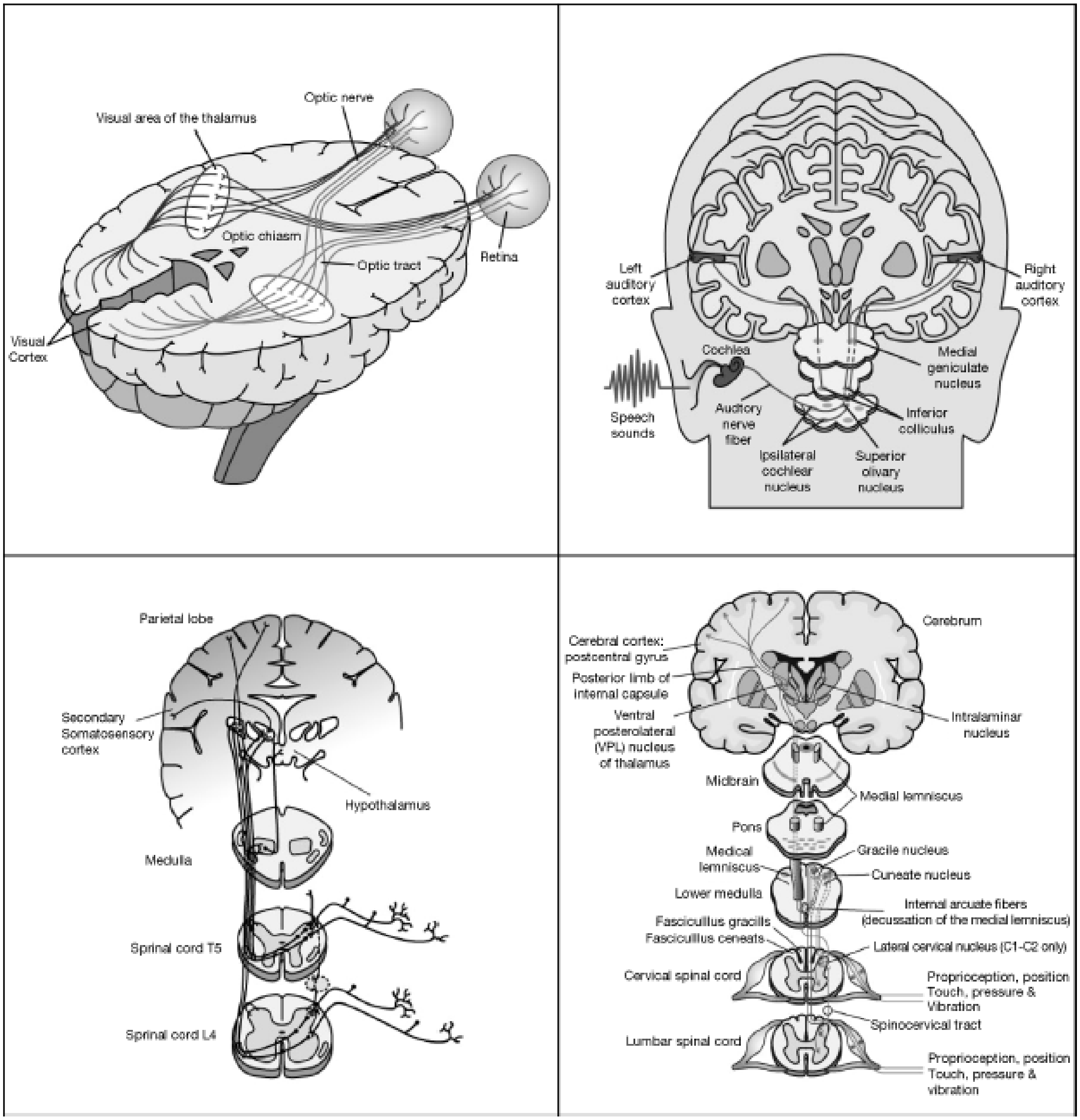
Sensory Processing Disorder (SPD) is an umbrella term used to cover a variety of neurological disabilities that interfere with the normal ability to use sensory information to function smoothly in daily life (Kranowitz, 2005). Sensory functions encompass our ability to process visual, auditory, kinesthetic, and olfactory information. Dysfunction in any one sensory system can have a dramatic effect on a child's learning capabilities and behavioral regulation. Sensory dysfunction can be 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 chapped 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 visual information then travels from the lateral geniculate nuclei to terminate in the primary visual area of the occipital lobe (see Figure 10.1).

Figure 10.1 The Neuroanatomy of the Visual Pathway (Upper Left); Auditory Pathway (Upper Right); Anterolateral System for Pain and Temperature Sense (Bottom Left); and the Dorsal Column-Medial Lemniscal System for Touch, Proprioception, and Movement (Bottom Right).



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 (see Figure 10.1).

The primary somatosensory cortex, *regulating the sense of touch, pain, temperature*, 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 (see Figure 10.1), and the dorsal column-medial lemniscal system for touch, proprioception, and movement (see Figure 10.1).

Vision, hearing, and touch, all have contralateral projections in the brain. This means that if a child has 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 10.1. 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 6).

Motor Functions

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 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.

Definitions

Disorders of motor functions have been historically assigned many labels including: sensory-integrative dysfunction, perceptuomotor dysfunction, developmental dyspraxia, minimal brain dysfunction, visuomotor difficulties, clumsy child syndrome, and motor-learning difficulties (Ball, 2002). The *Diagnostic and Statistical Manual of Mental Disorders—Fourth Edition, Text Revision* (American Psychiatric Association, 2000) 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-age 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.

Rapid Reference 10.1

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 (aka 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 3-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).

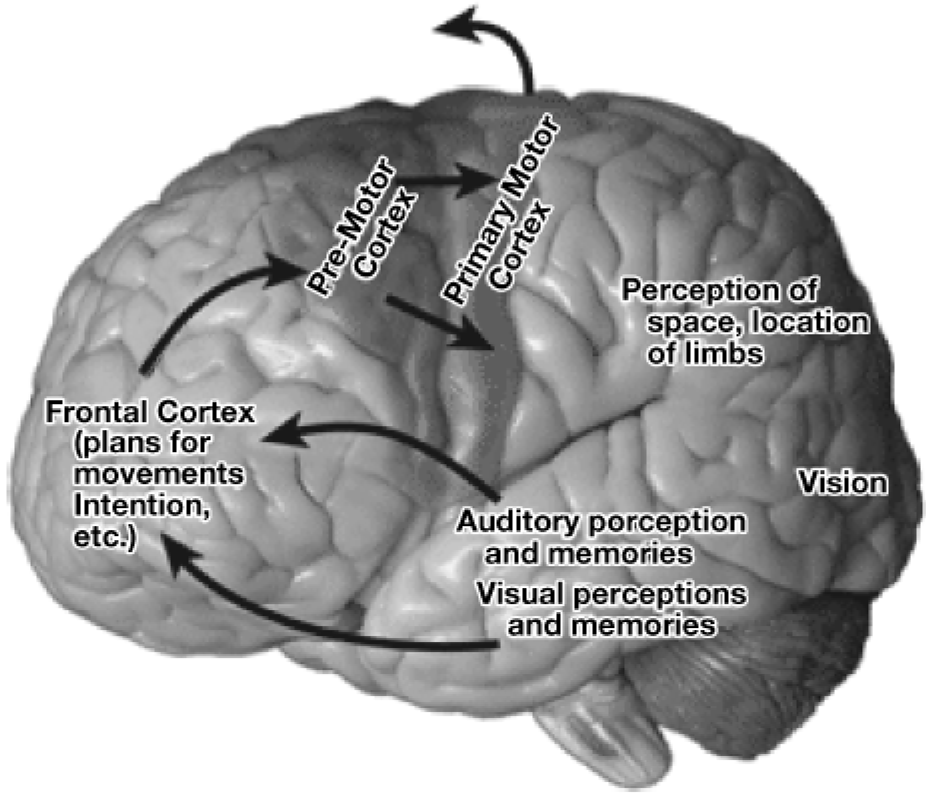
Sources: Ayd, 1995; Loring, 1999.

Prevalence of DCD has been estimated to be as high as 6% for children in the age range of 5 to 11 years (American Psychiatric Association, 2000). 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. DCD is often comorbid with attention deficit-hyperactivity disorder, conduct disorder, and pervasive developmental disorder (Hertza & Estes, 2011).

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 (2010) noted that because 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 10.2 illustrates the interconnections of multisystems that help to regulate motor activity. The premotor cortex helps regulate preprogrammed or sequential motor responses and 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 10.2 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 10.2 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's syndrome.

When to Assess Sensorimotor 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. 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), or psychological disorders (e.g., obsessive-compulsive disorder) (Kranowitz, 2005). See D. Miller (2010) for a review of the most common neurodevelopmental disorders with known sensorimotor deficits.

Rapid Reference 10.2

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, for example, 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.
- *Quadraplegia*—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's Syndrome*—Characterized by repeated and involuntary body movements (tics).

Sources: Ayd, 1995; Loring, 1999.

Identifying Sensorimotor Concerns

It is suggested that the *Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition* (NPCC-3: D. Miller, 2012) be completed by the parent/guardian and at least one teacher of the student being referred for a comprehensive assessment (see supplemental CD for the complete NPCC-3). The questions on the NPCC-3 that pertain to sensorimotor functions are shown in Rapid Reference 10.3. For each behavior listed on the NPCC-3, the rater is instructed to 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, the rater is instructed to put a check mark in one of the three columns marked Mild (behavior occasionally observed), Moderate (behavior frequently observed), or Severe (behavior almost always observed).

Rapid Reference 10.3

Sensorimotor Items From the Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition (NPCC-3: Miller, 2012)

Basic sensory deficits:

- Difficulty with pitch discrimination (tone deaf).
- Difficulty with simple sound discrimination.
- Known or suspected hearing acuity problems.
- Difficulty identifying basic colors (color blind).
- Difficulty smelling or tasting foods.
- Less sensitive to pain and changes in temperature.
- Complains of loss of sensation (e.g., numbness).

Motor functioning difficulties:

- Muscle weakness or paralysis.
- Muscle tightness or spasticity.
- Clumsy or awkward body movements.
- Walking or posture difficulties.

Visual spatial and visual motor functioning difficulties:

- Difficulties with drawing or copying.
- Difficulties with fine motor skills (e.g., using a pencil).

Neurologically related sensorimotor symptoms:

- Displays odd movements (e.g., hand flapping, toe walking).
- Displays involuntary or repetitive movements.
- Ignores one side of the page while drawing or reading.
- Difficulty with dressing (e.g., buttoning and zippering).

Sensory sensitivity issues:

- Does not like loud noises.
- Overly sensitive to touch, light, or noise.

The purpose of the NPCC-3 is to provide school neuropsychologists or other assessment specialists with specific examples of recently exhibited behaviors of the child or adolescent. These behaviors, either endorsed or not endorsed by caregivers and/or teachers, help assessment specialists assemble a testing battery to address the stated concerns. For example, if none of the sensorimotor items are observed by the caretaker(s) and/or teacher(s), the school neuropsychologist or other assessment specialists may choose not to include tests of sensorimotor functions in the assessment battery. However, if many of the basic sensory deficit items are endorsed by the raters, additional physiological examinations of the basic sensory systems may be warranted, such as a follow-up thorough visual examination or hearing examination. If many of the motor functioning items are endorsed, particularly at moderate or severe ratings, an assessment and/or consultation with a physical or occupational therapist may be warranted as part of the assessment plan. Finally, if many of the neurologically related sensorimotor symptoms or sensory sensitivity issues are endorsed, particularly at moderate or severe ratings, the assessment plan should include tools for differential diagnosis of autism spectrum disorders.

Assessing Sensorimotor Functions

Rapid Reference 10.4 restates the second- and third-order classifications of sensorimotor functions within the integrated SNP/CHC Model. Tests designed to measure these second- and third-order classifications of sensorimotor functions are presented in this section of the chapter.

Assessing Lateral Preference

Many of the sensory and motor tests require the examiner to know the student's lateral dominance or preference. The *Dean-Woodcock Sensory-Motor Battery* (DWSMB: Dean & Woodcock, 2003) has a Lateral Preference test. This test should be administered first in a sensorimotor assessment to establish the child's lateral preference. Lateral preference is not just limited to handedness, but also includes eye and foot preference (e.g., which eye is preferred to look through a telescope, or which foot would be used to kick a football).

Rapid Reference 10.4

Integrated SNP/CHC Model Classifications of Sensorimotor Functions

Broad Classifications	**Second-Order Classifications**	**Third-Order Classifications**
Sensorimotor functions	• Lateral preference	
	• Sensory functions	• Auditory and visual acuity
		• Tactile sensation and perception
		• Kinesthetic sensation and perception
		• Olfactory sensation and perception
	• Fine motor functions	• Coordinated finger/hand movements
	• Visual-motor integration skills	
	• Visual scanning	• Direct measures
		• Indirect measures
		• Qualitative behaviors
	• Gross motor functions	• Balance
		• Coordination
	• Qualitative behaviors	

Assessing Sensory Functions

The following section presents the tests designed to measure the sensory functions of: auditory and visual acuity, and tactile, kinesthetic, and olfactory sensation and perception.

Tests of Auditory and Visual Acuity

If a student has visual acuity problems, a more thorough visual examination by an optometrist or ophthalmologist, preferably a developmental ophthalmologist, may be warranted. Likewise, when a student has more serious known or suspected hearing problems, a more thorough audiological examination by an audiologist may be warranted.

Rapid Reference 10.5 presents some common tests of auditory and visual acuity that may be administered as part of a comprehensive school neuropsychological assessment battery.

Rapid Reference 10.5

Tests of Auditory and Visual Acuity

Test–Subtest: Description	Age/Grade Range	Publisher
DWSMB—Auditory Acuity: A basic auditory test (right, left, both).	4 to 90 years	Riverside
DWSMB—Near Point Visual Acuity: Measures near-point vision in each eye (right and left).		
DWSMB—Visual Confrontation: Measures visual field perception (right, left, and both).		
See Appendix for the full names of the tests and their references.		

Basic hearing and vision problems can have a pervasive negative impact on a student's classroom performance. A student with visual acuity problems may not be able to see information presented in the front of the classroom or may have difficulties seeing information close up in printed materials. A student with hearing problems may appear to be disengaged in classroom activities or not paying attention and may have difficulty comprehending and following verbally presented information and/or directions. Students with auditory and visual acuity problems should not be administered higher-order cognitive tasks that require verbal and visual inputs or processing.

Tests of Tactile Sensation and Perception

Rapid Reference 10.6 presents tests that are designed to measure tactile sensation and perception. The tests referenced in Rapid Reference 10.6 are designed to measure proprioception processes with the somatosensory strip area of the brain. Students with tactile sensation and perception deficiencies may have difficulty with fine motor activities such as applying the correct pressure to a pencil or pen when writing or being able to recognize objects based on touch. Tactile sensation and perception deficiencies may also cause students to be either hyposensitive or hypersensitive to touch, light, or sound sensations.

Assessing Fine Motor Functions

The following section presents the tests designed to measure the fine motor functions related to coordinated finger/hand movements.

Rapid Reference 10.6

Tests of Tactile Sensation and Perception

Test–Subtest: Description	Age/Grade Range	Publisher
DWSMB—Finger Identification: While blindfolded, identifying the finger that is touched (right and left).	4 to 90 years	Riverside
DWSMB—Object Identification: While blindfolded, identifying common objects by touch (right and left).		
DWSMB—Palm Writing: While blindfolded, recognizing a number or letter traced on palm by the examiner (right and left).		
DWSMB—Simultaneous Localization: While blindfolded, identifying the hand, cheek, or both that is touched (hands: right, left, and both; hand and cheek: right, left, and both).		
PAL-II RW—Finger Localization: Ability to point to the finger touched by the examiner's pencil behind a shield.	K to 6th grade	Pearson
PAL-II RW—Finger Recognition: Ability to give the number of the finger on a hand map that corresponds to the finger touched by the examiner.		
PAL-II M—Fingertip Writing Total: Ability to integrate kinesthetic-sensory input (touch) and abstract symbols without visual cues.		
See Appendix for the full names of the tests and their references.		

Tests of Coordinated Finger/Hand Movements

Rapid Reference 10.7 presents tests that are designed to measure coordinated finger or hand movements. Students with poor coordinated finger and hand movements will often have difficulty with tasks requiring coordinated motor output, including fine motor tasks such as buttoning buttons, using a zipper, picking up or manipulating objects, copying 2-dimensional drawings, and/or constructing 3-dimensional objects with hands.

Rapid Reference 10.7

Tests of Coordinated Finger/Hand Movements

Test–Subtest: Description	Age/Grade Range	Publisher
DWSMB—Coordination: Touching the end of nose with the index finger then touches the examiner's index finger as it moves across field of vision or touching the back of the hand then the front of the same hand to the thigh quickly (finger-to-nose: right and left; hand-to-thigh: right and left).	4 to 90 years	Riverside
DWSMB—Finger Tapping: Measuring the speed of fine-motor movement for the index finger of each hand over five trials (dominant and non-dominant hands).		
DWSMB—Left-Right Movements: Making purposeful left-right motor movements upon command.		
DWSMB—Mime Movements: Following commands (e.g., "Show me how you would brush your teeth").		
KABC-II—Hand Movements: Producing a sequence of motor acts with dominant hand.	3 to 18 years	Pearson
NEPSY-II—Fingertip Tapping: Dominant and nondominant hand completion times for two fine motor tasks.	5 to 16 years	Pearson
NEPSY-II—Imitating Hand Positions: Imitating hand positions shown by examiner with dominant and nondominant hands.	3 to 12 years	
NEPSY-II—Manual Motor Sequences: Sequencing motor acts with dominant hand.	3 to 12 years	
WRAVMA—Pegboard: Inserting as many pegs as possible, within 90 seconds, into a waffled pegboard.	3 to 17 years	PAR
See Appendix for the full names of the tests and their references.		

Assessing Visual-Motor Integration Skills

There are a wide variety of visual-motor copying tasks available for school neuropsychologists. Rapid Reference 10.8 presents tests that are designed to measure 2-dimensional visual-motor copying skills. Students with visual-motor copying deficiencies will have difficulty with writing and drawing activities in the classroom.

Rapid Reference 10.8

Tests of Visual-Motor Copying Skills

Test–Subtest: Description	Age/Grade Range	Publisher
Beery VMI—Total Test: Copying simple to complex designs on paper.	2 to 100 years	Pearson
• **Visual Perception:** Visual perception aspects of the task.		
• **Motor Coordination:** Motor coordination aspects of the task.		
Bender II—Copy: Copying 2-dimensional geometric figures.	3 to 85+ years	Riverside
• **Motor Test:** Motor coordination aspects of the task.		
• **Perception Test:** Visual perception aspects of the task.		
DWSMB—Construction: Drawing figures (cross and clock).	4 to 90 years	Riverside
DAS-II—Copying: Copying 2-dimensional geometric figures.	2–6 to 8–11 years	Pearson
NEPSY-II—Design Copying General Score: Copying simple to complex designs on paper.	3 to 16 years	Pearson
• **Process Motor:** This score represents the motor output portion of the overall score.		
• **Process Global:** Ability to recognize the overall configuration of the design.		
• **Process Local:** Ability to recognize details of the design.		
ECFT—Copy Score: Copying an abstract design on paper.	6 years through adult	Western Psychological Services
WMS-IV—Visual Reproduction II Copy: Copying a design on paper.	16 to 90 years	Pearson

Test–Subtest: Description	Age/Grade Range	Publisher
WRAVMA—Drawing: Coping designs that are arranged in order of increasing difficulty.	3 to 17 years	PAR
See Appendix for the full names of the tests and their references.		

Assessing Visual Scanning

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 11), as well as other tests that measure processing speed (described in Chapter 16), require visual scanning. Examples of several visual scanning tests are described in this section. Rapid Reference 10.9 presents a list of common tests of visual scanning/tracking for school-age children.

Children with visual scanning or tracking problems often have difficulties with reading words on a line, or writing text on a straight line, or efficiently searching for a key piece of information embedded within a visual array of data. Lining up mathematical operations may be a difficult challenge for students with visual scanning problems. A referral to a developmental ophthalmologist may be warranted for specific visual scanning remedial exercises.

Qualitative Behaviors of Visual Scanning/Tracking

On the WISC-IV Integrated (Wechsler et al., 2004a), the Cancellation test provides two process scores: Cancellation Random Search Strategy and Cancellation Structured (Organized) Search Strategy. Each of these scores generates a base rate or cumulative percentage of children in the same age range that use one of the two types of search strategies. This is useful information to consider when interpreting the performance on the Cancellation test.

Rapid Reference 10.9

Tests of Visual Scanning/Tracking

Test–Subtest: Description	**Age/Grade Range**	**Publisher**
Direct Measure of Visual Scanning/Tracking		
D-KEFS—Trail-Making Condition 1 (Visual Scanning): Marking all of the number 3s on a page as quickly as possible.	8–0 to 89–11 years	Pearson
Indirect Measures of Visual Scanning/Tracking		
NEPSY-II—Picture Puzzles Total: A large picture divided by a grid with four smaller pictures taken from sections of the larger picture is presented. The student identifies the location on the grid of the larger picture from which each of the smaller pictures was taken.	7 to 16 years	Pearson
WISC-IV—Cancellation: Marking target pictures within a visual set of pictures in a specified time period.	6–0 to 16–11 years	Pearson
WISC-IV—Coding: Symbols that are paired with simple geometric shapes or numbers are copied within a specified time limit.	6–0 to 16–11 years	Pearson
WISC-IV—Symbol Search: Visual scanning a group of stimuli to match target symbols.		
WNV—Coding: Copying symbols paired with geometric shapes or numbers within a time limit.	4–0 to 21–11 years	Pearson
WJIII-COG NU—Decision Speed: Rapidly matching two pictures in a row that belong in the same category.	2–0 to 90+ years	Riverside
WJIII-COG NU—Pair Cancellation: Matching target stimuli from a large visual array under time constraints.		
WJIII-COG NU—Visual Matching: Rapidly matching two numbers on a row.		
See Appendix for the full names of the tests and their references.		

Rapid Reference 10.10

Tests of Gross Motor Functions

Test–Subtest: Description	Age/Grade Range	Publisher
DWSMB—Gait and Station: Walking using three gaits—free walking, heel-to-toe, and hopping.	4 to 90 years	Riverside
DWSMB—Romberg: Maintaining balance with feet together, standing toe-to-heel, and standing on one foot, without visual cues.	4 to 90 years	Riverside
See Appendix for the full names of the tests and their references.		

Assessing Gross Motor Functions

There are several tests available to school neuropsychologists to assess gross motor functions within the areas of balance and gross motor coordination. If serious gross motor coordination problems are known or suspected, the school neuropsychologist should consider referring the student to a physical therapist for a thorough assessment.

Rapid Reference 10.10 presents tests that are designed to measure gross motor coordination. Students with poor gross motor skills present a wide variety of clinical symptoms that vary with the child's age (see Hertza & Estes, 2011, for a review). Young children may appear clumsy and uncoordinated and have frequent falls and poor posture. School-age children will have difficulties with handwriting and poor participation in sports. Adolescents will have difficulty with driving, self-grooming, and poor motor dexterity, which could affect future career choices.

Qualitative Behaviors of Sensorimotor Functions

One of the major advantages of the NEPSY-II (see Chapter 7 for a discussion of the NEPSY-II) is the inclusion of base rates for qualitative behaviors based on either age norms or one of the clinical diagnostic groups. Rapid Reference 10.11 presents qualitative measures related to sensorimotor functions. As an example, if a child used visual guidance to facilitate performance on the NEPSY-II's Fingertip Taping Test, the percentage of other children the same age (the base rate) that used visual guidance is provided by the test publisher. As an added feature, the test publisher also provides the qualitative behavior base rates for each of the clinical diagnostic groups. These base rates provide the clinician the opportunity to make statements such as “Mary used visual guidance to help her perform the fingertip tapping test on the NEPSY-II. Only 14% of other children Mary's age used this compensatory strategy; however, 35% of the children within the Attention Deficit Hyperactivity Disorder diagnostic group used this compensatory strategy.” The occurrence of qualitative behaviors, such as motor overflow, provides insights into the neuroanatomical functions of an individual. As an example, fingertip tapping should only elicit a precise activation of the motor strip area associated with finger control. However, when the individual produces mouth and tongue movements during the performance of a fingertip tapping task, this motor overflow is caused by broader areas of the motor strip being activated than what is typically observed.

Rapid Reference 10.11

NEPSY-II (Korkman, Kirk, & Kemp, 2007) Qualitative Behaviors Related to Sensorimotor Functions

Fingertip tapping

- **Visual guidance:** Looking at fingers during the performance of task.
- **Incorrect position:** Wrong position of fingers.
- **Posturing:** Finger/hand on opposite side extended stiffly.
- **Mirroring:** Fingers on opposite side move involuntarily.
- **Overflow:** The lips or mouth move involuntarily.

Imitating hand positions

- **Mirroring:** Fingers on opposite side move involuntarily.
- **Other hand helps:** The child uses the other hand to help model theposition.

Manual motor sequences

- **Rate change:** Variable speed and tempo during performance of task.
- **Overflow:** The lips or mouth move involuntarily.
- **Perseveration:** Movement continues for 3 to 4 sequences after beingtold to stop.
- **Loss of asymmetrical movement:** Loss of one side dominance on task.
- **Body movement:** Extraneous whole body movements in conjunctionwith the movement sequences.
- **Forceful tapping:** Tapping becomes louder during the production of themovement tasks.

Visuomotor precision

- **Pencil lift total:** Sum of the pencil lifts (a rule violation).
- **Quality of pencil grip:** Percentage of standardization sample with aspecific type of pencil grip.

Chapter Summary

In this chapter, the terminology, neuroanatomy, and major assessment instruments 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.

Test Yourself

1. True or False? *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.

2. Which of the neuropsychological terms below 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. True or False? The pyramidal and extrapyramidal neural systems help regulate motor activity in humans.

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-Butkencia 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

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

Chapter Eleven

Visuospatial and Auditory Cognitive Processes

Visuospatial Processes

Much of what is learned in school has either a visuospatial or auditory basis. Visuospatial skills and auditory processing 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 academic fluency. The school neuropsychologist should include measures of visuospatial processes in any comprehensive school neuropsychological evaluation. In this chapter, the neuropsychology of visuospatial and auditory processes are reviewed, subcomponents of visuospatial functions are defined, the neuroanatomy of visuospatial functions are described, and the common tests used to assess visuospatial functions are presented.

Subcomponents Associated with Visuospatial Processing

Visuospatial processing is a broad cognitive process that encompasses many subcomponents. Many of the visuospatial 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 Cancellation: Woodcock et al., 2001, 2007). Other neurocognitive tasks require visual-motor integration (e.g., *Beery-Buketenica Developmental Test of Visual-Motor Integration*: Beery, Buktenica, & Beery, 2010; *Wide Range Assessment of Visual Motor*

Abilities: Adams & Sheslow, 1995), visual-motor planning (e.g., WJIII-COG Planning: Woodcock et al., 2001, 2007; *WISC-IV Integrated* Elithorn Mazes: Wechsler, 2004), visual memory (e.g., *Children Memory Scale* Dot Localization: Cohen, 1997; *Wide Range Assessment of Memory and Learning—Second Edition* Design Memory: Sheslow & Adams, 2003), visual perception with a motor response (e.g., *Kaufman Assessment Battery for Children—Second Edition* Triangles: A. Kaufman & N. Kaufman, 2004), visuospatial reasoning (e.g., WJIII-COG Spatial Relations Woodcock et al., 2001, 2007), visual perception without a motor response (e.g., NEPSY-II Arrows: Korkman et al., 2007), visual perceptual organization (e.g., *Extended Complex Figure Test*: Fastenau, 1996), visual perceptual reasoning (e.g., WISC-IV Block Design: Wechsler, 2003), and visual scanning or tracking (e.g., D-KEFS: Trail Making Test [Condition 1]: Delis, Kramer, & Kaplan, 2001).

Rapid Reference 11.1

Visuospatial Processing Subcomponents

Subcomponent	**Where Covered in Conceptual Model**
• Visual attention	• Allocating and maintaining attention facilitators/inhibitors
• Visual-motor integration	• Covered under sensory-motor functions
• Visual-motor planning	• Covered under executive processes
• Visual (spatial) memory	• Covered under learning and memory processes
• Visual spatial perception	• Covered in this section
• Visual spatial reasoning	• Covered in this section
• Visual scanning/tracking	• Covered under sensory-motor functions

Rapid Reference 11.1 lists the subcomponents associated with visuospatial processing and indicates the areas in the Integrated SNP/CHC Model where the subcomponents are covered.

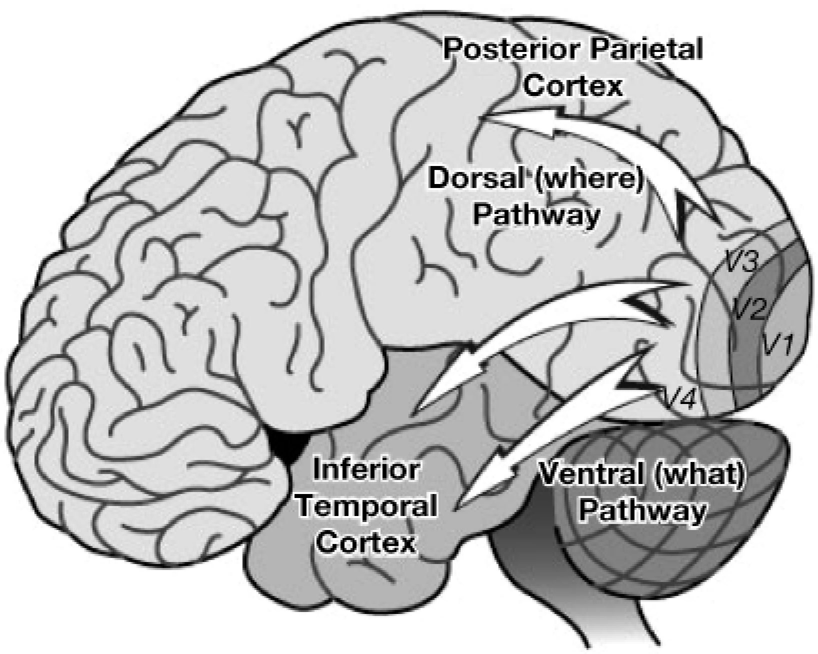
Neuroanatomy of Visuospatial Processes

This section reviews the neuroanatomy of the visuospatial processes including the primary visual pathway, the dorsal and ventral pathways, the areas of the brain activated during visual object recognition, and the areas of the brain activated during face recognition.

Primary Visual Pathway

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 remaining 10% 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 (see Figure 11.1).

Figure 11.1 The Dorsal and Ventral Streams



The primary visual cortex within the occipital lobe has many specialized areas. Visual perception appears to involve a "divide and conquer" strategy (Gazzaniga et al., 2002). 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, etc. The specialized visual areas provide distributed and specialized analyses that are integrated into perceptual wholes at higher levels of processing.

The Dorsal and Ventral Pathways

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 (1982) 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 (see Figure 11.1). Ungerleider and Mishkin (1982) 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 visuospatial impairments are presented in Rapid Reference 11.2. 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 the child's 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 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.

Rapid Reference 11.2

Neuropsychological Terms Associated With Visuospatial Impairments

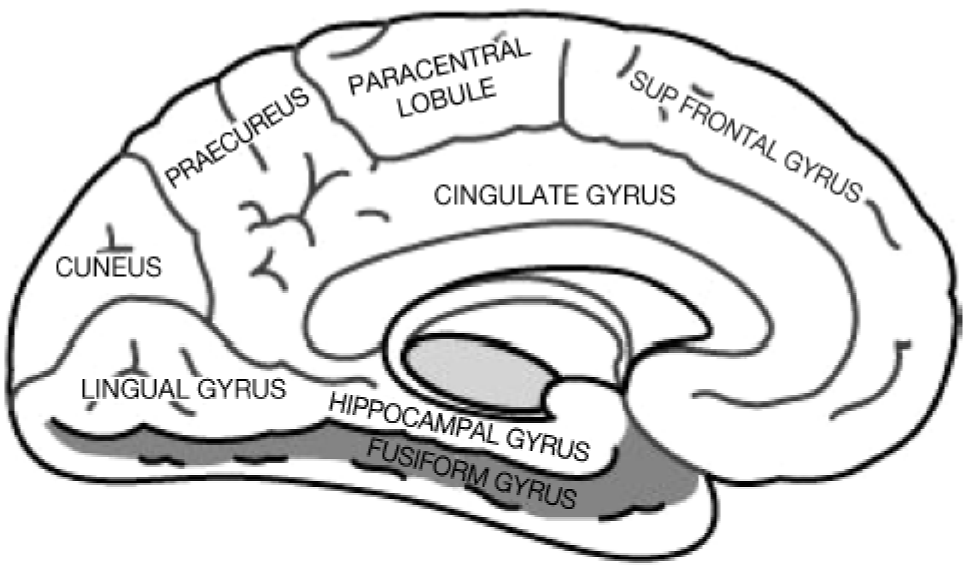
- *Apperceptive agnosia*—A form of visual agnosia in which the deficit is caused by impaired visual perception.
- *Associative agnosia*—A failure of visual object recognition that cannot be attributed to perceptual abilities.
- *Astereopsis*—Inability to perceive the depth of objects.
- *Color agnosia*—Inability 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.

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 their face. The inferior temporal lobe, specifically the fusiform gyrus, is involved in recognizing objects, especially faces (see Figure 11.2). When a face is recognized in the fusiform gyrus, the information is transmitted to the frontal lobes for processing. *Prosopagnosia* is a term used to describe the inability to recognize faces, which is a socially disabling disorder. Prosopagnosia rarely occurs with unilateral, left lesions. It is more likely associated with bilateral lesions caused by multiple stokes, head injury, encephalitis, or poisoning (Gazzaniga et al., 2002) or right hemispheric lesions that include the ventral regions of the occipital and temporal lobes (DeRenzi, Perani, Carlesimo, Silveri, & Fazio, 1994).

Figure 11.2 The Fusiform Gyrus Involved in Recognizing Objects, Particularly Faces



We live in a multimodal society where learning requires both intact auditory and visual processing skills. When a child is experiencing a visuospatial processing disorder it can severely impact the child's learning potential and their social functioning. Reading and math both rely heavily on the use of symbols (e.g., letters for reading and numbers and signs for math) and accurate visual perception is important. Writing also has a large visuospatial component. Students with visual perception problems may have difficulties with directionality, letter and number reversals, spacing problems in writing, visually discriminating shapes from a whiteboard, recognizing missing details within a partial visual object (visual closure), and so on. A child with visual perception difficulties may also have related social problems because of difficulties recognizing facial expressions and emotions in others. Some visual problems may just be related to an acuity problem and can be addressed by a visual exam and possible glasses or contacts. Other visual problems may be perceptual in nature and require a more thorough examination by and intervention from a developmental ophthalmologist.

Identifying Visuospatial Processing Concerns

It is suggested that the *Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition* (NPCC-3: Miller, 2012) be completed by the parent/guardian and at least one teacher of the student being referred for a comprehensive assessment (see the supplemental CD for the complete NPCC-3). The questions on the NPCC-3 that pertain to visuospatial problems are shown in Rapid Reference 11.3. Note that these items are contained with the Sensorimotor section of the NPPC. Any endorsed items in the moderate to severe range should be followed up with formal assessment measures in the school neuropsychological assessment.

Rapid Reference 11.3

Visuospatial Items From the Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition (NPCC-3: Miller, 2012)

- Confusion with directions (e.g., gets lost easily).
- Shows right-left confusion or directions (up-down).
- Difficulties with putting puzzles together.

Assessing Visuospatial Processes

Rapid Reference 11.4 restates the second- and third-order classifications of visuospatial processes within the Integrated SNP/CHC Model. Tests designed to measure these second- and third-order classifications of visuospatial processes are presented in this section.

Tests of Visuospatial Perception

The second-order classification of visuospatial perception separates the tasks into two categories: tests that require visual discrimination and spatial localization, and tests that require visual-motor constructions. Rapid Reference 11.5 presents a list of common tests of visuospatial perception for school-age children.

The Block Design test from the WISC-IV (Wechsler, 2003) is classified under Visual Spatial Perception (second-order classification) and Visual-Motor Construction (third-order classification). When considering a student's performance on the Block Design test, it is important to consider differences in performance when completion time is not considered (the Block Design No Time Bonus score). The WISC-IV Integrated (Wechsler et al., 2004a) provides variations of Block Design to test the limits and to isolate reasons for poor performance on the test. WISC-IV Integrated scores such as the Block Design Process Approach, Block Design Multiple Choice, and Block Design Multiple Choice No Time Bonus should all be administered and interpreted when a student achieves a low score on the WISC-IV Block Design test relative to performance on other cognitive measures.

Rapid Reference 11.4

Integrated SNP/CHC Model Classifications of Visuospatial Processes

Broad Classifications	**Second-Order Classifications**	**Third-Order Classifications**
Visuospatial processes	• Visual spatial perception	• Visual discrimination and spatial localization
		• Visual-motor constructions
		• Qualitative behaviors
	• Visual spatial reasoning	• Recognizing spatial configurations
		• Visual gestalt closure
		• Visuospatial analyses with and without mental rotations

Rapid Reference 11.5

Tests of Visuospatial Perception

Test–Subtest: Description	Age/Grade Range	Publisher
Visual Discrimination and Spatial Localization		
NEPSY-II—Arrows Total: Two arrows from many are chosen by letter label, which are thought to point to the center of the target.	5 to 16 years	Pearson
NEPSY-II—Picture Puzzles Total: A large picture divided by a grid with four smaller pictures taken from sections of the larger picture is presented. The student identifies the location on the grid of the larger picture from which each of the smaller pictures was taken.	7 to 16 years	
NEPSY-II—Route Finding Total: A schematic map with a target house is presented and the student is asked to find that house in a larger map with other houses and streets.	5 to 12 years	
TVPS-3—Visual Discrimination: Matching a target design among a set of designs on the same page.	4–0 to 18–11 years	Academic Therapy Publications
Visual-Motor Constructions		
DAS-II—Pattern Construction: Imitating constructions made by the examiner with wooden blocks, color tiles, or patterned cubes.	2–6 to 17–11 years	Pearson
KABC-II—Triangles: Re-creating shapes that were modeled by examiner.	3–0 to 18–0 years	
NEPSY-II—Block Construction total: Reproducing 3-dimensional constructions from models or 2-dimensional drawings under time constraints.	3 to 16 years	
WISC-IV—Block Design: Re-creation of a constructed model or a picture of a block design within a specified time limit.	6 to 16–11 years	
WNV—Object Assembly: Putting puzzle pieces together to form a meaningful whole.	4–0 to 21–11 years	
See Appendix for the full names of the tests and their references.		

Qualitative Behaviors of Visuospatial Perception

On the WISC-IV Integrated (Wechsler et al., 2004a), the Block Design subtest has a set of qualitative scores that aid in the clinical interpretation of the test. These qualitative scores are calculated as base rates comparing a student's performance to their same aged peers. These score are listed in Rapid Reference 11.6.

Tests of Visuospatial Reasoning

The second-order classification of visuospatial reasoning separates the tasks into three categories: tests that require recognition of spatial configurations, tests that require visual gestalt closure, and tests that require visuospatial analyses with and without mental rotations. Rapid Reference 11.7 presents a list of common tests of visuospatial reasoning for school-age children.

Visuospatial reasoning skills are required in the discrimination of letters, numbers, and words. Mathematical reasoning skills requiring estimates of quantity and certainly geometry rely heavily on visuospatial reasoning.

Auditory Processes

Samuel is a poor reader. He has difficulty sounding out words. If he is able to read a word, it is because he has memorized what the word looks like rather than sounding it out. As a result of his poor phonological processing skills, his reading fluency and reading comprehension are also weak.

Rapid Reference 11.6

Qualitative Behaviors for WISC-IV Integrated: Block Design

- *Partial Score Part A:* Percentage of same-age peers that received a partial score on the task that required the student to select the correct number of blocks to construct block designs that match a model presented on a page (global details).
- *Partial Score Part B:* Percentage of same-age peers that received a partial score on the readministration of failed Part A items using a grid overlay (specific details).
- *En Route Break in Configuration—Part A* Percentage of same-age peers that violated the rules of correct block placement or no rotation on Part A during the construction.
- *En Route Break in Configuration—Part B* Percentage of same-age peers that violated the rules of correct block placement or no rotation on Part B during the construction.
- *Break in Final Configuration—Part A* Percentage of same-age peers that violated the rules of correct block placement or no rotation on Part A at the completion of the construction.
- *Break in Final Configuration—Part B* Percentage of same-age peers that violated the rules of correct block placement or no rotation on Part B at the completion of the construction.
- *Extra Block Construction—Part A* Percentage of the same-age peers that used an extra block in the Part A construction.
- *Extra Block Construction—Part B* Percentage of the same-age peers that used an extra block in the Part B construction.

Rapid Reference 11.7

Tests of Visuospatial Reasoning

Test–Subtest: Description	Age/Grade Range	Publisher
Recognizing Spatial Configurations		
DAS-II—Matching Letter-Like Forms: Multiple-choice matching of shapes that are similar to letters.	2–6 to 8–11 years	Pearson
KABC-II—Block Counting: Counting 3-dimensional cubes.	3 to 18 years	Pearson
TVPS-3—Spatial Relationships: Choosing one design that is different from the rest.	4 to 18–11 years	Academic Therapy Publication
WJIII-COG NU—Spatial Relations: Identify two or more pieces that go together to form a complete target shape.	2–0 to 90+ years	Riverside
Visual Gestalt Closure		
KABC-II—Gestalt Closure: Figuring out what a picture is when it has been partially erased or obscured.	3 to 18 years	Pearson
RIAS—What's Missing: Naming a missing part of a visual picture.	3 to 94 years	PAR
TVPS-3—Visual Closure: Matching an incomplete pattern with a completed design.	4 to 18–11 years	Academic Therapy Publication
TVPS-3—Visual Figure-Ground: Finding one design among many within a complex background.		
WISC-IV—Picture Completion: Naming a missing part of a visual picture.	6 to 16–11 years	Pearson
WJIII-COG DS—Visual Closure: Verbally naming a drawing or picture that has been altered in some way.	2–0 to 90+ years	Riverside
Visuospatial Analyses with and without Mental Rotations		
NEPSY-II—Geometric Puzzles total: A picture of a large grid containing several shapes is presented, then the student matches two shapes outside of the grid to two shapes within the grid.	3 to 16 years	Pearson

Test–Subtest: Description	Age/Grade Range	Publisher
SB5—Nonverbal Visuospatial Processing: Ability to identify, analyze, and mentally rotate or assemble visual images, geometric shapes, or natural objects occurring in spatial arrangements.	2 to 85+ years	Riverside
TVPS-3—Form Constancy: Finding a design embedded within another object.	4 to 18–11 years	Academic Therapy Publication
WRAVMA—Matching: Looking at a visual "standard" and select the option that "goes best" with it.	3 to 17 years	Pearson
WJIII-COG DS—Block Rotation: Ability to select the two sets of blocks that are rotated versions of the target pattern.	2–0 to 90+ years	Riverside
See Appendix for the full names of the tests and their references.		

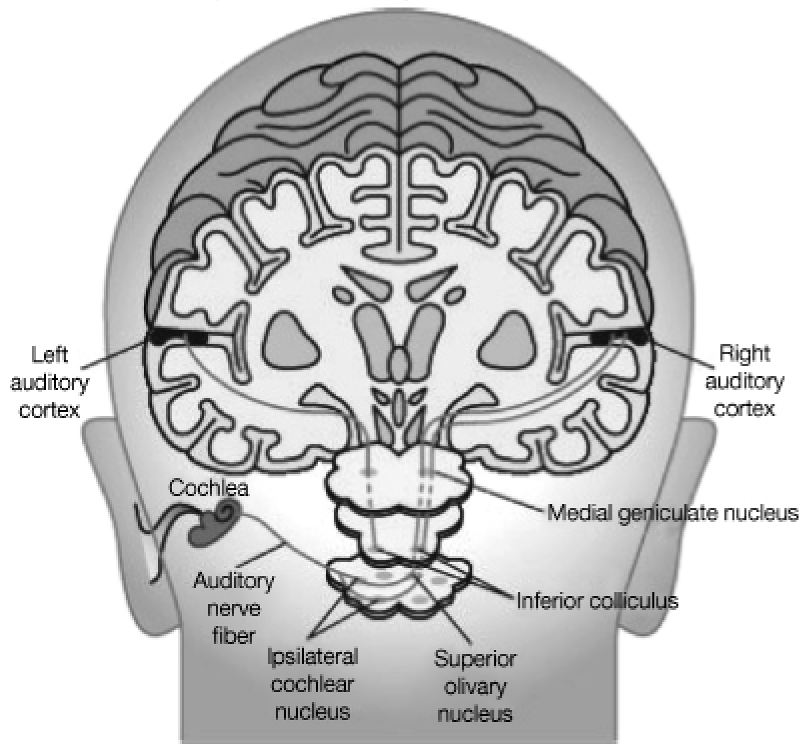
We live in a language-rich society where verbal skills are often valued above nonverbal skills. The basic building blocks of language are basic sound discrimination and auditory processing skills. When a first or second grader is still struggling with basic sound discrimination such as knowing words that sound alike or rhyme, the clinician should evaluate the student's basic sound discrimination skills. Sometimes a child has acquired basic sound discrimination but has difficulty manipulating phonemes such as blending sounds to form words or identifying missing phonemes to complete whole words. These auditory processing skills along with the ability to discriminate sounds are basic building blocks for the acquisition of reading. When delays occur in acquiring these basic skills, a referral for criterion-referenced or norm-referenced assessment is probably warranted.

Neuroanatomy of Auditory Processes

The ears receive sound waves that travel into the ear canal where they vibrate the eardrum. As the eardrum vibrates, it moves tiny bones in the middle ear, which in turn carry the vibrations through the fluid filled cochlea. Inside the cochlea a series of tiny hairs called cilia vibrate and are attached to the cochlear nerve. It is the movements of the cilia that stimulate the cochlear nerve and send signals to the brain. The ear receives auditory input but the brain hears.

Figure 11.3 illustrates the auditory pathway from the ear to the primary auditory cortex. The cochlear nerve passes through the medulla in the brainstem and then to the inferior colliculus. The auditory pathway divides so input from each ear can ultimately be received and processed in each hemisphere. The auditory pathway is then processed through the thalamus, the sensory relay station of the brain, and onto the auditory cortex. The auditory cortex is responsible for phonological processing, by allowing us to recognize words by the way they sound.

Figure 11.3 Neuroanatomy of Hearing



Identifying Auditory Processing Concerns

It is suggested that the *Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition* (NPCC-3: Miller, 2012) be completed by the parent/guardian and at least one teacher of the student being referred for a comprehensive assessment (see the supplemental CD for the complete NPCC-3). The questions on the NPCC-3 that pertain to auditory processing problems are shown in Rapid Reference 11.8. Any endorsed items in the moderate to severe range should be followed up with formal assessment measures in the school neuropsychological assessment.

Rapid Reference 11.8

Auditory Processing Items From the Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition (NPCC-3: Miller, 2012)

Phonological/auditory processing difficulties:

- Difficulty with sound discrimination.
- Difficulty with blending of sounds to form words.
- Difficulty with rhyming activities.
- Omits sounds when reading or speaking.
- Substitutes sounds when reading or speaking.

Rapid Reference 11.9

Integrated SNP/CHC Model Classifications of Auditory Processes

Broad Classifications	**Second-Order Classifications**	**Third-Order Classifications**
Auditory processes	• Sound discrimination	
	• Auditory/phonological processing	

Assessing Auditory Processing

Rapid Reference 11.9 restates the second- and third-order classifications of language processes within the Integrated SNP/CHC Model. Tests designed to measure these second- and third-order classifications of auditory processes are presented in this section.

Tests of Basic Sound Discrimination

Rapid Reference 11.10 lists the Sound Patterns—Music and Sound Patterns—Voice tests from *The Diagnostic Supplement to the Woodcock-Johnson III Tests of Cognitive Abilities* (WJIII-COG DS: Woodcock, McGrew, Mather, & Schrank, 2003, 2007) that were designed to measure basic sound discrimination skills. A speech and language pathologist has access to other tests that are designed to measure sound discrimination and the student should be referred for a speech and language assessment when deficits in this area are suspected. A student with deficits in basic sound discrimination will have difficulty learning to read using a phonological approach.

Rapid Reference 11.10

Tests of Sound Discrimination

Test–Subtest: Description	**Age/Grade Range**	**Publisher**
WJIII-COG DS—Sound Patterns—Music: Determining if musical sounds presented in a pair are the same or different.	2–0 to 90+ years	Riverside
WJIII-COG DS—Sound Patterns—Voice: Determining if human speech sounds presented in a pair are the same or different.		
See Appendix for the full names of the tests and their references.		

Tests of Auditory/Phonological Processing

Rapid Reference 11.11 lists the major tests at the disposal of a school neuropsychologist that are designed to assess auditory and/or phonological processing. This listing only includes tests that are typically used by school psychologists and school neuropsychologists. There are many other tests from the speech and language assessment batteries that are also designed to measure auditory and/or phonological processing.

Rapid Reference 11.11

Tests of Auditory/Phonological Processing

Test–Subtest: Description	Age/Grade Range	Publisher
CTOPP—Blending Words: Listening to words in small parts and blending the parts together to make a whole word.	5–0 to 24–11 years	PRO-ED
CTOPP—Elision: Omitting a phoneme from a word to create a new word.		
CTOPP—Sound Matching: Choosing a word that contains a target sound.	5–0 to 6–11 years	
DAS-II—Phonological Processing: Rhyming, blending sounds, deleting sounds, and identifying the individual sounds in words.	5–0 to 12–11 years	Pearson
DTAP—Composite Auditory Perception Index: Overall performance on various auditory perception tasks.	6–0 to 18–11 years	PRO-ED
KTEA-II—Phonological Awareness: Manipulation of sounds (e.g., rhyming, blending).	4–6 to 25 years	Pearson
NEPSY-II—Phonological Processing: Part 1: Word segment recognition Part 2: Phonological segmentation	3 to 16 years	
PAL-II RW—Phonological Coding Scores: Ability to segment spoken words into units that are related to units of written words.	Grades K to 6	
TAPS-3—Phonological Blending: Ability to synthesize a word when given the individual phonemes.	4 to 18–11 years	Academic Therapy Publications
TAPS-3—Phonological Segmentation: Ability to manipulate phonemes in words.		
TAPS-3—Word Discrimination: Ability to discern phonological differences and similarities in word pairs.		
TOPA-2+ Kindergarten Edition—Initial Sound Same: Marking which of three words begins with the same sound as a target word.	Kindergarten	PRO-ED
TOPA-2+ Kindergarten Edition—Initial Sound Different: Marking which of three words begins with a different first sound than the other three.		

Test–Subtest: Description	Age/Grade Range	Publisher
TOPA-2+ Early Elementary Edition—Ending Sound Same: Identify which of three words ends with the same sound as a target word.	First–second grades	
TOPA-2+ Early Elementary Edition—Ending Sound Different: Marking which of a group of four words ends in a different sound than the others.		
TOPAS—Incomplete Words: Ability to discern a missing phoneme from a spoken word.	Grades K to 3+	
TOPAS—Phoneme Deletion: Ability to repeat a word, then say the word with a certain phoneme missing.		
TOPAS—Rhyming: Ability to complete a sentence with a word that is both semantically correct and rhymes with another word.		
TOPAS—Sound Sequencing: Ability to sequence a set of color blocks that correspond to a speech sound.		
TPAS—Composite Score: Overall measure of phonological awareness in Spanish-speaking children.	4–0 to 10–11 years	
• **TPAS—Initial Sounds:** Determining if a second word begins with the same sound as a target word.		
• **TPAS—Final Sounds:** Determining if a second word ends with the same sound as a target word.		
• **TPAS—Rhyming Words:** Determining if a second word rhymes or sounds like the target word.		
• **TPAS—Deletions:** Repeating a specific word while leaving out a syllable or sound at the beginning, middle, or end of the word.		
WJIII-ACH NU—Sound Awareness: Rhyming, deletion, substitution, and reversal of phonemes.	2–0 to 90+ years	Riverside

Test–Subtest: Description	Age/Grade Range	Publisher
WJIII-COG NU—Incomplete Words: Listening to a word with one or more missing phonemes and then identifying the whole word.		
WJIII-COG NU—Sound Blending: Blending sounds to form a whole word.		
See Appendix for the full names of the tests and their references.		

On the Developmental Test of Auditory Perception (DTAP: Reynolds, Voress, & Pearson, 2008) there is an overall composite score that reflects overall auditory perception abilities; however, there are four separate indices that should be reported and interpreted as well. According to Reynolds et al. (2008), the Language Perception Index in an indicator of more left temporal lobe processing of language (Reynolds et al., 2008). The Non-Language Perception Index is an indicator of more right temporal lobe processing of language. The Background Noise Perception Index measures the ability to accurately perceive a target set of sounds in the presence of background noise, and the No Background Noise Perception Index measures the ability to accurately perceive a target set of sounds in the presence of no background noise.

On the *Process Assessment of the Learner—Second Edition: Diagnostics for Reading and Writing* (PAL-II RW: Berninger, 2007) the Phonological Coding test is designed to measure ability to segment spoken words into units that are related to units of written words. The test yields a composite score but also generates separate scores for the ability to segment words into phonemes (Phonemes), ability to analyze and generate rhymes for spoken words (Rhyming), understanding of rhymes in syllables (Rimes), and ability to segment spoken words into syllables (Syllables). Performance on these subtests should also be examined beyond the composite score.

Students with deficits in auditory/phonological processing have difficulties with reading acquisition that is taught using purely phonological instruction. Students with severe deficits in this area may have to learn how to read based on memorizing the whole word visually rather than applying a sounding out, phonetic approach to reading.

Chapter Summary

In this chapter, the terminology, neuroanatomy, and major assessment measures associated with visuospatial and auditory processes were reviewed. Visuospatial processes have a strong influence on academic achievement (e.g., handwriting, math, and reading fluency) and should be systematically assessed by a school neuropsychologist. Auditory processes serve as the foundation for reading and language skills and need to be assessed by the school neuropsychologist, particularly in young children. Visuospatial and auditory processing disorders are observed in many common developmental 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. True or False? Ungerleider and Mishkin refer to occipital-parietal pathway as the "where" pathway.

4. What part of the brain is responsible for processing hearing?

a. Temporal lobes

b. Frontal lobes

c. Parietal lobes

d. Occipital lobes

5. True or False? The KABC-II Block Counting subtest is an example of a visuospatial reasoning test.

6. Which of the tests below is an example of a visual gestalt closure type of task?

a. NEPSY-II—Arrows total

b. WISC-IV—Picture completion

c. DAS-II—Pattern construction

d. KABC-II—Triangles

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

Chapter Twelve

Learning and Memory Cognitive Processes

In this chapter learning and memory processes are defined, theories of learning and memory are reviewed, the neuroanatomy of learning and memory are described, and the common tests used to assess learning and memory within the school neuropsychological assessment model are presented.

Theories of Learning and 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 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 their 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 a friend. 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 (G. Miller, 1994).

Long-Term Memory

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, Ivry, & Magun, 2002, p. 312). 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 are 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 primary effect is thought to be reflective of 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.

A Conceptual Model of Learning and Memory for School Neuropsychologists

Rapid Reference 12.1 presents the classification of learning and memory 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.

Rapid Reference 12.1

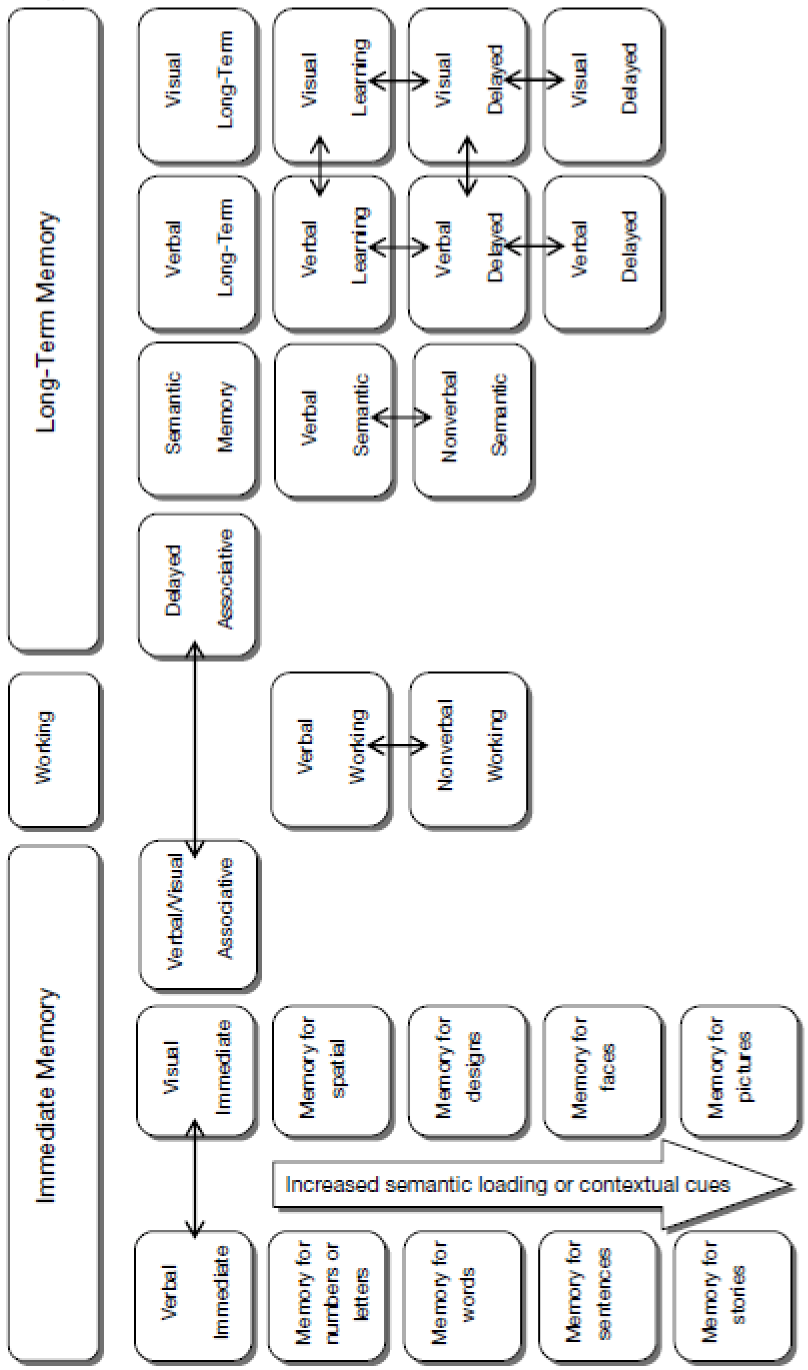
Classification of Tests of Learning and Memory

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 and memory	• Learning and retention of associated verbal and visual stimuli for prolonged periods of time.

Verbal-visual associative learning and memory is another construct frequently assessed. Associative learning and memory tasks pair verbal and visual information (e.g., the WJIII-COG Visual-Auditory Learning subtest). The final two common learning and memory 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 learning and memory for school neuropsychologists is illustrated in Figure 12.1. The conceptual model first subdivides learning and memory 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 12.1. Clearly, immediate memory is contingent on attentional factors as well.

Figure 12.1 Conceptual Model of Learning and Memory for School Neuropsychology (D. Miller, 2007)



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 learning and memory. Similar semantic loading changes in visual immediate memory tasks may be a part of a learning and memory 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.

Long-term memory can be divided into four categories: delayed associative memory, semantic memory, verbal long-term learning and memory, 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.

Long-term memory can also be classified as verbal long-term memory or 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 Learning and Memory Processes

Much of what we know today about the neuroanatomy of learning and memory comes from the study of patients with memory impairments, comparative animal research, and functional imaging techniques (Miller, Maricle, & Mortimer, 2010). 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). Jonides et al., (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 Learning and Memory Processes

Learning and memory form the foundation for what education is all about. A school neuropsychological evaluation must include assessment of both the subcomponents of learning and memory. There are many neuropsychological terms associated with learning and memory with which school neuropsychologists should become familiar (see Rapid Reference 12.2).

Rapid Reference 12.2

Neuropsychological Terms Associated with Learning and Memory

- *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, and 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.
- *Encoding*—The process by which the cognitive system builds up a stimulus representation to place into memory.
- *Episodic memory*—Memory that is content-specific and often autobiographical.
- *Flashbulb memory*—A vivid memory of the circumstance surrounding shocking or emotionally charged news.
- *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 aid 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*—A graph frequently used in memory tests to plot out the number of correctly recalled words over a number of trials.
- *Long-term memory*—The 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, and 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 sketchpad*—Allows manipulation of visuospatial 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.

When to Assess for Learning and Memory Processes

"In the school environment, the rapid acquisition and long-term retention of facts and concepts is fundamental to success" (Dehn, 2010, p. 3). From a school neuropsychological perspective, the question should not be when to assess for learning and memory functions, but when would you not assess for those functions. The acquisition of new knowledge and the subsequent storage and retrieval of that knowledge is the foundation of what we strive to accomplish in education.

A challenge for school neuropsychologists is to determine if a student's memory difficulties can be attributed to problems with initial encoding, inefficient storage, or poor retrieval strategies, or a combination of all three. Poor encoding is often attributable to not paying attention to the stimuli to be learned, due to distractibility. Poor encoding of verbal information may also be attributable to poor receptive language skills. If a child cannot understand verbal information, that information will not be encoded into memory.

A child may initially encode information but not store that information in an efficient manner. Information may be stored incorrectly based on how something sounds; a phonemic encoding error (e.g., the word "bat" is stored as "hat") or information may be stored inaccurately based on a semantic encoding error (e.g., the word "car" is stored as the word "truck).

The majority of current memory tests focus on retrieval of newly learned information. The school neuropsychologist must infer where the breakpoints occur in the memory process based on how well a child recalls newly learned material (immediate memory) or how well information is remembered over time (delayed recall or recognition and long-term memory). If a child shows little to no evidence of learning new material, such as a list of words over repeated trials, distractibility, poor attentional skills, and/or poor receptive language skills must be ruled out. Potential storage and/or retrieval problems can be suggested based on the types of errors made during retrieval (e.g., phonological or semantic errors).

Identifying Learning and Memory Concerns

It is suggested that the *Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition* (NPCC-3: D. Miller, 2012) be completed by the parent/guardian and at least one teacher of the student being referred for a comprehensive assessment (see the supplemental CD for the complete NPCC-3). The questions on the NPCC-3 that pertain to learning and memory difficulties are shown in Rapid Reference 12.3. Any endorsed items in the moderate to severe range should be followed up with formal assessment measures in the school neuropsychological assessment. The major tests of learning and memory for school-age children are reviewed in the next section.

Rapid Reference 12.3

Learning and Memory Items from the Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition (NPCC-3: Miller, 2012a)

General learning efficiency:

- Difficulty learning new verbal information.
- Difficulty learning new visual information.
- Difficulty integrating verbal and visual information.

Long-term memory difficulties:

- Forgets where personal items or school work were left.
- Forgets to turn in homework assignments.
- Forgets what happens days or weeks ago.
- Does well on daily assignments but does not do well on end of the week quizzes.
- Limited knowledge of basic facts for places, events, and people.

Assessing Learning and Memory

Rapid Reference 12.4 restates the second- and third-order classifications of learning and memory processes within the Integrated SNP/CHC Model. The next section of this chapter describes the major stand-alone test batteries of learning and memory followed by a cross-battery listing of tests designed to measure each of the second and third order learning and memory classifications in the Integrated SNP/CHC Model.

Rapid Reference 12.4

Integrated SNP/CHC Model Classifications of Learning and Memory Processes

Broad Classifications	**Second-Order Classifications**	**Third-Order Classifications**
Learning and memory processes	• Rate of new learning	• Verbal learning • Visual learning
	• Immediate verbal memory	• Letter recall (no contextual cues) • Number recall (no contextual cues)
		• Word recall (no contextual cues)
		• Sentence recall (contextual cues)
		• Story recall (contextual cues)
	• Delayed verbal memory	• Recall with contextual cues • Recall without contextual cues
		• Verbal recognition
		• Qualitative behaviors
	• Immediate visual memory	• Abstract designs, spatial locations, or visual sequences with motor response (no contextual cues)
		• Faces, objects, or pictures with verbal or pointing response (no contextual cues)
		• Visual digit span with verbal response (no contextual cues)
		• Picture or symbolic (with contextual cues)
	• Delayed visual memory	• Recall without contextual cues • Recall with contextual cues
		• Visual recognition
		• Qualitative behaviors
	• Verbal-visual associative learning and recall	• Verbal-visual associative learning • Verbal-visual associative delayed recall

Stand-Alone Tests of Learning and Memory

The major tests of learning and memory can be divided into two categories: (1) stand-alone tests (e.g., *Children's Memory Scale*), or (2) learning and memory tests embedded within test batteries (e.g., WJIII-COG Long-term Retrieval Cluster and related subtests). Rapid Reference 12.5 lists the major stand-alone tests of learning and memory for school-age children and youth.

Rapid Reference 12.5

Major Tests of Learning and Memory

Test	**Age Range**	**Publisher**
• *California Verbal Learning Test—Children's Version* (CVLT-C)	5 to 16 years	Pearson
• *Children's Auditory Verbal Learning Test-2* (CAVLT-2)	7 to 17 years	PAR
• *Children's Memory Scale* (CMS)	5 to 16 years	Pearson
• *Test of Memory and Learning—Second Edition* (TOMAL-2)	5 to 59–11 years	PRO-ED
• *Wechsler Memory Scale—Fourth Edition* (WMS-IV)	16–90.11 years	Pearson
• *Wide Range Assessment of Memory and Learning—Second Edition* (WRAML2)	5 to 90 years	PAR

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 learning and memory. The CVLT-C was standardized on 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 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 (the degree to which the child may favor a semantic strategy in recalling a list).

Children's Auditory Verbal Learning Test22 (CAVLT-2)

The CAVLT-2 (Talley, 1994) is similar to the CVLT-C and yields measures of immediate memory span, level of learning, immediate recall, delayed recall, recognition accuracy, and total intrusions. The CAVLT-2 scores for each trial may be obtained and base rate tables are included for standard score comparisons.

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, 1997, p. 1). The three core domains measured by the CMS are: (1) auditory/verbal learning and memory, (2) visual/nonverbal learning and memory, and (3) 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 14.

Test of Memory and Learning—Second Edition (TOMAL-2)

The TOMAL-2 (Reynolds & Voress, 2007) is a comprehensive memory battery designed for children ages 5 through adults up to 59 years, 11 months. The TOMAL-2 is composed of eight core subtests divided into a Verbal Memory Scale and a Nonverbal Memory Scale. The test generates a Composite Memory Scale. The TOMAL-2 has two delayed recall tasks that yield a Delayed Recall Index based on the delayed recall of both verbal and nonverbal information learned on the first four subtests. The test also includes six supplemental subtests, which are used in combination with the core subtests to generate supplemental indices for a Verbal Delayed Recall Index, Learning Index, Attention and Concentration Index, Sequential Memory Index, Free Recall Index, and an Associate Recall Index.

Wechsler Memory Scale—Fourth Edition (WMS-IV)

The WMS-IV (Wechsler, 2009) is an individually administered battery designed to measure learning and memory in individuals ages 16 to 90 years. The test has two distinct batteries: the Adult Battery for ages 16 to 69, and the Older Adult Battery for ages 65 to 90. The focus in this book is on the Adult Battery only.

The WMS-IV Adult Battery has seven subtests, with six of the seven considered primary and one considered to be optional. The primary subtests are: Logical Memory, Verbal Paired Associates, Designs, Visual Reproduction, Spatial Addition, and Symbol Span. The optional subtest is the Brief Cognitive Status Exam. Five index scores are derived from the primary subtests including: Auditory Memory, Visual Memory, Visual Working Memory, Immediate Memory, and Delayed Memory. The WMS-IV also provides additional process scores which aid in clinical interpretation.

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

The WRAML2 (Sheslow & Adams, 2003) is a comprehensive test of learning and memory 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. These 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 includes a

Working Memory Index that encompasses both verbal and visual working memory subtests.

The subtests from each of these stand-alone memory and learning tests are individually reported in the Integrated SNP/CHC Model based on which aspect of learning and memory is being assessed.

Assessing the Rate of New Learning

The acquisition of newly learned information is frequently assessed by school neuropsychologists. Many of the major stand-alone tests of memory include tests that require the student to learn content (e.g., words, word pairs, location of a pattern of dots on a page) over repeated trials. Rapid Reference 12.6 presents a list of tests designed to measure the rate of new learning.

Rapid Reference 12.6

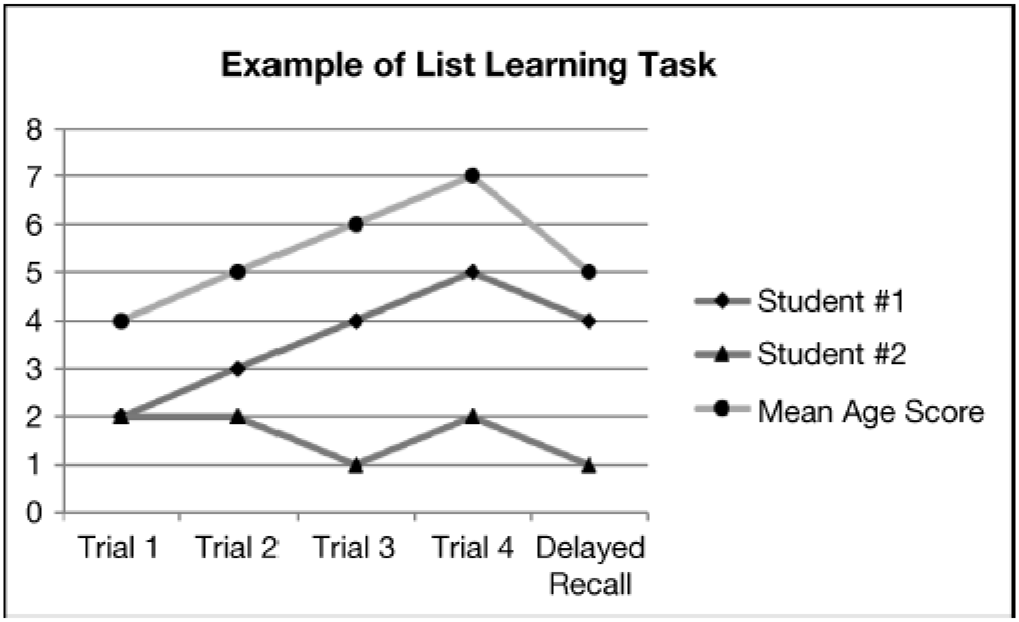
Tests of New Learning Rate

Test–Subtest: Description	Age/Grade Range	Publisher
Verbal Learning		
CMS—Word Lists—Learning: Learning a list of words over repeated trials.	5–0 to 16–11 years	Pearson
CMS—Word Pairs—Learning: Recalling a word that had been previously associated with another word.		
CVLT-C—Learning Slope: The average number of new words per trial across five trials.	5–0 to 16–11 years	
NEPSY-II—List Memory Learning Effect: The number of correctly recalled words on the last trial minus the number of correctly recalled words on the first trial.	7–0 to 12 years	
NEPSY-II—List Memory Interference Effect: Recalling a second list of words after the first list is presented.		
TOMAL-2—Word Selective Reminding: Recalling a list of words over repeated trials but only being reminded of the words not recalled each time.	6–0 to 59–11 years	PRO-ED
WRAML2—Verbal Learning: Learning a list of words over repeated trials.	5–0 to 90 years	PAR
Visual Learning		
CMS—Dot Locations Learning: Number of correctly recalled dots on a grid over three trials.	5–0 to 16–11 years	Pearson
CMS—Dot Locations Total: Number of correctly identified dots on a grid over three learning trails and one short delayed recall condition.		
See Appendix for the full names of the tests and their references.		

An index of learning is calculated differently across tests. Some tests total the number of correctly identified stimuli over repeated trials as an indicator of overall learning (e.g., WRAML2 Verbal Learning). Other tests with repeated trials subtract the number of correctly identified stimuli on the last learning trial from the number of correctly identified stimuli on the first learning trial (e.g., NEPSY-II List Memory Learning Effect). The majority of these types of tests have repeated trials of the same stimuli and the student is instructed to recall as many as possible of the stimuli each time. On one test, the Word Selective Reminding test from the TOMAL-2, the student is only reminded of the words not recalled on each trial, yet expected to recall as many as possible of the words on the list in each trial. When interpreting cross-battery assessment results within this section, the school neuropsychologist must consider the subtle differences in how the test scores are derived and how different task requirements may affect the test scores.

List learning tests should be a regular part of most neuropsychological test batteries and the student's learning curve across trials should be compared to the learning curve of the student's same aged peers. Figure 12.2 illustrates three different learning curves from children all the same age: Student #1, Student #2, and the average correct scores for same aged-peers. The average learning curve for the same-age peers shows a steady increase in the number of correctly identified words from a repeated list-learning task. Student #1 shows a pattern of performance frequently seen in children with ADHD. For Student #1, the number correct on the first trial of the task is below average but the number correct does improve with repeated exposure to the same list of words. The lower number of correctly recalled words in this example is due to initial distractibility, but the pattern of performance does suggest that the student will learn with repeated exposure to the same material.

Figure 12.2 Example of List Learning Curves



The learning curve of Student #2 indicates that the student did not benefit from repeated exposure to the same material and was incapable of learning the content. Student #2 may have an auditory processing disorder and has difficulty learning verbally presented information. Repeated exposure to verbal material is not an advisable instructional strategy for Student #2. The school neuropsychologist evaluates Student #2's visual learning skills to see if that mode of learning is best.

It is important to analyze what types of errors are made during the recall of a serial list of words. Intrusion errors are words that are recalled that were not part of the original list. Phonological errors are recalled words that sound like the originally presented words (e.g., "*far*" for "*car*"). Semantic errors are recalled words that are similar in meaning to the originally presented words (e.g., "*truck*" for "*car*"). Sometimes students recall nonlist words that are neither phonological or semantic error types, which could be indicative of more serious learning and memory problems. In a repeated list-learning task, students who make intrusion errors often repeat the same intrusion errors over and over again despite the repetition of the list of the words.

Assessing Immediate Verbal Memory

Rapid Reference 12.7 presents the major tests designed to measure immediate verbal memory across five third-order classifications. In the SNP Model, immediate verbal memory is a second-order classification within the broad classification of learning and memory functions. Immediate verbal memory is subdivided further into third-order classifications of: (1) letter recall (no contextual cues), (2) number recall (no contextual cues), (3) word recall (no contextual cues), (4) sentence recall (contextual cues), and (5) story recall (contextual cues).

Rapid Reference 12.7

Tests of Immediate Verbal Memory

Test–Subtest: Description	Age/Grade Range	Publisher
Letter Recall (No Contextual Cues)		
TOMAL-2—Letters Forward: Repeating a string of letters spoken by the examiner.	6–0 to 59–11 years	PRO-ED
WISC-IV Integrated—Letter Span–Rhyming: Repeating auditorially presented letters of increasing length which rhyme	6–1 to 16–11 years	Pearson
WISC-IV Integrated—Letter Span–Nonrhyming: Repeating auditorially presented letters of increasing length that do not rhyme		
Number Recall (No Contextual Cues)		
CMS—Numbers Forward: Repeating increasingly long series of digits.	5–0 to 16–11 years	Pearson
DAS-II—Recall of Digits Forward: Repeating increasingly long series of digits.	6–0 to 18–11 years	Pearson
KABC-II—Number Recall: Repeating a string of digits spoken by the examiner.	3 to 18 years	Pearson
TAPS-3—Number Memory Forward: Repeating a string of digits spoken by the examiner.	4 to 18–11 years	Academic Therapy Publications
TOMAL-2—Digits Forward: Repeating a string of digits spoken by the examiner.	6–0 to 59–11 years	PRO-ED
WISC-IV—Digits Forward: Repeating a string of digits spoken by the examiner.	6–0 to 16–11 years	Pearson
Word Recall (No Contextual Cues)		
CAS—Word Series: Recall of words from a verbally presented list.	5–0 to 17–11 years	PRO-ED
CVLT-C—Level of Immediate Recall: Recall of words from a verbally presented list across five trials (List A) or an additional trial of a new list of words (List B).	5–0 to 16–11 years	Pearson
CVLT-C—Learning Strategies: The type of strategy used to facilitate learning the list of words across multiple trials.		

Test–Subtest: Description	Age/Grade Range	Publisher
CVLT-C—List A Short-Delay Free Recall: Immediate recall of words on a list after multiple learning trials.		
CVLT-C—List A Short-Cued Free Recall: Immediate recognition of words contained on a list after multiple learning trials.		
CMS—Word Lists Total: Learning a list of unrelated words over multiple trials.	5–0 to 16–11 years	
CMS—Word Pairs Immediate Recall: Recalling word pairs over three trials.		
KABC-II—Word Order (without Color Interference): Touching a series of silhouettes of common objects in the same order as touched by the examiner.	3 to 18 years	
KABC-II—Word Order (with Color Interference): Same as the Word Order task with an added interference task (naming colors) between trials.		
NEPSY-II—Word List Interference Repetition: Repeating an initial string of unrelated words.	7 to 16 years	
TAPS-3—Word Memory: Ability to retain and manipulate simple sequences of auditory information.	4 to 18–11 years	Academic Therapy Publications
TOMAL-2—Word Selective Reminding: Learning a list of words then repeating it, and then only reminded of words left out.	6–0 to 59–11 years	PRO-ED
WJIII-COG DS—Memory for Words: Repeating a list of unrelated words in the correct sequence.	2–0 to 90+ years	Riverside
Sentence Recall (Contextual Cues)		
NEPSY-II—Sentence Repetition: Immediate recall of sentences of increasing length and complexity.	3 to 6 years	Pearson
TAPS-3—Sentence Memory: Memory for sentences of increasing length and complexity.	4 to 18–11 years	Academic Therapy Publications
WRAML2—Sentence Memory: Memory for sentences of increasing length and complexity.	5–0 to 90+ years	PAR

Test–Subtest: Description	Age/Grade Range	Publisher
WJIII-COG DS—Memory for Sentences: Memory for sentences of increasing length and complexity.	2–0 to 90+ years	Riverside
Story Recall (Contextual Cues)		
CMS—Stories Immediate: Details recalled from verbally presented stories.	5–0 to 16–11 years	Pearson
CMS—Stories Immediate Thematic: General themes recalled from verbally presented stories.		
NEPSY-II—Narrative Memory-Free Recall: Details recalled from verbally presented stories.	3 to 16 years	
RIAS—Verbal Memory: Details recalled from verbally presented sentences and stories.	3 to 94 years	PAR
TOMAL-2—Memory for Stories: Details recalled from verbally presented stories.	6–0 to 59–11 years	PRO-ED
WMS-IV—Logical Memory I: Details recalled from verbally presented stories.	16 to 90 years	Pearson
WRAML2—Story Memory: Details recalled from verbally presented stories.	5–0 to 90+ years	PAR
WJIII-ACH NU—Story Recall: Details recalled from verbally presented stories.	2–0 to 90+ years	Riverside
See Appendix for the full names of the tests and their references.		

The *California Verbal Learning Test: Children's Version* (CVLT-C: Delis et al., 1994) has several scores listed within the Word Recall (no contextual cues) third-order classification. The Level of Immediate Recall actually contains multiple scores designed to measure recall of words from a verbally presented list across five trials (List A) or an additional trial of a new list of words (List B). The multiple scores include: List A Total Trials 1–5, List A Trial 1 Free Recall, List A Trial 5 Free Recall, List B Free Recall, Percent Recall Consistency, Perseveration Errors, and Free-Recall Intrusions. Each of these scores needs to be considered in the interpretation of the test.

The CVLT-C also has several scores subsumed under the category of Learning Strategies, including: Semantic-Cluster Ratio, Serial-Cluster

Ratio, Percent of the Total Recall from Primacy Region, Percent of the Total Recall from Middle Region, and Percent of the Total Recall from Recency Region. Interpretation of these scores will determine the influence of the serial-order position effect on the word recall.

The NEPSY-II (Korkman, Kirk, & Kemp, 2007) Narrative Memory-Free Recall score is categorized within the Story Recall (contextual cues) third-order classification. The test has two subscores, Narrative Memory Recognition and Narrative Memory Free and Cued Recall, which need to be considered in the interpretation of the overall test score. The subscores help the clinician determine if there are beneficial effects of cued recall versus relying solely on free recall.

The Story Memory test from the WRAML2 (Sheslow & Adams, 2003) includes a total score and two subscores: Verbatim Total and Gist Total. The Verbatim Total is a measure of the exact story details recalled and the Gist Total score measures the recall of general details. These scores provide some insight into whether the student is a wholistic or “big picture” thinker or a detail-oriented thinker.

The clinician should evaluate the performance of the student across multiple levels of immediate verbal memory to determine if the inclusion of contextual cues makes a difference in facilitating or hindering recall. Some students are able to recall small chunks of verbal information easily such as memory for digits but quickly become overwhelmed when the cognitive load increases. Other students seem to need the added contextual cues to facilitate encoding and retrieval.

Assessing Immediate Visual Memory

In the Integrated SNP/CHC Model, immediate visual memory is a second-order classification within the broad classification of learning and memory functions. Immediate visual memory is subdivided further into eight third-order classifications of: (1) abstract designs with motor response (no contextual cues), (2) abstract designs with verbal response (no contextual cues), (3) faces with verbal or pointing responses (no contextual cues), (4) objects or pictures with verbal or pointing response (no contextual cues), (5) spatial locations with motor response (no contextual cues), (6) visual digit span with verbal response (no contextual cues), (7) visual sequential imitation with motor response (no contextual cues), and (8) picture or symbolic (contextual cues). Rapid Reference 12.8 presents the major tests designed to measure immediate visual memory across these eight third order classifications.

The NEPSY-II (Korkman et al., 2007) Memory for Designs test is categorized within the Abstract Designs with Motor Response third-order classification. The test requires the student to place elements of an abstract design into a grid after briefly looking at an abstract design. The test has two subscores that are important to consider in interpretation: A Content score and a Spatial score. The Content score reflects an accurate placement of a design piece into the proper position based on visual immediate memory. The Spatial score reflects a design piece placed in a position based on spatial memory alone but the piece does not match the exact piece originally seen in that position. The WMS-IV Designs I (2009) subtest has the same types of supplemental scores as the NEPSY-II Memory for Designs test. The only other supplemental score within these tests that needs to be considered in overall interpretation is the Picture Memory test from the WRAML2 (Sheslow & Adams, 2003), which includes a score for the number of commission errors made on the performance of the test.

Rapid Reference 12.8

Tests of Immediate Visual Memory

Test–Subtest: Description	Age/Grade Range	Publisher
Abstract Designs with Motor Response (No Contextual Cues)		
Bender Visual-Motor Gestalt Test—Recall: Drawing copies of abstract, geometric designs from memory.	3–0 to 85+ years	Pearson
CAS—Figure Memory: Tracing a geometric figure embedded within a more complex pattern after initial exposure to the geometric figure.	5–0 to 17–11 years	PRO-ED
DAS-II—Recall of Designs: Drawing copies of abstract, geometric designs from memory.	6–0 to 18–11 years	Pearson
NEPSY-II—Memory for Designs Total: Placing elements of an abstract design into a grid after briefly looking at an abstract design.	3 to 16 years	
WMS-IV—Designs I: Placing elements of an abstract design into a grid after briefly looking at an abstract design.	16 to 90 years	
WMS-IV—Visual Reproduction I: Drawing a set of five designs that were presented one at a time.		
WNV—Recognition: Identifying previously seen pictures embedded in a set of similar pictures.	4–0 to 21–11 years	
WRAML2—Design Memory: Redraw geometric shapes in proper locations after brief visual exposure.	5–0 to 90+ years	PAR
Abstract Designs with Verbal Response (No Contextual Cues)		
TOMAL-2—Abstract Visual Memory: Recalling geometric designs when order is not important.	6–0 to 59–11 years	PRO-ED
TOMAL-2—Visual Sequential Memory: Recalling a sequence of geometric designs.		
TVPS-3—Sequential Memory: Identifying a previously seen design sequence embedded in a set of similar design sequences designs.	4 to 18–11 years	Academic Therapy Publications

Test–Subtest: Description	Age/Grade Range	Publisher
TVPS-3—Visual Memory: Identifying previously seen abstract designs embedded in a set of similar abstract designs.		
Faces with Verbal or Pointing Response (No Contextual Cues)		
CMS—Faces Immediate Recall: Remembering faces.	5–0 to 16–11 years	Pearson
KABC-II—Face Recognition: Attending to photographs of faces briefly then picking the same photograph of faces in slightly different poses.	3 to 18 years	
NEPSY-II—Memory for Faces Immediate Recall: Picking out faces from many faces that were previously seen.	5 to 16 years	
TOMAL-2—Facial Memory: Recognition and identification of faces.	6–0 to 18–11 years	PRO-ED
Objects/Pictures with Verbal or Pointing Response (No Contextual Cues)		
DAS-II—Recognition of Picture: Recalling a set of pictures previously seen.	6–0 to 18–11 years	Pearson
UNIT—Object Memory: Identifying common objects shown in a first set of pictures now embedded with many other pictures of common objects.	5–0 to 17–11 years	Riverside
RIAS—Nonverbal Memory: Identifying previously seen pictures embedded in a set of similar pictures.	3 to 94 years	PAR
WISC-IV Integrated—Coding Recall: Immediate recall of the coding subtest shapes and numbers.	6–1 to 16–11 years	Pearson
WJIII-COG NU—Picture Recognition: Identifying previously seen pictures embedded in a set of similar pictures.	2–0 to 90+ years	Riverside
Spatial Locations with Motor Response (No Contextual Cues)		
CMS—Dot Locations Short Delayed Recall: Immediate recall of the location of dots on a grid after multiple learning trials.	5–0 to 16–11 years	Pearson
CMS—Picture Locations: Immediate recall of the location of pictures on a grid.		
TOMAL-2—Memory for Locations: Remembering the locations of dots on a page.	6–0 to 59–11 years	PRO-ED

Test–Subtest: Description	Age/Grade Range	Publisher
TOMAL-2—Visual Selective Reminding: Learning a pattern of dots then repeating it, and then only reminded of the dots left out.		
UNIT—Spatial Memory: Recreating a previously seen pattern of colored dots using colored chips on a grid.	5–0 to 17–11 years	Riverside
WISC-IV Integrated—Spatial Span Forward: Touching a sequence of blocks that was shown by the examiner.	6–1 to 16–11 years	Pearson
Visual Digit Span with Verbal Response (No Contextual Cues)		
WISC-IV Integrated—Visual Digit Span: Recalling numbers orally in the same sequence as shown in a visual sequence of numbers.	6–1 to 16–11 years	Pearson
Visual Sequences Imitation with Motor Response (No Contextual Cues)		
KABC-II—Hand Movements: Copying the examiner's precise sequence of taps on the table.	3 to 18 years	Pearson
TOMAL-2—Manual Imitations: Copying the examiner's precise sequence of taps on the table.	6–0 to 59–11 years	PRO-ED
Picture or Symbolic (with Contextual Cues)		
CMS—Family Pictures Immediate: Remembering the locations of family members in a picture.	5–0 to 16–11 years	Pearson
UNIT—Symbolic Memory: Re-creating a sequence of pictures of people.	5–0 to 17–11 years	Riverside
WRAML2—Picture Memory: Detecting changes in specific features or details after brief visual exposure to original scenes.	5–0 to 90+ years	PAR
See Appendix for the full names of the tests and their references.		

The clinician should evaluate student performance across multiple measures of immediate visual memory to determine if there is variability based on the type of stimuli to be remembered (e.g., abstract designs, faces, pictures, objects, spatial locations) or the type of response (verbal or motoric). Poor visual memory skills can affect sight word reading, writing production, and visual-spatial aspects of mathematics. Poor visual memory skills can also affect social-emotional skills such as face recognition and recall.

Assessing Delayed Verbal Memory

In the Integrated SNP/CHC Model, delayed verbal memory is a second-order classification within the broad classification of learning and memory functions. The third-order classifications are similar to the ones found in the immediate verbal memory second-order classifications including (1) delayed verbal recall with no contextual cues, (2) delayed verbal recall with contextual cues, (3) delayed verbal recognition with no contextual cues, and (4) delayed verbal recognition with contextual cues. Rapid Reference 12.9 presents the major tests designed to measure delayed verbal recall and recognition memory across these four third-order classifications.

Delayed verbal memory is often assessed using two conditions: (1) free recall, where the student recalls details freely without any cues, or (2) recognition recall, where the student is provided with partial cues to aid in the recall of previously learned material. If a student is able to freely recall details from previously learned material, testing formats in the classroom such as fill in the blank or essays will be appropriate. However, if a student is not able to freely recall details yet recall improves substantially when partial cues are presented, a multiple-choice format of testing in the classroom may be more appropriate.

Rapid Reference 12.9

Tests of Delayed Verbal Memory

Test–Subtest: Description	Age/Grade Range	Publisher
Delayed Verbal Recall (without Context)		
CVLT-C—List a Long-Delay Free Recall: Long-delay (after 20 minutes) recall of the List A words after multiple learning trials.	5–0 to 16–11 years	Pearson
CMS—Word Lists Delayed Recall: Delayed recall of unrelated words previously learned.	5–0 to 16–11 years	
CMS—Word Pairs Long-Delayed Recall: Delayed recall of word pairs previously learned.		
NEPSY-II—List Memory-Delayed Effect: The number of correctly recalled words on Trial 5 minus the number of correctly recalled words on the delayed recall trial.	7 to 12 years	
TOMAL-2—Word Selective Reminding Delayed: Delayed recall of the words learned in the word selective reminding task.	5–0 to 59–11 years	PRO-ED
WRAML2—Verbal Learning Delayed Recall: Number of correct words recalled from list after delay.	5–0 to 90 years	PAR
Delayed Verbal Recall (with Context)		
CMS—Stories-Delayed Recall: Delayed recall of story details.	5–0 to 16–11 years	Pearson
CMS—Stories-Delayed Thematic: Delayed recall of story themes.		
TOMAL-2—Memory for Stories Delayed: Delayed recall of story details.	5–0 to 59–11 years	PRO-ED
WMS-IV—Logical Memory II: Delayed free recall of story details.	16 to 90 years	Pearson
WRAML2—Story Memory-Delayed Recall: Number of correct story details recalled after delay.	5–0 to 90 years	PAR
WJIII-ACH NU—Story Recall Delayed: Delayed recall of story details.	2–0 to 90+ years	Riverside
Delayed Verbal Recognition (Without Context)		
CMS—Word Lists Delayed Recognition: Delayed recognition of words contained within the previously learned list of words.	5–0 to 90 years	PAR

Test–Subtest: Description	Age/Grade Range	Publisher
CMS—Word Pairs Delayed Recognition: Delayed recognition of previously learned word pairs.		
CVLT-C—Short- and Long-Delay Cued Recall: Short-delay cued recall of the List A words and long-delay (after 20 minutes) recall of the List A words after multiple learning trials.	5–0 to 16–11 years	Pearson
WMS-IV—Logical Memory II Recognition: Delayed recognition of story details.	16 to 90 years	Pearson
WRAML2—Verbal Learning Recognition: Number of words correctly recognized as being on the original learned list of words.	5–0 to 90 years	PAR
Delayed Verbal Recognition (With Context)		
CMS—Stories Delayed Recognition: Recognize details of a story after a delay.	5–0 to 90 years	PAR
WRAML2—Story Memory-Delayed Recognition: Number of story details recalled with additional multiple-choice cues.	5–0 to 90 years	PAR
See Appendix for the full names of the tests and their references.		

On the CVLT-C (Delis et al., 1994) the Short- and Long-Delay Cued Recall portion of the test generates multiple scores: List A Short-Delay Cued Recall, List A Long-Delay Cued Recall, Correct Recognition Hits (the number of List A words endorsed as correct on the recognition trial), Cued-Recall Intrusions (the number of recalled words not on the original list), Discriminability Index (a measure of overall recognition performance that takes into consideration both correct and incorrect responses), False-Positive Rate (endorsing a word as being on the original list of words when it was not present), and Response Bias (a tendency to overrespond with too many “yes” or “no” responses on the recognition trial). A well-trained clinician would consider all of these scores in the overall interpretation of the CVLT-C Short and Long-Delay Cued Recall performance.

The only other supplemental score within these tests that needs to be considered in overall interpretation is the Verbal Learning Recognition test from the WRAML2 (Sheslow & Adams, 2003), which includes a score for the number of Semantic Errors and the number of Phonological Errors made on the performance of the test. Semantic and phonological errors give insight into the types of encoding or retrieval errors made by a student.

Assessing Delayed Visual Memory

In the Integrated SNP/CHC Model, delayed visual memory is a second-order classification within the broad classification of learning and memory functions. The third-order classifications are similar to the ones found in the immediate visual memory second-order classifications including (1) delayed visual recall without contextual cues, (2) delayed visual recall with contextual cues, (3) delayed visual recognition without contextual cues, and (4) delayed visual recognition with contextual cues. Similar to delayed verbal memory, delayed visual memory is also often assessed using free recall and recognition conditions. Rapid Reference 12.10 presents a list of the major tests designed to measure delayed visual free and recognition recall.

The NEPSY-II (Korkman et al., 2007) Memory for Designs-Delayed Total test score has two subscores that are important to consider in interpretation: a Delayed Content score and a Delayed Spatial score. The interpretation of these scores is similar to the immediate memory version of the scores. The WMS-IV Designs II subtest has similar supplemental process scores including: Content, Spatial, and Recognition. The WMS-IV Visual Representation II subtest has supplemental process scores for Delayed Recognition and Copy (reported under Visual-Motor Integration Skills in the Sensorimotor section).

Long-term memory plays a major role in the acquisition and retrieval of new learning. Some students have good immediate memory but are not able to store that content into long-term memory. This could be due to forgetting content over time or a true neurological deficit in the ability to create memory traces. Occasionally, students will have poor immediate memory but obtain average scores for long-term retrieval. This generally indicates that the student needed extra time to process the information to be learned and once that information was encoded and stored in long-term memory it became more readily accessible. See *Long-Term Memory*

Problems in Children and Adolescents: Assessment, Intervention, and Effective Instruction by Dehn (2010) for a thorough review of the literature.

Rapid Reference 12.10

Tests of Delayed Visual Memory

Test–Subtest: Description	Age/Grade Range	Publisher
Delayed Visual Recall without Contextual Cues		
CMS—Dot Locations Long Delayed: Delayed recall of the location of dots on a grid.	5–0 to 90 years	PAR
CMS—Faces Delayed: Delayed recall of faces.		
NEPSY-II—Memory for Faces Delayed: Delayed recall of previously learned target faces.	5–0 to 16–0 years	Pearson
NEPSY-II—Memory for Designs Delayed Total: Delayed recall of the abstract designs.		
WMS-IV—Designs II: Delayed recall of spatial and visual memory with free recall and recognition tasks.	16 to 90 years	
WMS-IV—Visual Reproduction II: Delayed visual-spatial memory with free recall and recognition tasks.		
Delayed Visual Recall with Contextual Cues		
CMS—Family Pictures Delayed Recall: Delayed recall of the locations of family members in a picture.	5–0 to 90 years	PAR
Delayed Visual Recognition without Contextual Cues		
WRAML2—Design Memory Recognition: Correctly identifying designs that appeared in the original stimuli.	5–0 to 90 years	PAR
Delayed Visual Recognition with Contextual Cues		
WRAML2—Picture Memory Recognition: Correctly identifying portions of pictures that appeared in the original stimuli.	5–0 to 90 years	PAR
See Appendix for the full names of the tests and their references.		

Rapid Reference 12.11

Qualitative Behaviors for the WISC-IV Integrated: Coding

- Cued symbol recall:

  Percentage of same age peers correctly recalling which symbol goes with which number.

- Free symbol recall:

  Percentage of same age peers correctly recalling the symbols from Coding B with no regard to the associated number.

- Cued digit recall:

  Percentage of same age peers correctly recalling the numbers from paired associates in Coding B.

Qualitative Behaviors for Delayed Visual Memory

On the WISC-IV Integrated (Wechsler et al., 2004), the Coding subtest has a set of qualitative scores that aid in the clinical interpretation of the test. These qualitative scores are calculated as base rates comparing a student's performance to their same aged peers. These score are listed in Rapid Reference 12.11.

Assessing Verbal-Visual Associative Learning and Recall

In the Integrated SNP/CNC Model, verbal-visual associative learning and recall is a second-order classification within the broad classification of learning and memory functions. Verbal-visual associative learning and recall is subdivided further into third-order classifications of (1) verbal-visual associative learning, and (2) verbal-visual associative recall. Each of the verbal-visual associative learning and recall tasks involve learning to associate a visual stimulus (e.g., picture or face) with a verbal label. Many of the tasks involve an immediate learning and recall portion and a delayed recall portion. Rapid Reference 12.12 presents a list of the major tests designed to measure verbal-visual associative learning and recall.

Assessing verbal-visual associative learning is often overlooked; however, it is an important aspect of learning and memory. Verbal-visual associative learning plays a major role in the early stages of reading acquisition. For the automaticity of reading to develop, a child must learn sound-symbol associations. Verbal-visual associative learning is the cognitive process that facilitates verbal fluency in reading.

Rapid Reference 12.12

Tests of Verbal-Visual Associative Learning and Recall

Test–Subtest: Description	Age/Grade Range	Publisher
Verbal-Visual Associative Learning		
DAS-II—Recall of Object—Immediate: Naming pictures from memory over repeated trials.	2–6 to 8–11 years	Pearson
KABC-II—Atlantis: Learning visual-verbal associations and then recalling them.	3–0 to 18–0 years	
KABC-II—Rebus: Learning new information in the form of symbols and words.		
NEPSY-II—Memory for Names Total: Recalling names associated with faces over repeated trials.	5 to 16 years	
TOMAL-2—Object Recall: Recalling names associated with pictures.	5–0 to 59–11 years	PRO-ED
TOMAL-2—Paired Recall: Recalling a learned word paired with a first word provided by the examiner.		
WMS-IV—Verbal Paired Associates I: Recalling a learned word paired with a first word provided by the examiner.	16 to 90 years	Pearson
WRAML-2—Sound Symbol: Remembering the unique sound associated with a unique nonsense shape.	5 to 8 years	PAR
WJIII-COG NU—Visual-Auditory Learning: Learning visual-verbal associations and then recalling them.	2–0 to 90+ years	Riverside
WJIII-COG DS—Memory for Names: Ability to learn associations between unfamiliar auditory and visual stimuli.		
Verbal-Visual Associative Delayed Recall		
DAS-II—Recall of Objects—Delayed: Recalling the names of the pictures after a delay in time.	2–6 to 8–11 years	Pearson
KABC-II—Atlantis Delayed: Recalling visual-verbal associations after a delay.	3–0 to 18–0 years	

Test–Subtest: Description	Age/Grade Range	Publisher
KABC-II—Rebus Delayed: Recalling associations between symbols and words after a delay.		
NEPSY-II—Memory for Names Delayed: Recalling names associated with faces after a delay.	5 to 16 years	
WMS-IV—Verbal Paired Associates II Free Recall: Delayed free recall of a learned word pair.	16 to 90 years	
WMS-IV—Verbal Paired Associates II Recognition: Delayed recognition of a learned word pair.		
WRAML-2—Sound-Symbol Delayed Recall: Remembering the unique sound associated with a unique nonsense shape after a period of delay.	5 to 8 years	PAR
WJIII-COG NU—Visual-Auditory Learning Delayed: Recalling visual-verbal associations after a delay.	2–0 to 90+ years	Riverside
WJIII-COG DS—Memory for Names—Delayed: Ability to recall the previously learned associations between unfamiliar auditory and visual stimuli.		
See Appendix for the full names of the tests and their references.		

Chapter Summary

In this chapter the theories, terminology, neuroanatomy, and major tests associated with learning and memory functioning were reviewed. Learning and memory processes are essential elements in education and must be systematically evaluated by a school neuropsychologist. Learning and memory disorders are observed in many common developmental disorders.

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. True or False? The serial-order position effect lends support to the distinction between short- and long-term memory.

4. Baddeley and colleagues initially proposed a 3-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 aid of external cues?

a. Recognition

b. Free recall

c. Learning

d. Incidental learning

7. What part of the brain is responsible for the consolidation of memory from immediate- to long-term memory?

a. Hypothalamus

b. Amygdala

c. Hippocampus

d. Pituitary gland

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

Chapter 13

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 towards a goal (Stirling, 2002). This chapter reviews (1) the terms associated with executive functions; (2) the neuroanatomy of executive functions; (3) the major tests associated with executive functions; and (4) the behavioral rating scales designed to measure executive functions.

What are Executive Functions?

In the popular press, executive functions are often referred to as the *brain boss* that guides all behavior and basic definitions of executive functions often associate the frontal lobes as the primary source of these functions (McCloskey, Perkins, & Divner, 2009). Despite the fact that many executive functions are related to frontal lobe functioning there is not a single frontal lobe syndrome that has a point-by-point correspondence to an executive functioning homunculus (Stuss & Alexander, 2000).

Barkley 2012) defines executive functions as:

> [T]he use of self-directed actions so as to choose goals and to select, enact, and sustain actions across time toward those goals usually in the context of others often relying on social and cultural means for the maximization of one's long-term welfare as the person defines that to be. (p. 176)

McCloskey et al. (2009) propose that executive functions are a set of directive capacities that facilitate a person's ability to engage in purposeful processing of perceptions, emotions, thoughts, and actions. Executive functions can be thought of as facilitators that guide other cognitive processing. These facilitators include attentional control, goal-directed behaviors, behavioral regulation, organizational skills, planning, and problem-solving strategies. Some examples of terms researchers and practitioners use to describe executive functioning are presented in Rapid Reference 13.1.

Rapid Reference 13.1

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 generation • 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).

McCloskey's model of executive functions outlines five tiers of executive capacity including: self-activation, self-regulation, self-realization and determination, self-generation, and trans-self integration (see McCloskey et al., 2009). McCloskey's model of executive functions (McCloskey et al., 2009) initially identified 23 different self-regulation executive functions and the list has expanded to 32 self-regulation executive functions (McCloskey & Wasserman, 2012). See Rapid Reference 13.2 for a brief description of the 32 self-regulation executive function capacities.

From a theoretical standpoint, McCloskey's conceptualization of executive functions is very broad and seems to encompass many areas within the Integrated SNP/CHC Model. From an assessment standpoint, current assessment instruments designed to measure executive functions do not include the degree of specificity that McCloskey and his colleagues have postulated. Within the Integrated SNP/CHC Model, executive functions encompass cognitive flexibility or set shifting, concept formation, problem solving or reasoning, and response inhibition.

Rapid Reference 13.2

Brief Description of McCloskey's 32 Self-Regulation Executive Function Capabilities

Attention cluster	*Optimization cluster*
• *Perceive/aware*—Cueing the taking in of information from the external environment (e.g., seeing, hearing, touching), cueing awareness of the need to tune to thoughts and/or feelings, body position in space and body movements. • *Focus/select*—Cueing attention to the most relevant specifics of a given environment, situation, or content while downgrading or ignoring the less relevant elements. • *Sustain*—Cueing sustained engagement of the processes involved in perceiving, feeling, thinking, or acting for as long as a situation requires. *Engagement cluster* • *Initiate*—Cueing the initial engagement of perceiving, feeling, thinking, or acting. • *Energize*—Cueing the application of energy and effort into perceiving, feeling, thinking and acting. • *Inhibit*—Cueing resistance to, or suppression of, urges to perceive, feel, think, or act. • *Stop*—Cueing the immediate cessation of perceiving, feeling, thinking, or acting. • *Interrupt*—Cueing the brief interruption of perceiving, feeling, thinking, or acting. • *Flexible*—Cueing the realization and acceptance of the need to change	• *Modulate*—Cueing changes in the amount and intensity of mental energy invested in perceiving, feeling, thinking, and acting. For example, can effectively adjust voice volume, activity level, reactions to sights and sounds. • *Monitor*—Cueing the use of routines to check on the accuracy of perceptions, emotions, thoughts, or actions. • *Correct*—Cueing the correction of errors of perception, emotion, thought, or action based on feedback from internal or external sources. • *Balance*—Cueing the establishment of balance when perceiving, feeling, thinking, or acting to enhance or improve experiencing, learning, or performing. Cueing the sensing of the trade-off between opposing processes or states (e.g., pattern versus detail; speed versus accuracy; humor versus seriousness) to maintain a balance. *Evaluation/solution cluster* • *Gauge*—Cues the "sizing up" of the demands of a task to know the perceptions, emotions, thoughts, or actions needed to effectively engage the task or situation. • *Anticipate/foresee*—Cues the anticipation of conditions or events in the very near future, such as the consequences of one's own perceptions, feelings, thoughts, and/or actions. • *Estimate time*—Cues the use of an internal time sense to determine how long something will take to complete, or how much time is still left in a specific period of time. • *Pace*—Cues for the regulation of the rate at which perceptions, feelings, thoughts, and actions are experienced or performed.

perceptions, feelings, thoughts, or actions based on the situation at hand. • *Shift*—Cueing the transition from one perception, feeling, thought, or action to another without difficulty. • *Analyze*—Cues the close examination of perceptions, feelings, thoughts, or actions to obtain a greater understanding of a problem or situation. • *Associate*—Cues the activation of the resources needed to make the proper associations among perceptions, feelings, thoughts, and actions appropriate for the situation at hand. • *Generate*—Cues the activation of the resources needed to carry out novel problem-solving routines. • *Organize*—Cues the use of routines for sorting, sequencing, or otherwise arranging perceptions, feelings, thoughts, and/or actions, to enhance or improve the efficiency of experiencing, learning, or performing. • *Plan* (short term)—Cues for the specification of a series of perceptions, feelings, thoughts, and/or actions that, if carried out, would be most likely to produce a desired outcome in the very near future (within minutes to within several hours). • *Evaluate/compare*—Cues the making of comparisons among, or the evaluation of the adequacy of, perceptions, feelings, thoughts, or actions.	• *Sequence*—Cues for the ordering of a series of perceptions, feelings, thoughts, and/or actions, especially in cases where automated routines are being accessed or are initially being developed. • *Execute*—Cues for the activation of well-known series of perceptions, feelings, thoughts, and/or actions, especially in cases where automated routines have been practiced and used frequently. *Memory cluster* • *Hold*—Cues the holding onto of specific perceptions, feelings, thoughts, and actions for a brief period of time. • *Manipulate*—Cues for the manipulation of perceptions, feelings, thoughts, or actions as they are being held in mind. • *Store*—Cues the storing of specific perceptions, feelings, thoughts, and actions so that they can be retrieved as needed at a later time. • *Retrieve*—Cues for the retrieval of previously stored information about perceptions, feelings, thoughts, and actions.

• *Choose/decide*—Cues for the making of a choice or the rendering of a decision. *Efficiency cluster* • *Sense time*—Cues for the monitoring of the passage of time (recognizes the need for having an internal sense of how long they have been perceiving, feeling, thinking or acting).	

Source: Self-Regulation Executive Function Definitions. Copyright © 2012 George McCloskey, PhD Reprinted with permission.

Neuroanatomy of Executive Functions

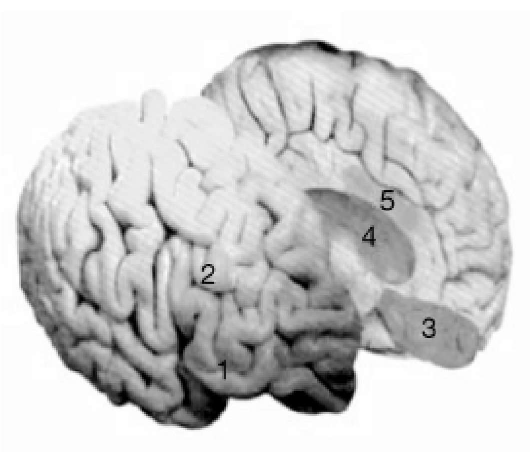
Historically, executive functions have been viewed to be synonymous with frontal lobe involvement. While the frontal and prefrontal lobes do play major roles in executive functioning, there are excitatory and inhibitory pathways that start in subcortical regions of the brain (e.g., the basal ganglia 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 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 inferotemporal/posterior parietal. The lateral and ventromedial orbitofrontal circuits are 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 evaluation of a student's handwriting would be an appropriate ecological validity check of the integrity of the skeletomotor circuit. The oculomotor circuit is related to the frontal eye fields and helps regulate visual scanning. Hale and Fiorello (2004) suggest 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 the most interest to school neuropsychologists. The locations of the major frontal-subcortical circuits that help regulate behavior are illustrated in Figure 13.1.

Figure 13.1 The Locations of the Major Frontal-Subcortical Circuits That Help Regulate Behavior Relative to the Location of the Limbic System



1. Orbitofrontal (lateral)
2. Dorsolateral prefrontal
3. Orbitofrontal (ventromedial)
4. Limbic System
5. Anterior Cingulate

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 13.3.

Rapid Reference 13.3

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

The dorsolateral prefrontal circuit serves as the principle “executor of the brain.” As shown in Rapid Reference 13.3, 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 most 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 13.4. The majority of neuropsychological and cognitive tests activate the dorsolateral prefrontal circuit (Ardila, 2008).

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, he was often crude, socially inappropriate, impatient, and obstinate.

Rapid Reference 13.4

Neurocognitive Deficits Associated With Damage or Dysfunction in the Dorsolateral Prefrontal Circuit

- Decreased verbal retrieval
- Decreased nonverbal retrieval
- 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 and sustaining attention.
- Difficulty generating hypotheses.

A summary of the neurocognitive deficits associated with damage or dysfunction to the orbitofrontal circuit is presented in Rapid Reference 13.5. "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 13.5

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, & Lesser, 1993). 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 13.6. The anterior cingulate circuit regulates motivational mechanisms. Apathy is the common behavioral manifestation to damage in 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 as well (Lichter & Cummings, 2001).

Rapid Reference 13.6

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, on the NEPSY-II Inhibition test, when the child is to name a "square" in lieu of a "circle" or vice versa, this would be 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 13.7 lists some common neuropsychological terms used to describe impairments in executive functioning.

Rapid Reference 13.7

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).
- *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.
- *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.
- *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.

When to Assess for Executive Functions

Deficits in some or all of these executive functions have been associated with more than one neurodevelopmental disorder including: attention-deficit hyperactivity disorder, Tourette's syndrome, obsessive-compulsive disorder, and schizophrenia. The relationships between these executive dysfunction disorders are not yet clearly understood and make differential diagnosis difficult (Maricle, Johnson, & Avirett, 2010). Given the fact that the majority of cognitive processes described in this book use some combination of executive facilitators it is suggested that screening for executive functions be included in all assessments. See Miller (2010) for a review of the common neurodevelopmental disorders, which have evidenced executive dysfunctions.

Identifying Executive Dysfunction Concerns

It is suggested that the *Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition* (NPCC-3: 2012) be completed by the parent/guardian and at least one teacher of the student being referred for a comprehensive assessment (see the supplemental CD for the complete NPCC-3). The questions on the NPCC-3 that pertain to executive function difficulties are shown in Rapid Reference 13.8. Any endorsed items in the moderate to severe range should be followed up with formal assessment measures in the school neuropsychological assessment.

Rapid Reference 13.8

Executive Function Items From the Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition (NPCC-3: Miller, 2012)

Flexibility in thinking difficulties:

- Gets stuck on one activity (e.g., playing video games).
- Does not seem to hear anything else while watching TV.
- Difficulty transitioning from one activity to another.

Planning difficulties:

- Difficulty with making plans.
- Quickly becomes frustrated and gives up easily.
- Difficulty figuring out how to start a complex task.
- Difficulty sticking to a plan of action.

Problem solving and organizing difficulties:

- Difficulty solving problems that a younger child can do.
- Difficulty learning new concepts or activities.
- Makes the same kinds of errors over and over, even after corrections.
- Frequently loses track of possessions.

Behavioral/emotional regulation difficulties:

- Demonstrates signs of over activity (hyperactivity).
- Does not seem to think before acting.
- Difficulty following rules.
- Demonstrates signs of irritability.
- Lacks common sense or judgment.
- Cannot empathize with the feelings of others.

Assessing Executive Functions

Behavioral samples of executive functioning come from four primary sources:

1. *Comprehensive test batteries designed to measure executive functioning* [e.g., Delis-Kaplan Executive Function System (D-KEFS: Delis, Kaplan, & Kramer, 2001)];

2. *Comprehensive test batteries designed to measure all major neuropsychological processes including executive functions* [e.g., NEPSY-II: Korkman, Kirk, & Kemp, 2007];

3. *Tests of cognitive functions* [e.g., Woodcock-Johnson III Tests of Cognitive Ability (WJIII-COG: Woodcock, McGrew, & Mather, 2001, 2007a)]; and

4. *Stand-alone tests that were designed to measure executive functions* [e.g., Wisconsin Card Sorting Test (Heaton, 1981)].

It is important to note that traditional cognitive abilities 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 their attention when distracted. Still, there are certain components within cognitive test batteries that attempt to tease out various aspects of executive functioning skills (e.g., measures of planning, reasoning, concept generation). Tests from cognitive instruments designed to measure executive functions will be reported in the second- and third-order classifications of the SNP Model in the sections below.

Rapid Reference 13.9 restates the second- and third-order classifications of executive functions within the Integrated SNP/CHC Model. Tests designed to measure these second- and third-order classifications of executive functions are presented in this section.

Rapid Reference 13.9

Integrated SNP/CHC Model Classifications of Executive Functions

Broad Classifications	Second-Order Classifications	Third-Order Classifications
Executive functions	• Cognitive flexibility (set shifting)	• Verbal set shifting • Visual set shifting • Verbal and visual set shifting
	• Concept formation	• Concept recognition • Concept generation

	• Problem solving, planning, and reasoning	• Planning
		• Deductive and inductive reasoning
		  • Verbal deductive and inductive reasoning
		  • Visual deductive and inductive reasoning
		• Sequential reasoning
		• Quantitative reasoning

	• Response inhibition	• Verbal response inhibition • Motoric response inhibition
	• Qualitative behaviors	
	• Behavioral rating scales	

Rapid Reference 13.10

Tests of Cognitive Flexibility

Test–Subtest: Description	Age/Grade Range	Publisher
Verbal Cognitive Flexibility		
D-KEFS—Color-Word Interference—Condition 4 (Inhibition/Switching): Completion time as the child rapidly switches back and forth between naming the dissonant ink colors and reading the words.	8–0 to 89–11 years	Pearson
D-KEFS—Verbal Fluency Condition 3—Category Switching: Total Correct Responses: Switching between verbalizing fruits and pieces of furniture.		
NEPSY-II—Inhibition Condition 3 (Switching): Rapidly and accurately name shapes while switching cognitive sets.	5 to 16 years	
Visual Cognitive Flexibility		
D-KEFS—Design Fluency Condition 3—Switching: Switching between connecting solid dots and empty dots.	8–0 to 89–11 years	Pearson
D-KEFS—Trail-Making Condition 4—Number-Letter Switching: A psychomotor task that requires switching between number and letter sequences (e.g., 1-A-2-B ...).		
TEA-Ch—Creature Counting Total Correct: Ability to follow a path and count up or down depending on the direction of the arrows along the path.	6 to 15–11 years	Pearson
WCST—Perseveration Responses: Responses that involve getting stuck on the correct response from a previously learned rule.	6–5 to 89 years	PAR
Verbal and Visual Cognitive Flexibility		
NEPSY-II—AARS—Response Set: Added shifting of attention while selectively responding to auditory target words and ignoring auditory nontarget words over time.	7 to 16 years	Pearson
PAL-II RW and PAL-II M—RAS Word and Digit Total Time: The time taken to rapidly name a mixture of words and digits.	Grades K to 6	
PAL-II RW and M—RAS Words and Digits Rate Change: The incidence rate of changing the speed of reading the words and digits.	Grades K to 6	

Test–Subtest: Description	Age/Grade Range	Publisher
PAL-II RW and M—RAS Words and Digits Total Errors: The total number of errors when rapidly reading the mixture of words and digits.		
TEA-Ch—Opposite Worlds—Same World Total: Ability to follow a path filled with the digits 1 and 2 while saying "1" when seeing a 1 and "2" when seeing a 2.	6 to 15–11 years	
TEA-Ch—Opposite Worlds—Opposite World Total: Ability to follow a path filled with the digits 1 and 2 while saying "1" when seeing a 2 and "2" when seeing a 1.		
WJIII-COG NU—Auditory Attention: Listening to a word while seeing four pictures and then pointing to the picture of the word that was spoken amid increasingly loud background noise.	2 to 80+ years	Riverside
See Appendix for the full names of the tests and their references.		

Assessing Cognitive Flexibility or Set Shifting

The second-order classification of cognitive flexibility or set shifting separates the tasks based on the modality of the input demands, either verbal or visual, or verbal and visual combined. Rapid Reference 13.10 presents tests that measure verbal, visual, or verbal and visual aspects of cognitive flexibility.

Within the verbal cognitive flexibility tasks, it is important to note that the fourth condition of the Color-Word Test on the Delis-Kaplan Executive Function System (D-KEFS: Delis et al., 2001) measures verbal inhibition and switching of attention. The D-KEFS Color-Word Test includes scores for total completion time and the total number of switching (or shifting attention) errors. Likewise, the third condition of the Verbal Fluency test on the D-KEFS includes scores for the total number of correct responses and the total number of correct switches between verbal categories of words retrieved. Finally, the third part of the Inhibition test on the NEPSY-II (Korkman et al., 2007) measures verbal cognitive flexibility and includes a Switching Combined score that is a composite score derived from the Total Completion Time score and the Total Number of Errors score. There are also supplemental scores for the Total Number of Uncorrected Errors and the Total Number of Self-Corrected Errors. It is important for the school neuropsychologist to analyze and report these subscores to accurately describe the performance of a student on each test, respectively.

Condition 4 (Number-Letter Switching) of the D-KEFS's Trail-Making Test is reported in the visual cognitive flexibility section. When a student achieves a low score on this test, the clinician will need to examine and possibly report the scores from the other conditions on the Trail-Making Test, which measure visual scanning (Condition 1), number sequencing (Condition 2), letter sequencing (Condition 3), and motor speed (Condition 5). See a discussion of how to interpret these scores in Chapter 8.

Creature Counting from the TEA-Ch has a total correct and a timing score, which should both be considered when interpreting the test results. Likewise, the Wisconsin Card Sorting Test (WCST) yields scores for the percent of perseveration responses, the number of perseveration errors, and the percentage of perseveration errors; all of which should be considered in test interpretation.

Within the verbal and visual cognitive flexibility tasks, the Response Set portion (Part 2) of the Auditory Attention and Response Set test on the NEPSY-II measures aspects of both auditory and visual selective/focused, sustained, and shifting of cognitive set. This test includes several scores, which should all be interpreted and reported. Response Set (Part 2 of the test) scores include Response Set Combined, a composite of the Commission Errors and Total Correct scores, and supplemental scores of Total Omission Errors and Total Inhibitory Errors. A school neuropsychologist needs to fully understand how the student's performance on this task influences these scores (see Chapter 8 for an interpretative example). Students with cognitive flexibility deficits have difficulty with transitioning from one activity in the classroom to another. They have a tendency to perseverate, or get stuck, doing one task and have difficulty letting go of that task to start a new one.

Assessing Concept Formation

Tests designed to measure concept formation are presented in Rapid Reference 13.11. It is important to make a distinction between concept recognition and concept generation. Concept recognition provides a measure of the underlying reasoning and concept formation skills. Tests that measure concept recognition may involve classification of pictures or objects based on a common concept or describing a common characteristic that two words share. Another example of concept recognition is the ability to verbally describe common attributes used to sort stimuli into conceptual groupings.

Rapid Reference 13.11

Tests of Concept Recognition and Generation

Test–Subtest: Description	Age/Grade Range	Publisher
Concept Recognition		
Boehm-3—Preschool: Measures the child's ability to identify basic concepts.	3–0 to 5–11 years	Pearson
Boehm-3—Grades K to 2: Measures the child's ability to identify basic concepts.	Grades K–2	
CTONI-2—Geometric Categories: Categorical classification using geometric designs.	6–0 to 89–11 years	PRO-ED
CTONI-2—Pictorial Categories: Categorical classification using pictures of familiar objects.		
DAS-II—Early Number Concepts: Oral math questions with illustrations.	2–6 to 8–11 years	Pearson
DAS-II—Picture Similarities: Multiple-choice matching of pictures on the basis of relationships.		
DAS-II—Verbal Similarities: Explaining how three things or concepts go together.	5 to 17–11 years	
D-KEFS—Sorting Test—Combined Conditions 1 + 2 Description: Accuracy in describing sorts either completed by self or by the examiner.	8 to 89–11 years	
D-KEFS—Twenty Questions Initial Abstraction: Level of abstract reasoning in the first questions asked.		
D-KEFS—Twenty Questions Total Questions Asked: The fewer the questions asked the better.		
D-KEFS—Twenty Questions Total Weighted Achievement: This score is used only if the child guesses the correct answer quickly.		
WISC-IV—Similarities: Describing how two words that represent common objects or concepts are similar.	6–0 to 16–11 years	
WISC-IV Integrated—Similarities Multiple-Choice: A multiple-choice version of the Similarities subtest, which lowers the verbal and memory demands of the task.	6–1 to 16–11 years	
Concept Generation		

Test–Subtest: Description	Age/Grade Range	Publisher
D-KEFS—Sorting test—Condition 1 (free sorting) Confirmed Correct Sorts: The number of confirmed correct sorts made on the two card sets.	8 to 89–11 years	Pearson
NEPSY-II—Animal Sorting Combined: A combination of the number of correct sorts and the number of errors. Measures initiation, cognitive flexibility, self-monitoring, and conceptual knowledge.	7 to 16 years	
See Appendix for the full names of the tests and their references.		

Concept generation is the ability to classify objects into conceptual groupings that share a common characteristic; however, no verbal justification or rationale used for sorting the objects is required. Some students achieve an average score on concept generation tasks because their sorts are correct by chance only; however, on tasks that require the additional step of describing the rationale for sorting, as in many concept recognition tasks, they are not always able to perform as well.

The D-KEFS Sorting Test (Delis et al., 2001) includes measures of both concept generation and recognition and is the most thorough of all of the concept recognition and generation measures. The D-KEFS Sorting Test includes four additional measures that should be included in the interpretation of the overall performance on the test including: Free Sorting Description (Condition 1), Sort Recognition Description (Condition 2), Combined Conditions 1 + 2 Description (verbal rules), and Combined Conditions 1 + 2 (perceptual rules).

In the classroom, concept recognition plays an important role in learning. When presented with new information an efficient learner must try to relate that new information to previous learning. In Piagetian terms this was described as assimilation and accommodation. If the new information can be categorically or semantically related to previous learning it is assimilated into our memory stores. If the new information is unique to our semantic classifications we must accommodate that information by modifying or creating a new way of storage. Concept recognition facilitates the storage and retrieval of information. Concept generation also plays an important role in learning. However, concept generation is a more active process of seeing the similarities in objects or concepts or words and being able to identify those shared similarities. Concept generation is concept recognition put into action.

Assessing Problem Solving, Planning, and Reasoning

The second-order classification of problem solving, planning, and reasoning separates the tasks into the third-order classifications of planning, deductive and inductive reasoning, sequential reasoning, and quantitative reasoning.

Tests of Planning

Tests designed to measure planning are presented in Rapid Reference 13.12.

Rapid Reference 13.12

Tests of Planning

Test–Subtest: Description	Age/Grade Range	Publisher
CAS—Planned Connections: Quickly connecting number and letter sequences.	2–0 to 90+ years	Riverside
KABC-II—Rover: Moving a toy dog through a maze in an efficient manner.	3–0 to 18–0 years	Pearson
UNIT—Mazes: Tracing a path through mazes.	5–0 to 17–11 years	Riverside
WISC-IV Integrated—Elithorn Mazes: Tracing a path through mazes as quickly as possible.	6–1 to 16–11 years	Pearson
WISC-IV Integrated—Elithorn Mazes: No Time Bonus: The Elithorn mazes task with no completion time bonus.		
WJIII-COG NU—Planning: Measures the mental control process in determining, selecting, and applying solutions to problems using forethought.	2–0 to 90+ years	Riverside
See Appendix for the full names of the tests and their references.		

Tests of Deductive and Inductive Reasoning

Tests designed to measure deductive and inductive reasoning are presented in Rapid Reference 13.13.

Rapid Reference 13.13

Tests of Deductive and Inductive Reasoning

Test–Subtest: Description	Age/Grade Range	Publisher
Verbal Deductive and Inductive Reasoning		
D-KEFS—Proverbs Total Achievement: Free Inquiry: Knowledge of verbal proverbs.	16–0 to 89–11 years	Pearson
D-KEFS—Proverbs Total Achievement: Multiple Choice: Recognition of verbal proverbs.		
D-KEFS—Word Context Total Consecutively Correct: Verbal abstract deductive reasoning.	8–0 to 89–11 years	
RIAS—Guess What: Deduction of object or concept being described with a set of 2–4 clues.	3 to 94 years	PAR
RIAS—Verbal Reasoning: Competing sentences to form verbal analogies.		
SB5—Verbal Fluid Reasoning: Ability to solve novel problems presented in words and sentences.	2 to 85+ years	Riverside
TAPS-3—Auditory Reasoning: Understanding jokes, riddles, inferences, and abstractions.	4 to 18–11 years	Academic Therapy Publications
WISC-IV—Comprehension: Answering questions based on understanding of general principles and social situations.	6–0 to 16–11 years	Pearson
WISC-IV Integrated—Comprehension Multiple Choice: A multiple-choice version of the Comprehension subtest. Lesser verbal and recall memory demands.	6–1 to 16–11 years	
WISC-IV—Word Reasoning: Identifying an object, word, or concept with incremental clues.	6–0 to 16–11 years	
Visual Deductive and Inductive Reasoning		
CAS—Nonverbal Matrices: Comprehend the relationships among the parts of a visual matrix and choose the best of six options.	2–0 to 90+ years	Riverside
CTONI-2—Geometric Analogies: Completing nonverbal analogies using geometric designs.	6–0 to 89–11 years	PRO-ED
CTONI-2—Pictorial Analogies: Completing nonverbal analogies using pictures of familiar objects.		

Test–Subtest: Description	Age/Grade Range	Publisher
D-KEFS—Tower Total Achievement: Overall quality of tower building within time limits.	8–0 to 89–11 years	Pearson
DAS-II—Matrices: Solving visual puzzles.	2–6 to 17–11 years	
NEPSY-II—Clocks: Recognizing time on analog clocks, and constructing clock faces.	7 to 16 years	
RIAS—Odd-Item Out: Designating one item out of many visual objects that does not match the remainder of the objects.	3 to 94 years	PAR
SB5—Nonverbal Fluid Reasoning: Ability to solve novel problems presented in pictures and figures.	2 to 85+ years	Riverside
UNIT—Analogic Reasoning: Completing a matrix analogies task using common objects.	5–0 to 17–11 years	Riverside
UNIT—Cube Design: Completing a 3-dimensional block design.		
WISC-IV—Matrix Reasoning: Completing a missing portion of a picture matrix.	6–0 to 16–11 years	Pearson
WISC-IV—Picture Concepts: Choosing one picture from among two or three rows of pictures to form a group with a common characteristic.		
WNV—Matrices: Completing a missing portion of a picture matrix.	4–0 to 21–11 years	
WCST—Total Number of Errors: Number of errors made in categorizing cards.	6–5 to 89 years	PAR
WJIII-COG NU—Concept Formation: Categorical reasoning and inductive logic.	2–0 to 90+ years	Riverside
See Appendix for the full names of the tests and their references.		

The D-KEFS measures (Delis et al., 2001) all have additional processing scores that aid in the clinical interpretation of the test. For example, the Word Context test has a global score for the total consecutive correct but also yields scores for the number of repeated incorrect responses and the consistently correct ratio. The Proverbs test yields a total achievement score based on free inquiry but also provides the clinician with separate scores for common and uncommon proverbs and scores for accuracy only and abstraction only. The Proverbs test also yields a total achievement score based on multiple choice and process scores for common and uncommon proverbs, total correct abstract or concrete responses, and total incorrect phonemic or unrelated choices.

On the *Wisconsin Card Sorting Test* (Heaton, Chelune, Talley, Kay, & Curtiss, 1993) the primary score generated is the total number of errors. However, the test also provides the clinician with supplemental scores, which will aid in clinical interpretation, including percentage of total errors, total number of nonperseverative errors, percentage of perseverative errors, percentage of conceptual level responses, and a learning to learn score.

Tests of Sequential Reasoning

Tests designed to measure sequential reasoning are presented in Rapid Reference 13.14.

Rapid Reference 13.14

Tests of Sequential Reasoning

Test–Subtest: Description	Age/Grade Range	Publisher
CTONI-2—Geometric Sequences: Sequential reasoning using geometric designs.	6–0 to 89–11 years	PRO-ED
CTONI-2—Pictorial Sequences: Sequential reasoning using pictures of familiar objects.		
KABC-II—Pattern Reasoning: Selecting a pattern that completes a logical, linear pattern.	3–0 to 18–0 years	Pearson
KABC-II—Story Completion: Selecting a scene that completes a complete story sequence.		
WNV—Picture Arrangement: Rearrange a set of pictures to tell a story that makes sense.	4–0 to 21–11 years	
WJIII-COG NU—Analysis/Synthesis: General sequential (deductive) reasoning.	2–0 to 90+ years	Riverside
See Appendix for the full names of the tests and their references.		

Tests of Quantitative Reasoning

Tests designed to measure quantitative reasoning are presented in Rapid Reference 13.15.

Rapid Reference 13.15

Tests of Quantitative Reasoning

Test–Subtest: Description	Age/Grade Range	Publisher
DAS-II—Sequential and Quantitative Reasoning: Figuring out sequential patterns in pictures or geometric figures, or common rules in numerical relationships.	5–0 to 17–11 years	Pearson
WJIII-COG DS—Number Matrices: Ability to analyze the relationship among numbers and identify the missing number.	2–0 to 90+ years	Riverside
WJIII-COG DS—Number Series: Ability to determine a numerical pattern and provide the missing number in a series.		
See Appendix for the full names of the tests and their references.		

Problem solving, fluid reasoning, and planning are processes that help students be active learners. These processes help students to make complex choices and decisions, understand the interconnections between subject matter, learn to identify and ask significant questions that help clarify differing points of view which lead to better solutions, and framing, analyzing, and synthesizing information to solve problems and answer questions. Problem solving skills are especially important in learning the procedural steps and reasoning required in mathematics.

Assessing Response Inhibition

A distinction needs to be made between cognitive and behavioral response inhibition. If a child has difficulty controlling his or her impulse to lash out at another child sitting nearby, this would be an example of a behavioral response inhibition control problem. In this section, cognitive response inhibition is the focus. An example of a cognitive response inhibition task is the classic Stroop effect when a student is asked to look at a series of color words (“red,” “green,” and “blue”) and inhibit the natural tendency to read the word itself rather than naming the color of the ink in which the word is printed. For example, the student sees the word “red” printed in green ink and is instructed to say “green.” Response inhibition requires vigilance to rules, patience, and impulse control, attributes that many students struggle with in an educational environment.

Tests designed to measure verbal and visual response inhibition are presented in Rapid Reference 13.16. The major scores for these tests are listed but some of the measures yield supplemental scores, which will aid in clinical interpretation. For example, the third condition of the Color-Word Interference test on the D-KEFS (Delis et al., 2001) is the classic inhibition portion of the test and generates a total score based on the amount of time required to complete the task. A supplemental score is generated for the total number of uncorrected and corrected errors made on the task. This supplemental score for errors is important to consider in the interpretation of the test, because completion time may be very slow due to poor processing speed or due to the high number of self-corrected errors made during the performance of the task.

Rapid Reference 13.16

Tests of Response Inhibition

Test–Subtest: Description	Age/Grade Range	Publisher
Verbal Response Inhibition		
CAS—Expressive Attention: Rapidly naming animals or color words with varying degrees of stimulus distraction.	5–0 to 17–11 years	PRO-ED
D-KEFS—Color-Word Interference Condition 3 (Inhibition): Time taken to rapidly name the color of the ink a color word (“red”) is printed in.	8–0 to 89–11 years	Pearson
NEPSY-II—Inhibition (Condition 2) Combined: Rapidly and accurately naming the opposite names of shapes (e.g., “circle” for “square”).	5 to 16 years	
Motoric Response Inhibition		
NEPSY-II—Statue Total: Maintaining a body position during distractions.	3 to 6 years	Pearson
TEA-Ch—Walk Don't Walk: Marking a line on a printed pathway only in response to a target tone.	6 to 15–11 years	
See Appendix for the full names of the tests and their references.		

On the second condition of the NEPSY-II Inhibition test (Korkman et al., 2007), the students are shown pictures of circles and squares or up and down arrows. On this condition students are asked to say “circle” every time they see a square and say “square” every time they see a circle, and the same alternative labels for up and down arrows. The test yields a total score, which combines the effects of completion time and errors. It is important for the clinician to analyze the supplemental scores on this test, which include separate scores for completion time and total errors. The interplay between speed and accuracy has important clinical implications and may be masked by the total combined score. Two additional scores provide greater interpretative precision for analyzing the errors by examining a supplemental score for the total number of uncorrected errors versus the total number of self-corrected errors.

On the NEPSY-II Statue test (Korkman et al., 2007), students are asked to stand with their eyes closed and pretend to hold a flag while the examiner provides distractions. The task measures the student's ability to inhibit motoric responses. The test yields a total score and supplemental scores for the number of body movement inhibitory errors, eye opening inhibitory errors, and vocalization inhibitory errors. These supplemental scores will provide additional insight to the clinician about the types of errors made in a motoric response inhibition task.

Qualitative Behaviors of Executive Functions

Several tests such as the D-KEFS (Delis et al., 2001) and NEPSY-II (Korkman et al., 2007) have provided clinicians with normative information that quantifies qualitative behaviors. The qualitative behaviors that relate to executive functions are presented in Rapid Reference 13.17.

Rapid Reference 13.17

Qualitative Behaviors Related to Executive Functions

Set-loss errors (failure to maintain the directions):

- D-KEFS: Design Fluency: Total Set-Loss Designs
- D-KEFS: Sorting Test Condition 1 Set-Loss Sorts
- D-KEFS: Trail-Making Test: Condition 2—Number Sequencing Set-Loss Errors
- D-KEFS: Trail-Making Test: Condition 3—Letter Sequencing Set-Loss Errors
- D-KEFS: Trail-Making Test: Condition 4—Number-Letter Switching Set-Loss Errors
- D-KEFS: Twenty Questions: Set-Loss Questions
- D-KEFS: Verbal Fluency: Set-Loss Errors
- D-KEFS: Verbal Fluency: Percent Set-Loss Errors
- D-KEFS: Word Context: Total Correct-to-Incorrect Errors
- WCST: Failure to Maintain Set

Repetition errors (close together = perseveration, far apart = memory weakness):

- D-KEFS: Design Fluency: Total Repeated Designs
- D-KEFS: Proverbs Repeated Responses
- D-KEFS: Sorting Test Condition 1 Repeated Sorts
- D-KEFS: Sorting Test Combined Repeated Descriptions
  - Condition 1: Free Sorting Repeated Descriptions
  - Condition 2: Sort Recognition Repeated Descriptions
- D-KEFS: Twenty Questions: Repeated Questions
- D-KEFS: Verbal Fluency: Repetition Errors
- D-KEFS: Verbal Fluency: Percent Repetition Errors
- D-KEFS: Word Context Repeated Incorrect Responses

Corrected errors (good self-monitoring):

- D-KEFS: Color-Word Interference Test: Condition 3—Inhibition Corrected Errors
- D-KEFS: Color-Word Interference Test: Condition 4—Inhibition/Switching Corrected Errors

Uncorrected errors (poor self-monitoring):

- D-KEFS: Color-Word Interference Test: Condition 3—Inhibition Uncorrected Errors
- D-KEFS: Color-Word Interference Test: Condition 4—Inhibition/Switching Uncorrected Errors

Omission errors:

- D-KEFS: Trail-Making Test: Condition 1—Visual Scanning Omission Errors

Commission errors:

- D-KEFS: Trail-Making Test: Condition 1—Visual Scanning Commission Errors

Sequencing errors:

- D-KEFS: Trail-Making Test: Condition 2—Number Sequencing: Sequencing Errors
- D-KEFS: Trail-Making Test: Condition 3—Letter Sequencing: Sequencing Errors
- D-KEFS: Trail-Making Test: Condition 4—Number-Letter Switching: Sequencing Errors

Time-discontinuation errors:

- D-KEFS: Trail-Making Test: Condition 2—Number Sequencing: Time Discontinuation Errors
- D-KEFS: Trail-Making Test: Condition 3—Letter Sequencing: Time Discontinuation Errors
- D-KEFS: Trail-Making Test: Condition 4—Number-Letter Switching: Time Discontinuation Errors
- D-KEFS: Trail-Making Test: Condition 5—Motor Speed: Time Discontinuation Errors

initiating behaviors (reflective or impulsive):

- D-KEFS: Tower Mean First-Move Time
- D-KEFS: Verbal Fluency First 15” Interval Correct
- D-KEFS: Verbal Fluency Second 15” Interval Correct
- D-KEFS: Verbal Fluency Third 15” Interval Correct
- D-KEFS: Verbal Fluency Fourth 15” Interval Correct
- WCST: Trials to Complete First Category

Rule violations during task performance (impulsive response style or oppositional response style):

- D-KEFS: Tower Total Rule Violations
- D-KEFS: Tower Rule Violations-Per-Item Ratio
- NEPSY-II: Memory for Designs and Memory for Designs Delayed

Total attempted items:

- D-KEFS: Design Fluency: Total Attempted Designs
- D-KEFS: Sorting Test: Condition 1 Attempted Sorts

Percent accuracy:

- D-KEFS: Design Fluency Percent Design Accuracy
- D-KEFS: Sorting Test: Condition 1 Percent Sorting Accuracy

See Appendix for the full names of the tests and their references.

Interpreting Set-Loss Errors (Failure to Maintain the Directions)

Set-loss errors are quantified on several of the D-KEFS tests (Delis et al., 2001) and the Wisconsin Cart Sorting Test (Heaton et al., 1993; see Rapid Reference 13.16). A trained school neuropsychologist can look for signs of set-loss errors on other instruments as well. Set-loss errors occur when a student loses track of the task requirements. A student may have accurate performance on practice test items; however, during the actual test performance set-loss errors occur. When interpreting set-loss errors, make sure that the student's receptive language skills and sustained attention skills are intact. Set-loss errors may be indicative of a student's inability to maintain the cognitive set or task requirements due to a high level of distractibility or failure to fully comprehend the task requirements (Delis et al., 2001). In the classroom, a student with frequent set-loss errors may appear lost or confused in the middle of assignments and would require frequent redirection or reminder of the task requirements.

Interpreting Repetition Errors

Repetition errors are quantified on several of the D-KEFS tests (Delis et al., 2001; see Rapid Reference 13.17). Repetition errors occur when answers are repeated on a task despite explicit instructions asking the student not to repeat answers. Repetition errors may be attributable to poor receptive language skills, in that, the student did not understand the directions in the first place. If receptive language is intact, the examiner should evaluate the proximity of the repetition errors. If the same answers are repeated close together, it is characterized as a perseveration error (an executive dysfunction). If the same answers are repeated far apart it is characterized as a working memory problem.

Interpreting Corrected versus Uncorrected Errors

Corrected errors are better than uncorrected errors. A corrected error indicates that a student is using an executive function called *self-monitoring* and catches some or all errors as they occur. Uncorrected errors indicate that the student has poor self-monitoring skills. Self-corrected errors are recorded and norm-referenced on the D-KEFS Color-Word Test (Delis et al., 2001) (see Rapid Reference 13.17).

Self-monitoring skills can be taught to students and it is an important executive skill, which encourages students to check their work before turning in assignments (see Dawson & Guare, 2010, or Metzler, 2010, for some instructional strategies for teaching self-monitoring). It is important for the school neuropsychologist to keep in mind that many tests measure completion time and accuracy rate. If a student has many self-corrections during a test, completion time will be slower than normal. It is important to consider the interaction between completion time and accuracy when interpreting the overall test scores. A student who has slow completion time and few self-corrected errors is a qualitatively different type of student than one who has slow completion time with a high number of self-corrected errors.

Interpreting Omission and Commission Errors

On the D-KEFS Trail-Making Test (Delis et al., 2001), the omission and commission errors are norm-referenced for the first condition of the test that requires visual scanning. Omission errors generally reflect an impulsive or careless response style (Delis et al., 2001). Commission errors are rare and may indicate a marked impairment in either the student's ability to sustain attention or a failure to maintain a cognitive set.

Interpreting Sequencing Errors

On the D-KEFS Trail-Making Test (Delis et al., 2001), Condition 2 requires number sequencing and Condition 3 requires letter sequencing. If a student has difficulty finding stimuli in the correct sequence, this may reflect a fundamental sequential processing deficit.

Interpreting Time Discontinuation Errors, Initiating Behaviors, Rule Violations, Total Attempted Items, and Percent Accuracy

The total number of attempted items is recorded and norm-referenced for the D-KEFS Design Fluency and Sort Test—Condition 1 (Delis et al., 2001: see Rapid Reference 13.17). Poor problem solving or poor concept generation will result in a low score on total attempted items. A low score may indicate poor effort due to poor motivation or a total lack of the cognitive skills or processes being measured.

The percent accuracy score is usually interpreted in conjunction with the total number of attempted items. Some students will try to complete very few designs, but the designs that they do construct reflect set-loss errors. Other students will attempt an average number of items but the percent correct is low, which indicates good initiation but poor problem solving or concept generation.

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 (Boll, 1993) and the WCST (Heaton et al., 1993) are active learning tasks. Children must learn to modify their 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 the task include the D-KEFS: Twenty Questions (Delis et al., 2001), and the WJIII-COG: Analysis-Synthesis, Concept Formation, and Visual-Auditory Learning tests (Woodcock et al., 2001, 2007a). These tests are covered in other parts of the book. The D-KEFS tests were reviewed earlier in this chapter.

Summary of Behavioral Measures of Executive Functions

The proceeding section of this chapter has reviewed the common behavioral tests for measuring deficits in executive functioning. The tests of executive function are categorized into measures of concept generation, problem solving, planning, reasoning, and qualitative behaviors. The next section of this chapter reviews an indirect method of gathering information about a child's executive functioning, through behavioral rating scales.

Behavioral Rating Scales of Executive Functions

There are several new rating scales for evaluating executive functions in children and adolescents that were being published just prior to the release of this book. These new executive function rating scales include: the *Barkley Deficits in Executive Functioning Scale: Children and Adolescents* (BDEFS: CA; 2012), *Delis-Rating of Executive Functions* (D-REF; Delis, 2012), and the *Comprehensive Executive Function Inventory* (CEFI; Naglieri & Goldstein. 2012). It was not possible to review these rating scales for this book, but clinicians are encouraged to investigate the clinical utility of these instruments. The *Behavior Rating Inventory of Executive Function* (BRIEF) is reviewed in this section.

Behavior Rating Inventory of Executive Function (BRIEF) Scales

The BRIEF is an indirect method of gathering information about a child's executive functioning (see Rapid Reference 13.18). The BRIEF uses a questionnaire format that is completed by parents, teachers, day care providers, or the adolescent, based on the version of the test. The BRIEF 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 (BRIEF-P: Gioia, Espy, & Isquith, 2003) designed for preschool children 2-5 to 11 years; and the BRIEF—Self-Report Version (BRIEF-SR: Guy, Isquith, & Gioia, 2004) designed for adolescents ages 11 to 18 years.

Rapid Reference 13.18

The Behavior Rating Inventory of Executive Function

	BRIEF			BRIEF-P			BRIEF-SR		
Age ranges	5 to 18 years			2 to 5–11 years			11 to 18 years		
Raters	Parent or teacher			Parent, teacher, or day care provider			Adolescent self-report		
Behavioral regulation scale	X		X	X	X		X		X
Flexibility scale									
Inhibitory self-control									
Inhibit	X				X	X	X		
Shift	X			X		X	X		
Emotional control	X			X	X	X	X		
Metacognition scale	X		X				X		X
emergent metacognition scale				X					
Initiate	X								
Working memory	X			X		X	X		
Plan/organize	X			X		X	X		
Organization of materials	X								
Monitor	X						X		
Task completion							X		
Global executive composite			X			X			X
Validity scales:									
Negativity scale		X			X			X	
Inconsistency scale		X			X			X	

The BRIEF has two empirically validated factor scales: the Behavioral Regulation Index and the Metacognition Index. Rapid Reference 13.18 shows the BRIEF factor scales and the subtests that load on them for the version 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 et al., 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 is split 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 et al., 2000, p. 20). The Metacognition Index is a factor score for both the BRIEF and BRIEF-SR versions of the test, although subtests used to derive each of the indices differ between versions. The BRIEF-P has 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 et al., 2000, p. 14). 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.

Chapter Summary

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.

Test Yourself

1. All of the terms below 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 prefrontal circuit
- **d.** Orbitofrontal circuit

4. Damage to the 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 prefrontal circuit
- **d.** Oculomotor circuit

5. True or False? Phineas Gage was a railroad worker who sustained a head injury to his orbitofrontal region of the brain.

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. True or False? The Wisconsin Card Sorting Test is typically associated with measuring retrieval fluency.

8. Which of the tests below measures a child's executive functioning using a rating scale completed by either the parent or teacher?

- **a.** D-KEFS
- **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

Chapter Fourteen

Attention and Working Memory Facilitators/Inhibitors

In this chapter, the facilitators/inhibitors of attention and working memory are defined, their neuroanatomy are described, and the common tests used to assess attention and working memory are presented.

In the SNP Model (D. Miller, 2007, 2010, 2012; D. Miller & Maricle, 2012), attention processes and executive functions are separated into two broad classifications; whereas, Korkman, Kirk, and Kemp (2007) combine attention and executive functions into a single domain on the NEPSY-II. The process of allocating sufficient attentional resources to perform a given mental operation or the process of shifting attentional focus from one activity to another can also be viewed as an executive facilitator. Likewise, working memory was classified within the SNP Model under the broad classification of Learning and Memory but may also be viewed as a facilitator/inhibitor. In the updated Integrated SNP/CHC Model presented in Chapter 5, some of the processes and functions originally classified as executive functions have been reclassified as facilitators/inhibitors.

Allocating and Maintaining Attention Facilitators/Inhibitors

In addition to sensory-motor functions, attentional processes 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 task 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 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. Approximately 9.5% or 5.4 million children, 4 to 17 years of age, have been diagnosed with ADHD, as of 2007 (Centers for Disease Control and Prevention, 2010). 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, or untreated.

The *Diagnostic and Statistical Manual of Mental Disorders—Fourth Edition—Text Revision* (American Psychiatric Association, 2000) classifies ADHD within four subtypes: 314.01—ADHD, Combined Subtype; 314.00—Predominantly Inattentive Type; 314.01 ADHD, Predominantly Hyperactive-Impulsive Type; and 314.9—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, Anthony, Duncan, Ahearn, & Kellam, 1991; Mirsky & Duncan, 2001) conducted a factor analysis of neuropsychological tests, 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; Block, 2002; Burden, Jacobson, Sokol, & Jacobson, 2005 (children with fetal alcohol exposure); Ewing-Cobbs et al., 1998; Kavros et al., 2008 (children rolandic epilepsy); Leffard, 2009; Loss, Yeates, & Enrile, 1998 (children with myelomenigocele); McDiarmid, 2003 (children with lead exposure); Mirsky, Pascualvaca, Duncan, & French, 1999; Thaler, Allen, Park, McMurray, & Mayfield, 2010 (children with traumatic brain injury); Wolfe, 2006 (children with ADHD)].

Mirsky's *focus/execute*, *sustain*, and *shift* subcomponents 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, 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 Adult Intelligence Scale—Revised (WAIS-R: 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 Integrated SNP/CHC Model are selective/focused, sustained, and capacity. Each of these subcomponents of attention are 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 him tapping her pencil on her desk, the rich 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, or the loose Band-Aid on his finger. 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 & Duncan, 2001; Mirsky et al., 1991) refer 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-execute 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 & Duncan, 2001; Mirsky et al., 1991) refer 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 the 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.

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 & Duncan, 2001; Mirsky et al., 1991) did not find a subcomponent of attention called *attentional capacity* because the neuropsychological tasks that were factor analyzed did not require those skills. Attentional capacity has a direct relationship with the cognitive capacity or load required on memory tasks (Miller & Maricle, 2012). As the length of the stimuli to be recalled increases, as in digits or letters, and as the semantic loading increases from words to sentences, to stories, there are concurrent changes in the attentional demands of the tasks. 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, or 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 13). Mirsky and his colleagues (1991, 1996) 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) (see Figure 14.1). Posner and Peterson (1990) believed selective attention was linked to the functions of the anterior cingulate and the supplemental motor areas (see Figure 14.2). Mirsky and his colleagues believed 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) (see Figure 14.1). Posner and Peterson believed sustained attention was regulated by the right side of the brain, particularly the anterior, prefrontal regions (see Figure 14.2). Mirsky and his colleagues believed the dorsolateral prefrontal cortex and the anterior cingulate gyrus were the brain structures involved with *shifting attention* (see Figure 14.1).

Figure 14.1 Neuroanatomical Regions Associated with Mirsky's Model of Attention

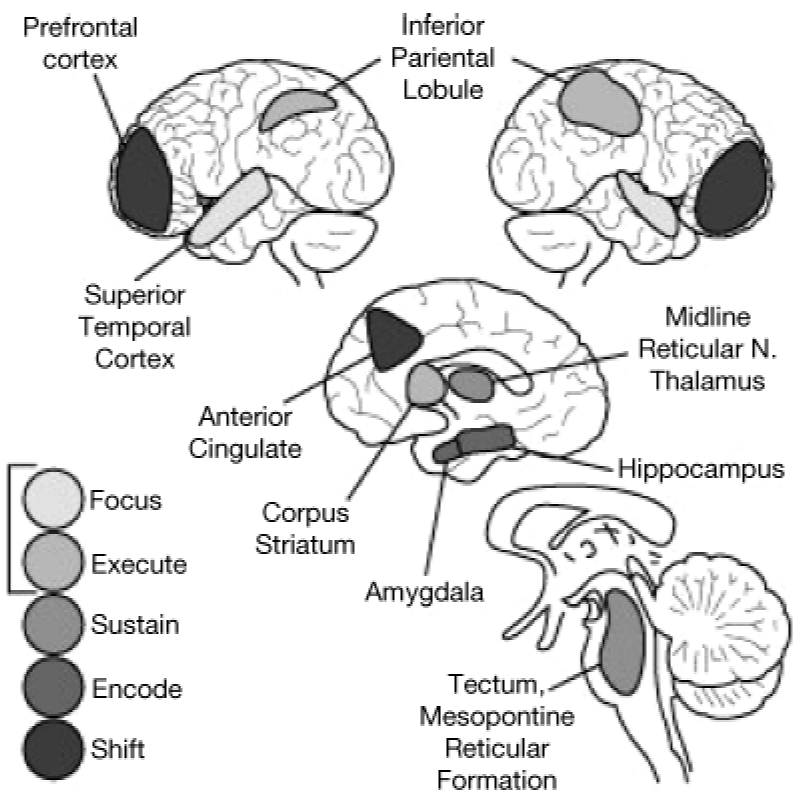
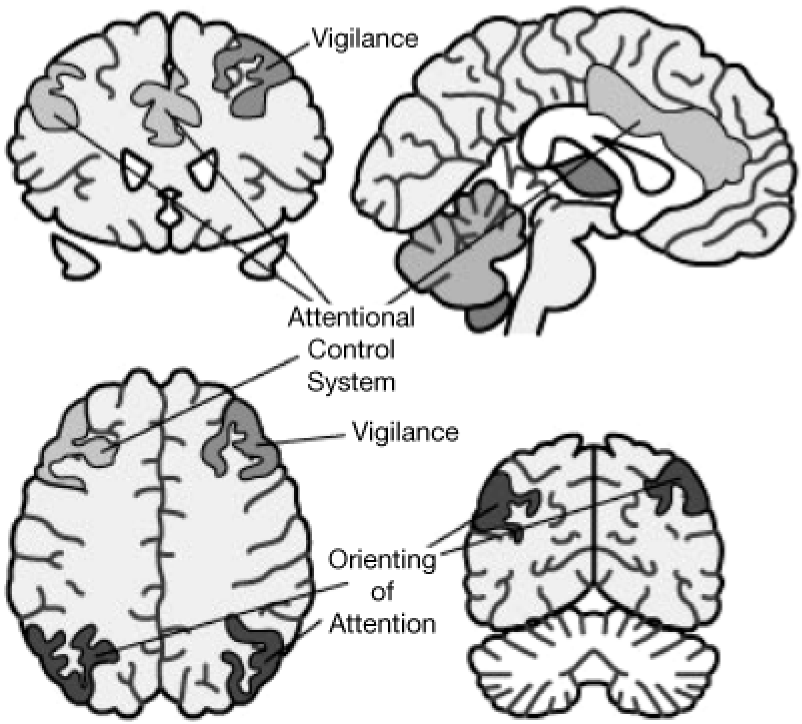


Figure 14.2 The Neural Network of Attention According to Posner (1994). This Model Highlights Brain Regions That are Involved in the Attentional Control System, Orienting of Attention, and Vigilance



Casey, Tottenham, and 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-II; Korkman et al., 1997). Casey and colleagues found performance on the go/no go task produced activation in the orbitofrontal, dorsolateral, and right anterior cingulate cortex. The orbitofrontal and right anterior cingulate 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 may be attributed to differences in neuroimaging techniques, adult versus child populations, and tasks that require more "bottom-up" versus "top-down" attentional processes. Rapid Reference 14.1 presents some neuropsychological terms associated with attention deficits.

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 Integrated SNP/CHC Model conceptualizes attention in the subdomains of selective/focused attention, sustained attention, and attentional capacity. Many neuroimaging studies support the frontal-subcortical bases of attention, though precise anatomical locations of specific attentional subtypes have shown varying results.

Rapid Reference 14.1

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 attributed 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.

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; see Hale, Reddy et al., 2010, for a thorough review). Reductions in volume and/or hypoactive regions within the right prefrontal, globus pallidus, caudate nucleus, and cerebellar regions of the brain have been found in ADHD populations (Castellanos et al., 2002; Durston, 2003; Rubia et al., 1999; Vaidya et al., 1998; Valera, Faraone, Murray, & Seidman, 2007). Other neuroimaging studies with ADHD samples have also implicated deficiencies in the frontal-subcortical, and possibly limbic regions (Benson, 1991; Heilman, Voeller, & Nadeau, 1991; Zametkin et al., 1990; Zametkin et al., 1993). 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).

When to Assess Attentional Processes

Attentional processing deficits are common in a wide variety of neurodevelopmental disorders beyond ADHD. Since attentional processing is such an important basic function that permeates all other higher-order cognitive processes, it is important to include some basic attentional processing measures in a school neuropsychological battery to verify the integrity of attention.

Identifying Attentional Processing Concerns

It is suggested that the *Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition* (NPCC-3: Miller, 2012) be completed by the parent/guardian and at least one teacher of the student being referred for a comprehensive assessment (see the supplemental CD for the complete NPCC-3). The questions on the NPCC-3 that pertain to attention problems are shown in Rapid Reference 14.2. Any endorsed items in the moderate to severe range should be followed up with formal assessment measures in the school neuropsychological assessment.

Assessing Attentional Processes

Rapid Reference 14.3 restates the second- and third-order classifications of attentional facilitators/inhibitors within the Integrated SNP/CHC Model. Tests designed to measure these second- and third-order classifications of attentional facilitators/inhibitors are presented in this section.

Tests of Selective/Focused and Sustained Attention

The second-order classification of selective/focused and sustained attention facilitators/inhibitors separates the tasks based on the modality of the input demands, either verbal or visual. Ideally, tests designed to measure selective/focused attention would be different from tests designed to measure sustained attention; however, this is the exception instead of the rule. Many of the tests designed to measure attention co-mingle the two types of attention. Some tests, such as continuous performance tests are specifically designed to measure sustained attention and these tests are discussed in the next section. Rapid Reference 14.4 presents tests that measure aspects of either selective/focused attention, or sustained attention, or both.

Rapid Reference 14.2

Attention Items From the Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition (NPCC-3: D. Miller, 2012a)

Selective or sustained attention difficulties:

- Seems to get overwhelmed with difficult tasks.
- Difficulty paying attention for a long period of time.
- Seems to lose place in an academic task (e.g., reading, writing, math).
- Mind appears to go blank or loses train of thought.
- Inattentive to details or makes careless mistakes.

Rapid Reference 14.3

Integrated SNP/CHC Model Classifications of Attentional Facilitators/Inhibitors

Broad classifications	Second-Order Classifications	Third-Order Classifications
Allocating and maintaining attention facilitators/inhibitors	Selective/focused attention	• Auditory selective/focused attention • Visual selective/focused attention
	Sustained attention	• Auditory sustained attention • Visual sustained attention • Auditory and visual sustained attention
	Attentional capacity	• Memory for numbers, letters, or visual sequences • Memory for words and sentences • Memory for stories
	Qualitative behaviors	
	Behavioral rating scales	

Rapid Reference 14.4

Tests of Selective/Focused and Sustained Attentional Facilitators/Inhibitors

Test–Subtest: Description	Selective	Sustained	Age/ Grade Range	Publisher
Auditory Selective/Focused and Sustained Attention				
NEPSY-II—Auditory Attention: Selectively responding to auditory target words while ignoring auditory nontarget words over time.	X	X	5 to 16 years	Pearson

TEA-Ch—Code Transmission: Listening to a series of numbers and recalling the number heard just prior to two fives being heard together.			X	6 to 15–11 years	
TEA-Ch—Score! Keeping count of "scoring sounds."			X		
TEA-Ch—Score DT: Keeping count of "scoring sounds" from an audiotape with the presence of an auditory distracter.			X		
Visual Selective/Focused and Sustained Attention					
CAS—Number Detection: Quickly finding target numbers within a visual array.	X			5 to 17–11 years	PRO-ED
CAS—Receptive Attention: Quickly finding target letters within a visual array.	X				
TEA-Ch—Map Mission: Searching a map to find as many target symbols as possible in one minute.	X			6 to 15–11 years	Pearson
TEA-Ch—Sky Search Attention Score: Quickly finding as many "target" spaceships as possible on paper filled with target and nontarget ships.	X				
TEA-Ch—Sky Search Dual Task (DT): Combines two tasks of finding spaceships and counting score sounds.	X	X			
WJIII-COG NU—Pair Cancellation: Matching target stimuli from a large visual array under time constraints.		X		2 to 80+ years	Riverside

See Appendix for the full names of the tests and their references.

The Auditory Attention portion of the Auditory Attention and Response Set test on the NEPSY-II (Korkman et al., 2007) measures aspects of both auditory selective/focused attention and sustained attention and includes several scores, which should all be interpreted and reported. Auditory Attention (Part 1 of the test) scores include: Auditory Attention Combined, a composite of the Commission Errors and Total Correct scores, and supplemental scores of Total Omission Errors and Total Inhibitory Errors. A school neuropsychologist needs to fully understand how the student's performance on this task influences these scores (see Chapter 8 for an interpretative example).

The *Test of Everyday Attention for Children* (TEA-Ch: Manly, Robertson, Anderson, & Nimmo-Smith, 1999) is a stand-alone measure of attention that is modeled after Mirsky's conceptualization of attention. One of the concerns about using the TEA-Ch in clinical practice in the United States is the fact the test was standardized on only 293 Australian children. However, the latent factor structure of the TEA-Ch has been shown to be the same as the Australian standardization sample with a sample of Chinese children (Chan, Wang, Ye, Leung, & Mok, 2008) and a stratified sample of children from the United States (Belloni, 2011). In regard to the SNP Model, the Sky Search test from the TEA-Ch includes a composite score, separate scores for the number of correctly identified targets, and a score for the processing time per target. These scores should be reported and interpreted separately in light of the student's performance on the overall task.

Continuous Performance Tests

Riccio, Reynolds, and Lowe (2001) provide 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 14.5 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.

Students with selective/focused attention deficits will have difficulties determining what is relevant in their learning environments and what can be ignored. Children with ADHD frequently have difficulty with selective/focused attention, which leads to distractibility, inefficiency in learning, and uneven performance. Students with sustained attention or vigilance deficits, have difficulty maintaining their attentional focus in the classroom. These children may be able to initially focus on the relevant task at hand, but quickly lose that focus.

Rapid Reference 14.5

Continuous Performance Tests

Test Name	Modality	Age Range	Publisher
• *Auditory Continuous Performance Test* (ACPT: Keith, 1994)	Auditory	6 to 11–11 years	Pearson
• *Conners' Continuous Performance Test II Version 5* (Connors & MHS Staff, 2004a)	Visual	6 years to Adult	Multihealth Systems (MHS)
• *Conners' Continuous Performance Test for Windows®: Kiddie Version* (Connors & MHS Staff, 2004b)	Visual	4 to 5 years	MHS
• *Gordon Diagnostic System* (Gordon, 1983; Gordon, McClure, & Alyward, 1996)	Auditory only Visual only auditory and visual	4 to 16 years	Gordon Systems
• *Integrated Visual and Auditory Continuous Performance Test* (IVA+Plus: Sandford & Turner, 1993–2006)	Auditory and visual	6 to 96 years	BrainTrain
• *Test of Variables of Attention* (T.O.V. A.: Greenberg & Waldman, 1993)	Auditory only Visual only	6 to 16 years	The TOVA Company

Tests of Attentional Capacity

The second-order classification of attentional capacity separates the tasks based on the cognitive load of the tasks. These same tasks measure aspects of learning and memory but in this interpretative section, the focus is on how does changing the level of semantic meaning or contextual cues and increasing the length of stimuli to be learned affect the student's capacity to pay attention to the respective task. Attentional capacity is examined as a function of learning a series of numbers or letters of increasing length, or learning visual sequential patterns of increasing length, or recalling word strings or sentences of increasing lengths, or finally recalling content from stories with increasing semantic cues. Rapid Reference 14.6 presents tests that measure attentional capacity based on these third-order classifications.

Rapid Reference 14.6

Tests of Attentional Capacity

Test–Subtest: Description	Age/Grade Range	Publisher
Attentional Capacity for Numbers or Letters with Verbal Response		
DAS-II—Recall of Digits Forward: Repeating a series of digits of increasing length.	2–6 to 17–11 years	Pearson
KABC-II—Number Recall: Repeating auditorially presented digits of increasing length.	3 to 18 years	
TOMAL-2—Digits Forward: Repeating auditorially presented digits of increasing length.	5 to 59–11 years	PRO-ED
TOMAL-2—Letters Forward: Repeating auditorially presented letters of increasing length.		
WRAML2—Number/Letter: Repeating auditorially presented number/letter strings of increasing length.	5 to 90 years	PAR
WISC-IV—Digits Forward: Repeating auditorially presented digits of increasing length.	6 to 16–11 years	Pearson
WISC-IV Integrated—Letter Span—Rhyming: Repeating auditorially presented letters of increasing length that rhyme.	6–1 to 16–11 years	
WISC-IV Integrated—Letter Span—Nonrhyming: Repeating auditorially presented letters of increasing length that do not rhyme.		
WISC-IV Integrated—Visual Digit Span: Repeating visually presented digits of increasing length.		
Attentional Capacity for Visual Sequential Patterns with Motor Response		
WISC-IV Integrated—Spatial Span Forward: Repeating visually presented motoric sequences of increasing length.	6–1 to 16–11 years	Pearson
WRAML2—Finger Windows: Using a finger to repeat a visual pattern of increasing length.	5 to 90 years	PAR
Attentional Capacity for Words and Sentences (Increased Meaning) with Verbal Response		
CAS—Word Series: Recall of words from a verbally presented list.	5–0 to 17–11 years	PRO-ED
KABC-II—Word Order (without Color Interference): Touching pictures in sequential order based on the order spoken by the examiner.	3 to 18 years	Pearson

Test–Subtest: Description	Age/Grade Range	Publisher
NEPSY-II—Sentence Repetition: Repeating sentences of increased length and complexity.	3 to 6 years	
WRAML2—Sentence Memory: Repeating sentences of increased length and complexity.	5 to 90 years	PAR
WJIII-COG DS—Memory for Sentences: Memory for sentences of increasing length and complexity.	2 to 90+ years	Riverside
WJIII-COG NU—Memory for Words: Repeating lists of unrelated words in correct sequence.	2 to 90+ years	
Attentional Capacity for Stories (Even More Contextual Meaning) with Verbal Response		
CMS—Stories Immediate: Recalling verbally presented story details.	5 to 16–11 years	Pearson
NEPSY-II—Narrative Memory Free Recall: Recalling verbally presented story details.	3 to 16 years	
TOMAL-2—Memory for Stories: Recalling verbally presented story details.	5 to 59–11 years	PRO-ED
WRAML2—Story Memory: Recalling verbally presented story details.	5 to 90 years	PAR
WJIII-ACH NU—Story Recall: Recalling verbally presented story details.	2 to 90+ years	Riverside
See Appendix for the full names of the tests and their references.		

The patterns of performance that a clinician looks for across the attentional capacity tasks are:

- Does the student perform well when recalling short strings of information (e.g., digit recall) but performance drops significantly when too many strings of numbers are presented?
- Does the student's performance worsen as words, sentences, and finally stories are presented? In other words, as the semantic cues increase does that cause information overload?
- Does the student not perform well on the simple digit or letter recall tasks but performs much better as the semantic cues are increased from words, to sentences, to stories?

Some children need the added contextual cues and increased meaning to capture and maintain their attentional focus; whereas, other children (particularly children with ADHD) shut down their learning when too much information is presented.

Qualitative Behaviors of Attention

On the NEPSY-II, the frequency of two qualitative behaviors such as inattentive/distracted off-task behaviors and out of seat/physical movements are recorded and base rates compared to the student's same age group or to one of the clinical validation sample groups can be generated. These base rates provide the clinician the opportunity to make statements such as "Alice exhibited out of seat/physical movements in her seat on the Auditory Attention and Response Set test of the NEPSY-II. Only 14% of other children Alice's age engaged in this level of out of seat behaviors; however, 35% of the children within the Attention Deficit Hyperactivity Disorder diagnostic group had this same level of out-of-seat behaviors."

Behavioral Rating Scales of Attention

Following an integrative style of report writing, any behavioral rating of attention and/or hyperactivity is reported in the attentional processing section of the report since those behaviors are related to attention. The remainder of behavioral rating scales, which measure psychological concerns such as depression, conduct disorders, and anxiety, are reported in the social-emotional section of the report.

There are multiple behavioral rating scales for assessing ADHD and attentional processing disorders, including, but not limited to:

- ACTeRS: *ADHD-H Comprehensive Teacher's Rating Scale* (2nd ed.) [Teacher, Parent, and Self-Report Forms] (Ullmann, Sleator, & Sprague, 1991; Ullman, Sleator, Sprague, & Meritech Staff, 1996).
- ADDES/ADDES-S: *Attention Deficit Disorders Evaluation Scale Third Edition/Attention Deficit Disorders Evaluation Scale: Secondary-Age* (McCarney, 2004a, 2004b). 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).
- BASC-2: *Behavior Assessment System for Children* (2nd ed.) (Reynolds & Kamphaus, 2009).
- CBRS: *Conners Comprehensive Behavior Rating Scales* (Conners, 2008a).
- Conners 3: *Conners* (3rd ed.) (Conners, 2008b).
- CBCL/6–18; TRF; YSR: *Child Behavior Checklist* (CBCL), *Teacher Rater Form* (TRF), and *Youth Self Report* (YSR) (Achenbach, 2007a, 2007b, 2007c).

There are other behavioral rating scales that assess attention within a broader context. The BASC-2, Conners-3, CBCL/6–8; TRF, & YSR, *Brown Attention-Deficit Disorder Scales for Adolescents and Adults* (BADDS: Brown, 1996), the *Brown Attention-Deficit Disorder Scales for Children and Adolescents* (BADDS: Brown, 2001), and the *Clinical Assessment of Attention Deficit–Child* (CAT-C: Bracken & Boatwright, 2005) are all examples of rating scales for attention within a broader context.

Working Memory Facilitators/Inhibitors

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 memory system that underpins our capacity to "keep things in mind' when performing complex tasks" (Baddeley, Eysenck, & Anderson, 2008, p. 9).

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; see Dehn, 2008, for a review).

Baddeley and colleagues (Baddeley, 1986, 1995; Baddeley & Hitch, 1974) originally 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.*

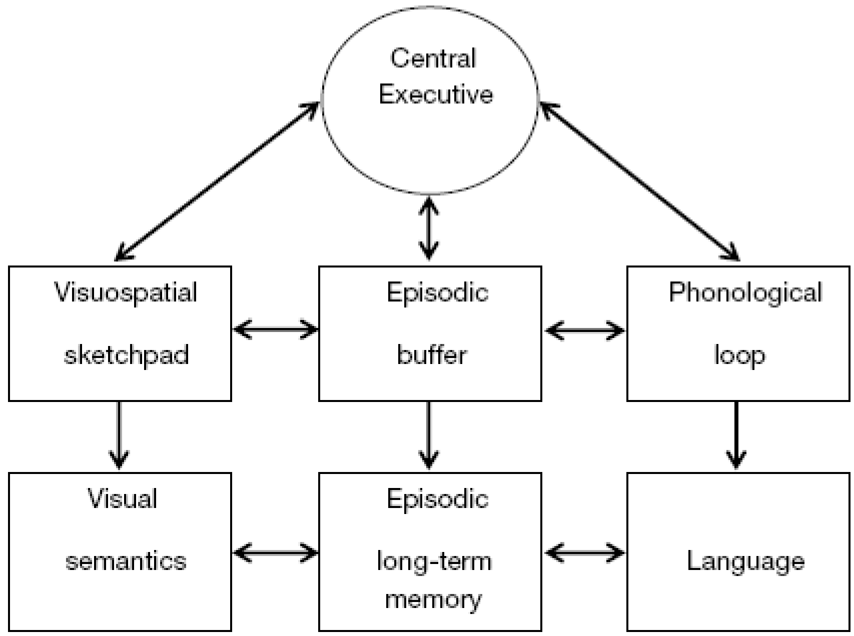
The central executive system is a command and control center that presides over the interactions between the two subordinate systems and long-term memory (Gazzaniga et al., 2002). Norman and Shallice (1980) referred to the central executive system as the supervisory attentional system (SAS). The phonological loop is thought to be responsible for the temporary storage of speech-like information (Baddeley et al., 2008). The visuospatial sketchpad is thought to be responsible for temporary maintenance of visual and spatial information (Baddeley et al., 2008).

In 2000, Baddeley (2000) made two major changes in the working memory model. The first change was the assumed linkage between the phonological and visuospatial subsystems to long-term memory. The long-term memory and phonological loop linkage allows for the acquisition of language. The long-term memory and visuospatial sketchpad allows for the acquisition of visual-spatial information.

The second change to Baddeley and Hitch's original working memory model (1974), was the inclusion of the episodic buffer (Baddeley, 2000). The episodic buffer is assumed to be a system of storage that can hold a limited amount (four chunks) of information. The information within the episodic buffer is thought to be multidimensional in nature, meaning that information from our senses, emotions, and memory stores are all combined. As a result of this multidimensional storage of information, the episodic buffer can act as a link between the phonological loop and the visuospatial sketchpad with input from long-term memory and from our perceptual processing. The episodic buffer is theorized by Baddeley

(2000) to be the site of a mental workspace that assists in performing complex cognitive activities. See Figure 14.3 for an illustration of Baddeley's current model of working memory.

Figure 14.3 Baddeley's Current Model of Working Memory (2000)



Neuroanatomy of Working Memory

There is neuroanatomical evidence for Baddeley's working memory model. 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 phonological working memory system is thought to involve 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* (Wechsler et al., 2004) Spatial Span test, in which the child has to touch blocks on a board following the same sequence as the examiner.

Identifying Working Memory Concerns

It is suggested that the *Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition* (NPCC-3: Miller, 2012) be completed by the parent/guardian and at least one teacher of the student being referred for a comprehensive assessment (see the supplemental CD for the complete NPCC-3). The questions on the NPCC-3 that pertain to working memory difficulties are shown in Rapid Reference 14.7. Any endorsed items in the moderate-to-severe range should be followed up with formal assessment measures in the school neuropsychological assessment. The major tests of working memory for school-age children are reviewed in the next section.

Rapid Reference 14.7

Working Memory Items from the Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition (NPCC-3: D. Miller, 2012)

Working memory difficulties:

- Frequently asks for repetitions of instructions/explanations.
- Trouble following multiple step directions.
- Loses track of steps/forgets what they are 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.
- Trouble remembering facts or procedures in mathematics.

Rapid Reference 14.8

Integrated SNP/CHC Model Classifications of Working Memory Facilitator/Inhibitor

Broad Classifications	**Second-Order Classifications**	**Third-Order Classifications**
Working memory facilitator/inhibitor	• Working memory	• Verbal working memory • Visual working memory • Qualitative behaviors

Assessing Working Memory

Rapid Reference 14.8 restates the second- and third-order classifications of learning and memory processes within the Integrated SNP/CHC Model. The next section of this chapter describes the major stand-alone test batteries of learning and memory followed by a cross-battery listing of tests designed to measure each on the second and third order learning and memory classifications in the Integrated SNP/CHC Model.

In the Integrated SNP/CHC Model, working memory is classified within the broad classification of Working Memory Facilitator/Inhibitor. Working memory is subdivided further into third-order classifications of (1) verbal working memory, and (2) visual working memory. Working memory has a major impact on many aspects of academic achievement (see *Working Memory and Academic Learning: Assessment and Intervention,* Dehn, 2008, for a thorough review). Rapid Reference 14.9 presents a list of the major tests designed to measure either verbal or visual working memory.

Qualitative Behaviors of Working Memory

On the WISC-IV (Wechsler, 2003) and *WISC-IV Integrated* (Wechsler et al., 2004), the Working Memory subtests have a set of qualitative scores that are calculated as base rates comparing a student's performance to their same aged peers (see Rapid Reference 14.10).

Rapid Reference 14.9

Tests of Working Memory Facilitators/Inhibitors

Test– Subtest: Description	**Age/Grade Range**	**Publisher**
Verbal Working Memory		
CMS—Numbers Backward: Repeating number strings previously spoken by examiner in reverse order.	5–0 to 16–11 years	Pearson
CMS—Sequences: Ability to manipulate and sequence verbal information quickly.		
DAS-II—Recall of Digits Backward: Repeating number strings previously spoken by examiner in reverse order.	2–6 to 17–11 years	
DAS-II—Recall of Sequential Order: Sequencing, from highest to lowest, increasingly long sequences of words.		
KABC-II—Word Order (with Color Interference): Touching pictures in sequential order based on the order spoken by the examiner.	3 to 18 years	
NEPSY-II—Word List Interference Recall: Repeating an initial string of unrelated words after a second interference list of unrelated words is presented.	7 to 16 years	
PAL-II M—Numeric Coding Total: Ability to code written numerals into working memory accurately and quickly.	K to 6 grades	
PAL-II M—Quantitative Working Memory: Ability to store numbers and perform quantitative operations on them in working memory.		
PAL-II RW—Letters + Words: Ability to store and manipulate letters or words in working memory.		
PAL-II RW—Sentences: Listening + Sentences: Ability to manipulate sentences in working memory.		
SB5—Verbal Working Memory: Ability to store verbal information in short-term memory and then sort or transform that information.	2 to 85+ years	Riverside
TAPS-3—Number Memory Reversed: Repeating number strings previously spoken by examiner in reverse order.	4 to 18–11 years	Academic Therapy Publications
TOMAL-2—Digits Backward: Repeating number strings previously spoken by examiner in reverse order.	5 to 59–11 years	PRO-ED

Test– Subtest: Description	Age/Grade Range	Publisher
TOMAL-2—Letters Backward: Repeating letter strings previously spoken by examiner in reverse order.		
WISC-IV—Arithmetic: Mentally solving orally presented arithmetic problems within time limits.	6–0 to 16–11 years	Pearson
WISC-IV—Digit Span Backward: Repeating number strings previously spoken by examiner in reverse order.		
WISC-IV—Letter-Number Sequencing: Recalling numbers in ascending order and letters in alphabetical order after listening to a sequence of numbers and letters spoken by the examiner.		
WJIII-COG NU—Auditory Working Memory: Repeating the name of the objects in sequential order, followed by the numbers in sequential order, after listening to an audio recording of a series of names of both objects and digits.	2–0 to 90+ years	Riverside
WJIII-COG NU—Numbers Reversed: Repeating number strings in reverse order that were spoken by the examiner.		
WRAML-2—Verbal Working Memory: Three levels of difficulty, which requires reordering of words to some stimulus property (e.g., word order, size of object).	5–0 to 90 years	PAR
Visual Working Memory		
PAL-II M—Spatial Working Memory: Ability to locate objects in a 2-dimensional visual array and code their quantity.	K to 6 Grades	Pearson
SB5—Nonverbal Working Memory: Ability to store nonverbal information in short-term memory and then sort or transform that information.	2 to 85+ years	Riverside
WISC-IV Integrated—Spatial Span Backward: Touching a sequence of blocks that was shown by the examiner in reverse order.	6–1 to 16–11 years	Pearson
WMS-IV—Spatial Addition: Adding or subtracting the location of circles based on a set of rules.	16 to 90 years	
WMS-IV—Symbol Span: Selecting symbols from an array in the same order previously presented.		
WNV—Spatial Span: Touching a sequence of blocks that was shown by the examiner in forward to reverse order.	4–0 to 21–11 years	

Test– Subtest: Description	Age/Grade Range	Publisher
WRAML-2—Symbolic Working Memory: 1Pointing to number strings recalled or number letter strings.	5 to 90 years	PAR
See Appendix for the full names of the tests and their references.		

Rapid Reference 14.10

Qualitative Behaviors for the WISC-IV and WISC-IV Integrated: Working Memory

- Longest digit span forward versus backward:

  Percentage of same age peers with a better verbal immediate memory (digits forward) compared to verbal working memory (digits backward).

  - Longest digit span forward:

    Percentage of same age peers who achieved this number of the longest digit span forward (verbal immediate memory).

  - Longest digit span backward:

    Percentage of same age peers who achieved this number of the longest digit span backward (verbal working memory).

- Longest visual digit span:

  Percentage of same age peers who achieved this number of the longest visual digit span (visual immediate memory).

- Longest spatial span forward versus backward:

  Percentage of same age peers with a better visual immediate memory (spatial span forward) compared to visual working memory (spatial span backward).

  - Longest spatial span forward:

    Percentage of same age peers who achieved this number of the longest spatial span forward (visual immediate memory).

  - Longest spatial span backward:

    Percentage of same age peers who achieved this number of the longest spatial span backward (visual working memory).

- Longest letter span nonrhyming versus rhyming:

  Percentage of same age peers whose encoding is better for nonrhyming letters compared to rhyming letters.

  - Longest letter span nonrhyming:

    Percentage of same age peers who achieved this number of the longest non-rhyming letter spans (verbal immediate memory).

  - Longest letter span rhyming:

    Percentage of same age peers who achieved this number of the longest rhyming letter spans (verbal immediate memory).

- Longest letter-number sequence versus process approach:

  Percentage of same age peers who achieved a higher number of the longest letter-number sequences (verbal immediate memory) compared to the number of the longest letter-number sequences using a process approach (verbal working memory).

  - Longest letter-number sequence:

Percentage of same age peers who achieved this number of the longest letter-number sequences (verbal immediate memory).

- Longest letter-number sequence process approach:

  Percentage of same age peers who achieved this number of the longest letter-number sequences using a process approach (verbal working memory).

Chapter Summary

In this chapter the theories, terminology, neuroanatomy, and major tests associated with the cognitive facilitators/inhibitors of attention and working memory were reviewed. Attention and working memory help facilitate many essential elements in education and must be systematically evaluated by a school neuropsychologist. Attention and working memory deficits are observed in many common developmental disorders.

Test Yourself

1. Mirsky's model of attention includes all of the following except:

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

4. Baddeley and colleagues initially 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 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-II

d. Das-Naglieri Cognitive Assessment System

6. 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. d; 3. true; 4. d; 5. d; 6. c

Chapter Fifteen

Speed, Fluency, and Efficiency of Processing Facilitators/Inhibitors

Speed and efficiency of information processing constructs are not as clearly defined and agreed upon by researchers as the other processes that have already been discussed in previous chapters. This chapter reviews the definitions of the speed of information processing constructs, presents the theoretical neuroanatomical bases for the constructs, and reviews the common tests used to assess these constructs.

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 his speed and efficiency of cognitive processing.

Measures of processing speed have been explicitly included in two of the mainstream tests of intelligence since the late 1980s (*Wechsler Intelligence Scale for Childre—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, 2001, 2007a).

However, not all processing speed tests measure the same construct (Feldmann, Kelly, & Diehl, 2004; Floyd, Evans, & McGrew, 2003), which has led to interpretation confusion for clinicians. Motor speed (aka psychomotor skill, graphomotor speed, or paper-and-pencil skill) and number facility (skill in dealing with numbers ranging from number recognition, 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 et al. (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—Second Edition's (DAS-II; Elliott, 2007) Speed of Information Processing. Feldmann and colleagues (2004) found that Motor Speed accounted for small (7% to 17%) but significant amounts of variance on all five processing speed tests. Number Facility was found to account for 14% of the variance for the WJR Visual Matching and the DAS-II Speed of Information Processing tests and 8% 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).

Following the Cattell-Horn-Carroll (CHC) model, processing speed (*Gs*) measures the speed with which an individual performs simple cognitive tasks (Schrank, Miller, Wendling, & Woodcock, 2010). 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. Schneider and McGrew (2012) point out that processing speed is not that crucial during the initial learning phases of a task, but becomes “an important predictor of skilled performance once people know how to do a task” (p. 119). Processing speed is of special importance to consider when students have already learned a particular task or skill and the difference in speed with which they perform that task or skill is being measured. For example, two children could each have good reading decoding skills, yet one child is a slow and methodical reader and the other child reads very quickly.

Models of Processing Speed

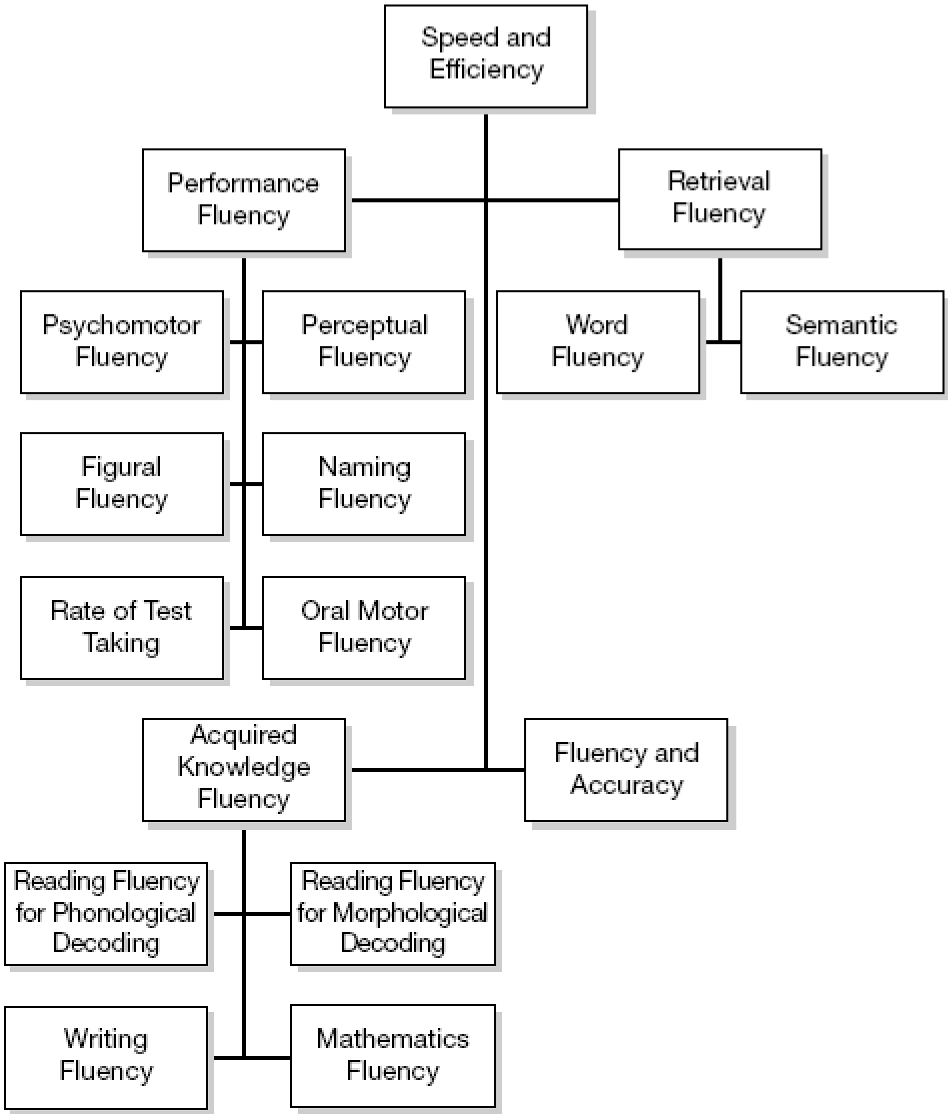
Processing speed may be best conceptualized as a broad construct containing several specific or narrow abilities based on item content (Carroll, 1993). Carroll found replicated evidence that processing speed is composed of mutually exclusive narrower abilities such as movement time, reaction time, correct decision speed, incorrect decision speed, perceptual speed, short-time retrieval speed, and retrieval fluency. Horn and Blankson (2012) note that speed is related to reaction time, decision making, perception, and problem solving in almost all of the abilities that are involved with what is widely considered as human intelligence. They suggest that although there are certainly different types of processing speed, there is not a unified general factor for the speediness of thinking. Processing speed has been shown to improve in children through adolescence and with practice (Kail, 2007).

Based on the synthesis of multiple exploratory and confirmatory factor analytic studies, McGrew (2005) and McGrew and Evans (2004) concluded that processing speed (*Gs*) might be best represented as a set of hierarchically organized speed taxonomy. Schneider and McGrew (2012) modified the aforementioned hierarchical model of processing speed to include a hypothesized general *g* factor of speed and composed of the broad factors of cognitive speed, decision speed, and psychomotor speed. These broad factors included constructs of perceptual speed, rate of test taking, reaction time, movement time, and retrieval fluency.

In the current conceptualization of the Integrated SNP/CHC Model, speed, fluency, and efficiency of processing is classified as a type of facilitator/inhibitor. As previously stated, almost all cognitive and behavioral tasks require some aspect of processing speed to increase the automaticity of responses. However, fast processing speed is not always a desired outcome as evidenced by the child who rushes through an assignment to get it done, but makes multiple errors in completing the task. The interplay between speed, efficiency, fluency, and accuracy must be considered in evaluating the facilitating and inhibiting influences of processing speed. A child may consciously choose to slow down speed of processing to improve accuracy which is more desirable than the alternative, but that may be a compensatory strategy on the part of the child and not indicative of a processing speed deficit per se.

The broad classification of speed, fluency, and efficiency of processing facilitators/inhibitors is conceptualized to be composed of four second-order classifications: performance fluency, retrieval fluency, acquired knowledge fluency, and fluency and accuracy (see Figure 15.1). Performance fluency is defined as the ability to quickly perform simple, repetitive tasks. Retrieval fluency is defined as how quickly information can be retrieved from long-term memory. Performance fluency tasks do not require accessing previously learned or stored information; whereas, retrieval fluency requires quick access to long-term memory.

Figure 15.1 Miller's Integrated Speed, Fluency, and Efficiency Model



Acquired knowledge fluency relates to the automaticity of academic achievement including reading fluency, writing fluency, and mathematic fluency. The final second-order classification within the speed and efficiency of processing area is fluency as it relates to accuracy. Processing speed must be interpreted within the context of performance accuracy. For example, a student that rushes through a task while making many errors is qualitatively different from a child who slows down completion of a task to improve accuracy. The third-order classifications related to each of the second-order classifications are discussed in the following sections.

Neuroanatomy of Speed, Fluency, and Efficiency of Processing

The neuroanatomical bases of speed, fluency, and efficiency of processing are not fully understood. The neuroanatomy of speed of information processing is thought to 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). Speed of visual searches in children ages 6 to 17 years were reported to change as a function of increases in parietal white matter (Mabbott, Laughlin, Noseworthy, Rockel, & Bouffett, 2005). In addition, children treated with radiation for acute lymphoblastic leukemia (ALL) have secondary damage to myelin and as a result have slower processing speeds (Cousins, Ungerer, Crawford, & Stevens, 1991; Schatz, Kramer, Ablin, & Matthay, 2000, 2004).

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.

When to Assess for Speed, Fluency, and Efficiency of Processing

Students who are experiencing difficulties with school assignments or homework completion in a reasonable period of time are probably candidates to be assessed for processing speed deficits. Other possible signs of processing speed deficits include difficulty understanding lengthy directions or lectures, difficulty with complex mathematical calculations, difficulty on timed tests, and difficulty with tasks that involve coordinated eye-hand skills. Fluency deficits are manifested by slow oral speech, or academic fluency for reading, writing, and math. Retrieval deficits are manifested by difficulty bringing information out of long-term memory for current use.

If this author was granted permission to change the IDEA law for the identification of children with special needs, several changes would be appropriate; however, the inclusion of processing speed as a specific learning disability would be paramount. Many children have neuropsychological deficits that are caused by physiological damage or degradation of the white matter tracts in the brain, which results in processing speed deficits (see Davis & Broitman, 2011, and Yalof & McGrath, 2010, for reviews of neuropsychological deficits associated with nonverbal learning disabilities and other white matter diseases). At a minimum, these children certainly need to have educational accommodations made for their slow processing speed, with the most common sense one being extended time for task completion.

Identifying Speed, Fluency, and Efficiency of Processing Deficits

It is suggested that the *Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition* (NPCC-3; D. Miller, 2012) be completed by the parent/guardian and at least one teacher of the student being referred for a comprehensive assessment (see the supplemental CD for the complete NPCC-3). The questions on the NPCC-3 that pertain to speed and efficiency of cognitive processing difficulties are shown in Rapid Reference 15.1. Any endorsed items in the moderate to severe range should be followed up with formal assessment measures in the school neuropsychological assessment.

Rapid Reference 15.1

Speed, Fluency, and Efficiency of Cognitive Processing Items from the Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition (NPCC-3: Miller, 2012)

Processing speed and fluency difficulties:

- Takes longer to complete tasks than others the same age.
- Homework takes too long to complete.
- Requires extra time to complete tests.
- Responds slowly when asked questions.

Processing speed and accuracy difficulties:

- Does not do well on timed tests.
- Difficulty recalling information accurately and quickly.

Reading fluency difficulties:

- Has a limited reading vocabulary.
- Slow reading that makes reading comprehension poor.
- Difficulty reading quickly and accurately.
- Slow and deliberate reader.
- Difficulty using appropriate phrasing and expression while reading.

Writing fluency difficulties:

- Takes a long time to write even simple sentences.
- Develops an organized sequence in writing that is easy to follow.
- Maintains a clear and sustained focus on the main writing topic.

Mathematics fluency difficulties:

- Takes a long time to solve simple math problems.
- Difficulty pulling basic math facts out of memory quickly.

Assessing Speed and Efficiency of Cognitive Processing

Rapid Reference 15.2 restates the second- and third-order classifications of speed and efficiency of processing within the Integrated SNP/CHC Model. Tests designed to measure these second- and third-order classifications of speed and efficiency of processing are presented in this section.

Assessing Performance Fluency

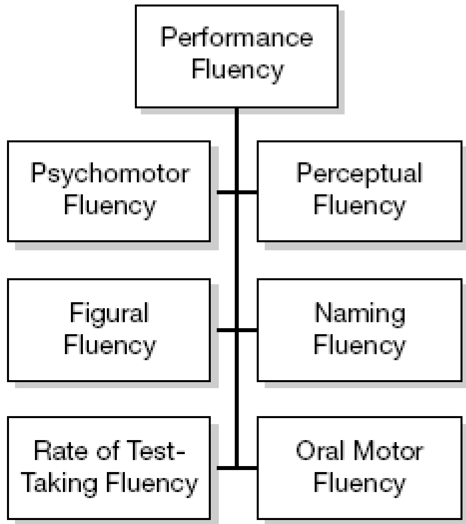
As previously defined, performance fluency is the ability to quickly perform simple, repetitive tasks. Performance fluency tasks do not require any memory retrieval. The tasks in this area are all related to overlearned, automatic processing. The second-order classification of performance fluency has several third-order classifications including psychomotor fluency, perceptual fluency, figural fluency, naming fluency, rate of test-taking fluency, and oral motor fluency (see Figure 15.2).

Rapid Reference 15.2

Integrated SNP/CHC Model Classifications of Speed and Efficiency of Cognitive Processing

Broad Classifications	**Second-Order Classifications**	**Third-Order Classifications**
Speed, fluency and efficiency of processing facilitators/inhibitors	• Performance fluency	• Psychomotor fluency • Perceptual fluency • Figural fluency • Naming fluency • Rate of test-taking fluency • Oral motor fluency
	• Retrieval fluency	• Word fluency • Semantic fluency
	• Acquired knowledge fluency	• Reading fluency: Rapid phonological decoding • Reading fluency: Rapid morphological decoding • Writing fluency • Mathematics fluency
	• Fluency and accuracy	

Figure 15.2 Third-Order Classifications of Performance Fluency



Tests of Psychomotor Fluency

The demands of a psychomotor fluency task require rapid motor output. In CHC nomenclature, psychomotor fluency is a measure of psychomotor speed (*Gps*) and movement time (*MT*). An example of this kind of task would be keeping a pencil line moving through a maze as quickly as possible. Students with psychomotor speed and accuracy deficiencies take longer to complete assignments with motor output demands. The interplay between speed and accuracy is discussed in more detail later in this chapter. Some students sacrifice accuracy for speed while others slow down to be more accurate. Ideally, students will be sufficiently fast and accurate instead of slow and inaccurate. Rapid Reference 15.3 presents a list of tests designed to measure the third-order classification of psychomotor fluency.

The Visuomotor Precision test on the NEPSY-II (Korkman et al., 2007) yields an overall combined score and this is often the only score reported by some clinicians. The test also yields three additional measures that should be interpreted as well. These additional scores are for the total completion time, the total number of errors, and the total number of pencil lifts (a rule violation). The overall combined score is a combination of the total completion time and the total number of errors and may be misleading depending on the individual scores for the total completion time and total number of errors, respectively. The clinician needs to examine the interplay between completion time and errors. A student who is slow and accurate does better than a student who is slow and inaccurate or fast and inaccurate. The number of pencil lifts is a measure of how well the student can follow a set of rules and is reflective of self-monitoring, a behavioral executive function. Students with psychomotor fluency deficits will have difficulty with writing fluency in general, and experience difficulty with accurately copying information from a projected computer screen, whiteboard, or blackboard in the front of a classroom.

Rapid Reference 15.3

Tests of Performance Fluency: Psychomotor Fluency

Test–Subtest: Description	**Age/Grade Range**	**Publisher**
D-KEFS—Trail-Making Condition 5—Motor Speed: Tracing a dotted line as quickly as possible.	8 to 89 years	Pearson
NEPSY-II—Visuomotor Precision: Tracing a path from start to finish quickly and while trying to stay within the lines.	3 to 12 years	
WISC-IV Integrated—Coding Copy: Rapidly and accurately copying symbols.	6–1 to 16–11 years	
See Appendix for the full names of the tests and their references.		

Tests of Perceptual Fluency and Rate of Test Taking

Perceptual speed or fluency (*P*) is defined as the ability to quickly distinguish similar but different visual patterns and maintain attention under timed conditions (Horn & Blankson, 2012). Rate of Test Taking (*R9*) is a narrow ability within the CHC nomenclature and relates to the perform of tests that are relatively easy or those that require very simple decisions (Horn & Blankson, 2012). On several of the major tests of cognitive abilities there are tests that are designed to measure perceptual fluency or rate of test taking in isolation and other tests require both aspects. Rapid Reference 15.4 presents a list of tests designed to measure the third order classification of perceptual fluency and/or rate of test taking fluency.

Tests of Figural Fluency

Figural fluency refers to the ability to connect dots with unique line patterns while following discrete rules. Difficulty with figural fluency has been associated with right dorsolateral prefrontal circuit damage or dysfunction (Baldo, Shimamura, Delis, Kramer, & Kaplan, 2001). On the D-KEFS Design Fluency test (Delis et al., 2001) a total score is generated for the total number of correct responses across conditions 1 (filled dots) and condition 2 (empty dots). Supplemental scores are also generated for each of the conditions separately to aid in clinical interpretation. Rapid Reference 15.5 presents a list of tests designed to measure the third order classification of figural fluency.

Rapid Reference 15.4

Tests of Performance Fluency: Perceptual Fluency and Rate of Test Taking

Test–Subtest: Description	Perceptual Fluency	Rate or Test Taking	Age/ Grade Range	Publisher
CAS—Matching Numbers: Underlining the two numbers in each row that are the same.	X	X	2–0 to 90+ years	PRO-ED
CAS—Planned Codes: Quickly filling in the appropriate codes in empty boxes beneath each letter from a corresponding legend.		X	5–0 to 17–11 years	
DAS-II—Speed of Informational Processing: Marking a target figure or number contained within a row of similar objects or numbers.	X		6–0 to 18–11 years	Pearson
WISC-IV—Cancellation: Marking target pictures within a visual set of pictures in a specified time period.	X	X	6 to 16 years	
WISC-IV—Coding: Copying symbols paired with geometric shapes or numbers within a time limit.		X	4 to 16 years	
WISC-IV—Symbol Search: Scanning a search group and marking the presence or absence of a target symbol or symbols within a time limit.	X	X	4 to 89 years	
WNV—Coding: Copying symbols paired with geometric shapes or numbers within a time limit.		X	4 to 21 years	

WJIII-COG DS—Cross Out: Rapidly scanning a row of 19 drawings and marking the 5 that match a target drawing.	X		4–0 to 90+ years	Riverside
WJIII-COG NU—Visual Matching: Rapidly matching two numbers on a row.	X	X	2–0 to 90+ years	

See Appendix for the full names of the tests and their references.

Tests of Naming Fluency (Rapid Automatized Naming)

Rapid Reference 15.6 presents a list of commonly used measures of naming fluency, or what is often referred to as rapid automatized naming (RAN). These tasks require the student to rapidly name common objects, colors, words, or letters as quickly as possible. Naming fluency or RAN tests are frequently used for diagnosing reading disabilities in children.

Naming fluency tests require efficient processing speed and accuracy. Several of these measures (KTEA-II: A. Kaufman & Kaufman, 2005; CTOPP: Wagner, Torgesen, & Rashotte, 1999) only include completion time as a measure of verbal fluency. Other measures in this area, discussed below, include supplemental scores to help the clinician parse out the contributions of processing speed, accuracy, and the role self-corrected errors play in the interpretation of the results.

Rapid Reference 15.5

Tests of Figural Fluency

Test– Subtest: Description	**Age/Grade Range**	**Publisher**
D-KEFS—Design Fluency: Total Correct Condition 1 + 2: The total number correct across Conditions 1 and 2.	8–0 to 89–11 years	Pearson
NEPSY-II—Design Fluency Total: Connecting dots with unique line patterns.	3 to 16 years	
See Appendix for the full names of the tests and their references.		

Rapid Reference 15.6

Tests of Naming Fluency

Test–Subtest: Description	**Age/Grade Range**	**Publisher**
CTOPP—Rapid Digit Naming: Naming numbers on a page as quickly as possible.	7–0 to 24–11 years	PRO-ED
CTOPP—Rapid Letter Naming: Naming letters on a page as quickly as possible.		
CTOPP—Rapid Color Naming: Naming colors on a page as quickly as possible.	5–0 to 24–11 years	
CTOPP—Rapid Object Naming: Naming objects on a page as quickly as possible.		
DAS-II—Rapid Naming: Naming colors or pictures as quickly as possible.	5–0 to 17–11 years	Pearson
D-KEFS—Color-Word Interference Condition 1 (Color Naming): Time taken to name the color of colored squares rapidly.	8 to 89–11 years	
D-KEFS—Color-Word Interference Condition 2 (Word Reading): Time taken to name color words (e.g., “red”) rapidly.		
KTEA-II—Naming Facility (RAN): Naming objects, colors, and letters quickly.	4–6 to 25 years	
NEPSY-II—Inhibition: Naming: Rapidly and accurately naming shapes.	5 to 16 years	
NEPSY-II—Speeded Naming Combined: Rapidly naming attributes of objects or a series of numbers and letters.	3 to 16 years	
PAL-II M—RAN Digits and Double Digits: Total time required to rapidly read single and double digits.	Grades K to 6	
PAL-II RW—RAN Letters + Letter Groups + Words: Total time required to rapidly read letters, letter groups, and words.		
RAN/RAS—Rapid Automatized Naming Objects: Correctly identifying pictures of objects as rapidly as possible.	5 to 18–11 years	PAR
RAN/RAS—Rapid Automatized Naming Colors: Correctly identifying color names as rapidly as possible.		
RAN/RAS—Rapid Automatized Naming Letters: Correctly identifying letters by name as rapidly as possible.		

Test–Subtest: Description	**Age/Grade Range**	**Publisher**
RAN/RAS—Rapid Alternating Switching Letters and Numbers: Correctly identifying letters and numbers as rapidly as possible.		
RAN/RAS—Rapid Alternating Switching Letters, Numbers, and Colors: Correctly identifying letters, numbers, and colors as rapidly as possible.	5 to 18–11 years	
WJIII-COG NU—Rapid Picture Naming: Quickly naming pictures of common objects across a row of five objects.	2–0 to 90+ years	Riverside
See Appendix for the full names of the tests and their references.		

On the first condition of the D-KEFS's Color-Word Interference test (Delis et al., 2001), the student is asked to name the color of a series of squares as quickly as possible. This condition of the Color-Word Interference test generates a score for the total completion time and a separate score for the number of errors. It is important for a clinician to choose a test that provides this level of detail because it allows for the analysis of the completion time as a function of accuracy. Some students will slow down the task in order to improve accuracy, which can be a good compensatory skill. Other students will exhibit signs of impulsivity and rush through the task with above average completion times but make many errors along the way. The second condition of the Color-Word Interference test, in which the student has to read color words (e.g., *red*, *blue*, *green*) as quickly as possible, also includes scores for completion time and the number of errors.

Another factor that needs to be considered in interpreting these naming fluency tests relates to the self-corrected or uncorrected errors made during the performance of the tasks. The NEPSY-II (Korkman et al., 2007) has two tests that are classified in this section that provide greater specificity for clinical interpretation: the first condition of the Inhibition test, the Naming portion, and the Speeded Naming test. On the Naming portion of the Inhibition test, the student is required to name common shapes as quickly as possible. The principle score is completion time on this task; however, students are allowed to self-correct items as the test is administered but the timing continues during those self-corrections. A student with slow completion time and a high number of uncorrected errors is very different from a student with slow completion due to a high number of self-corrected errors. Self-corrected errors are a sign of an executive function skill called self-monitoring which is better than a student not being aware of the fact that errors are being made on the tasks.

The *Process Assessment of the Learner—Second Edition: Diagnostics for Math* (PAL-II M; Berninger, 2007a) contains RAN tests for single and double digits, and yields scores for both completion time and the total number of errors. Likewise, the PAL-II RW (Berninger, 2007b) contains RAN tests for letters, letter groups, and words, and yields scores for both completion time and the total number of errors. If a clinician suspects naming fluency deficiencies in a student, it is recommended that the clinician choose one of the tests that provide additional scores beyond completion time, such as the number of errors and types of errors.

Tests of Oral Fluency

Rapid Reference 15.7 presents a list of commonly used measures of oral motor fluency. Many of the tests that measure oral motor fluency require the student to repeat words that are not real words but require the application of phonological rules. Students with deficits in this area should be referred to a speech and language therapist for a thorough evaluation.

Rapid Reference 15.7

Tests of Oral Motor Fluency

Test–Subtest: Description	Age/Grade Range	Publisher
CAS—Sentence Repetition: Repeating nonsense sentences.	5–0 to 17–11 years	PRO-ED
CAS—Speech Rate/Sentence Questions: Repeating a three word series of high imagery, single or double syllable words in order, 10 times in a row.		
CTOPP—Segmenting Words: Repeating a word then saying it one sound at a time.	7–0 to 24–11 years	
CTOPP—Segmenting Nonwords: Listening to nonwords, repeats each nonword, then says it one sound at a time.		
DWSMB—Expressive Speech: Repeating groups of successively more difficult words and phrases.	4 to 90 years	Riverside
KTEA-II—Oral Expression: Performing specific speaking tasks in the context of real-life scenarios.	4–6 to 25 years	Pearson
NEPSY-II—Oral Motor Sequences Total: Repetition of articulatory sequences like tongue twisters.	3 to 12 years	
NEPSY-II—Repetition of Nonsense Words Total: Repetition of nonsense words.	5 to 12 years	
OWLS-II—Oral Expression: Answering questions, completing sentences, or generating sentences in response to oral or verbal stimuli.	3 to 21 years	Western Psychological Services
PAL-II RW—Oral Motor Planning Total Time: Time taken to plan the production of alternating syllables compared to repeatedly producing the same syllables.	Grades K to 6	Pearson
PAL-II RW—Oral Motor Planning Errors Total: Total errors in the production of alternating syllables compared to repeatedly producing the same syllables.		
WIAT-III—Oral Expression: Naming concepts, words, or repeating sentences.	4–0 to 50–11 years	
See Appendix for the full names of the tests and their references.		

On the NEPSY-II Oromotor Sequences test (Korkman et al., 2007), clinicians are provided with three process scores that aid in clinical interpretation: oral motor hypotonia, rate change, and stable misarticulations. Base rates can be established for each of these scores. Oral motor hypotonia refers to poor muscle tone, which could affect the oral production of speech. Rate change refers to the variability in the rate of the motor output response. Stable misarticulations are not counted as errors on the Oromotor Sequences test but are noted by the clinician. If these behaviors are observed or inferred by the clinician, the student should be referred to a speech and language pathologist for a thorough evaluation.

Assessing Retrieval Fluency

Retrieval fluency tasks require a student to recall as quickly as possible words that start with a particular letter or words that can be categorized within a particular semantic category (e.g., examples of furniture). The performance fluency measures previously discussed do not require memory skills to complete those fairly automatic tasks; whereas, the retrieval fluency tasks combine speed of retrieval and memory recall. Schrank and Wendling (2012) pointed out that the WJIII-COG Retrieval Fluency test does not measure the encoding and storage elements of memory, but rather emphasizes the rate or automaticity of retrieval. The memory component of these tasks is important and must be considered in the overall interpretation of the results; however, for purposes of classification within the Integrated SNP/CHC Model, the emphasis is placed on the speed of retrieval for retrieval fluency tasks.

Tests designed to measure retrieval fluency are presented in Rapid Reference 15.8. Difficulty with verbal retrieval fluency has been associated with left dorsolateral prefrontal circuit damage or dysfunction (Butler, Rorsman, Hill & Tuma, 1993) and/or damage or dysfunction to the striatum (Stuss et al., 1998). Students with retrieval fluency deficits may exhibit difficulties with finding the right words to say in oral and written expressions.

Rapid Reference 15.8

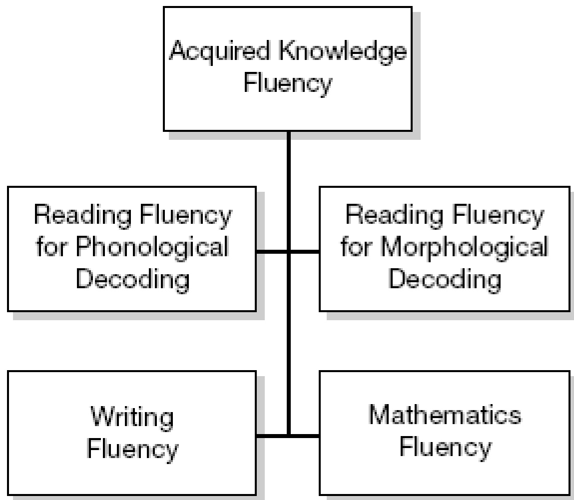
Tests of Retrieval Fluency

Test–Subtest: Description	**Age/Grade Range**	**Publisher**
Word Fluency		
D-KEFS—Verbal Fluency—Condition 1 (Letter Fluency): Naming as many words within a time limit that start with a specific letter.	8–0 to 89–11 years	Pearson
NEPSY-II—Word Generation Initial Letter Total: Words recalled quickly that start with a particular letter.	3 to 16 years	
Semantic Fluency		
D-KEFS—Verbal Fluency—Condition 2 (Category Fluency): Naming as many words within a time limit that all fall in the same category (e.g., fruits).	8–0 to 89–11 years	Pearson
KTEA-II—Associational Fluency: Naming words quickly that belong to a semantic category to start with the same letter.	4–6 to 25 years	
NEPSY-II—Word Generation Semantic Total: Words recalled quickly that fit into a category.	3 to 16 years	
WJIII-COG NU—Decision Speed: Rapidly matching two pictures in a row that belong in the same category.	2–0 to 90+ years	Riverside
Word and Semantic Fluency		
WJIII-COG NU—Retrieval Fluency: Naming words as quickly as possible that start with a particular letter or fit in the same category (e.g., animals).	2–0 to 90+ years	Riverside
See Appendix for the full names of the tests and their references.		

Assessing Acquired Knowledge Fluency

Within the Integrated SNP/CHC Model, acquired knowledge fluency is designed as a second order classification within the broad classification of speed, fluency, and efficiency of processing facilitators/inhibitors. Figure 15.3 illustrates the third-order classifications of acquired knowledge fluency. These academic fluency measures represent the automaticity of processing for rapid reading, writing, and solving math problems. These academic fluency measures are classified as facilitators/inhibitors because that is how they function. For example, reading fluency is important because it allows the reader to maintain an even flow of comprehension. Therefore, good reading fluency facilitates reading comprehension and poor reading fluency inhibits reading comprehension. The same logic applies to writing and math fluency.

Figure 15.3 Third-Order Classifications of Acquired Knowledge Fluency



Tests of Reading Fluency

With the revision of IDEA in 2004 (U.S. Department of Education, 2004), reading fluency was added as a type of specific learning disability. The major academic test publishers have included a variety of reading fluency measures. Rapid Reference 15.9 presents a list of the tests designed to measure the third order classifications of reading fluency.

Typically, students with poor reading fluency will have poor decoding skills, which slows down the automaticity of reading and thus adversely affects reading comprehension. Many achievement tests include measures of reading fluency based on rapid phonological decoding. The *Process Assessment of the Learner: Diagnostic Assessment for Reading and Writing* (PAL-II RW; Berninger, 2007) includes a measure of rapid phonological decoding as a measure of reading fluency, but also adds a measure of rapid morphological decoding. Morphological decoding fluency measures the ability to read words orally and to distinguish between common initial spelling patterns that do and do not serve as morphemes, or prefixes to a base word (e.g., take, taken, taking). Berninger (2007) also included a test on the PAL-II RW called *Sentence Sense Fluency*, which measures silent reading fluency. The Sentence Sense Fluency test assesses the ability to integrate word decoding with sentence-level comprehension. When reading fluency skills are a deficit area for a student and the clinician wants to thoroughly assess this area, the PAL-II RW is recommended.

Rapid Reference 15.9

Tests of Reading Fluency

Test–Subtest: Description	Age/Grade Range	Publisher
Reading Fluency: Rapid Phonological Decoding		
GORT-5—Rate: The amount of time taken to read a story.	6–0 to 23 years	PRO-ED
GORT-5—Fluency: Rate and Accuracy Scores combined.		
KTEA-II—Decoding Fluency: Quickly applying decoding nonsense words.	4–6 to 25 years	Pearson
KTEA-II—Word Recognition Fluency: Reading isolated words quickly.		
PAL-II RW—Pseudoword Decoding Fluency Total Correct at 60 Seconds: Number of words accurately decoded after 60 seconds.	Grades K to 6	
TOSWRF—Silent Word Reading Fluency: Ability to properly segment letters into words rapidly.	6–6 to 17–11 years	PRO-ED
WIAT-III—Oral Reading Fluency: Reading passages aloud and then orally responding to comprehension questions.	Grades 1 to 12	Pearson
WJIII COG NU—Reading Fluency: Rapidly reading short, simple sentences and circling yes or no if they make sense over a 3-minute interval.	2–0 to 90+ years	Riverside
Reading Fluency: Rapid Morphological Decoding		
PAL-II RW—Morphological Decoding Composite: Quickly and accurately pronouncing words when different suffixes are added to the same word base.	Grades K to 6	Pearson
• **PAL-II RW—Find the True Fixes:** Ability to differentiate spelling patterns that are and are not prefixes and suffices.		
• **PAL-II RW—Morphological Decoding Fluency Accuracy:** Number correct of pronounced words in which the base word is modified with different suffixes.		
• **PAL-II RW—Morphological Decoding Fluency:** Quickly pronouncing words when different suffixes are added to the same word base.		

Test–Subtest: Description	Age/Grade Range	Publisher
PAL-II RW—Sentence Sense Fluency: Ability to quickly coordinate silent word-recognition and sentence comprehension when reading for meaning under timed conditions.		
See Appendix for the full names of the tests and their references.		

Tests of Writing Fluency

Although writing fluency is not yet recognized as a specific learning disability in IDEA, it is an important skill to be assessed. Rapid Reference 15.10 presents a list of the tests designed to measure the third-order classification of writing fluency. Writing fluency represents the automaticity of writing, which can be adversely affected by a variety of deficiencies such as poor graphomotor output or poor language abilities. The subtypes of written language disorders are discussed in Chapter 17.

Rapid Reference 15.10

Tests of Writing Fluency

Test–Subtest: Description	Age/Grade Range	Publisher
PAL-II RW—Narrative Compositional Fluency:	Grades K to 6	Pearson
• **Narrative Compositional Fluency Total Number of Words:** Total number of words written across items.		
• **Narrative Compositional Fluency Total Correctly Spelled Words:** Total number of correctly spelled words written across items.		
WIAT-III—Alphabet Writing Fluency: Ability to write the letters of the alphabet quickly.	Grades Pre-K to 3	
WJII ACH NU—Writing Fluency: Producing, in writing, simple sentences that are legible.	2–0 to 90+ years	Riverside
See Appendix for the full names of the tests and their references.		

Tests of Mathematics Fluency

Mathematics fluency is also not yet recognized as a specific learning disability in IDEA, yet it is also an important skill to be assessed. Mathematics fluency represents the automaticity of completing math problems quickly and efficiently. There are many reasons why mathematics fluency can be disrupted. The various subtypes of math disabilities are discussed in Chapter 17. Rapid Reference 15.11 presents a list of the tests designed to measure the third-order classification of mathematics fluency.

Assessing Fluency with Accuracy

An important measure to consider in a school neuropsychological evaluation is the interaction between fluency and accuracy. Anytime a test requires the examiner to record completion time, processing speed is indirectly being measured. Typically, tests that measure completion time also provide a measure of performance accuracy. Figure 15.4 presents a list of processing speed tests from the D-KEFS and NEPSY-II that record completion time. The tests are presented in a table that provides a method of evaluating the interaction between completion time and accuracy.

Rapid Reference 15.11

Tests of Mathematics Fluency

Test—Subtest: Description	Age/Grade Range	Publisher
PAL-II M—Numerical Writing: Ability to write numerals both legibly and automatically.	Grades K to 6	Pearson
• **Automatic Legible Numeral Writing at 15 Seconds:** The sum of legible numerals written in 15 seconds.		
• **Legible Numeral Writing:** The sum of legible numerals written in 3 minutes.		
• **Total Time:** Total completion time required to complete writing of 26 numerals.		
WIAT-III—Math Fluency—Addition: Solving simple addition problems quickly.	Grades 1 to 12	
WIAT-III—Math Fluency—Subtraction: Solving simple subtraction problems quickly.		
WIAT-III—Math Fluency—Multiplication: Solving simple multiplication problems quickly.	Grades 3 to 12	
WJII ACH NU—Math Fluency: Solving simple math problems quickly.	2–0 to 90+ years	Riverside
See Appendix for the full names of the tests and their references.		

Figure 15.4 A Chart for Analyzing the Interaction Between Completion Time and Accuracy

Tests	Average to Low Number of Errors			High Number of Errors		
	Fast Completion Time	Average Completion Time	Slow Completion Time	Fast Completion Time	Average Completion Time	Slow Completion Time
D-KEFS Color-Word Interference Test: Color Naming						
D-KEFS Color-Word Interference Test: Word Reading						
D-KEFS Color-Word Interference Test: Inhibition Condition						
D-KEFS Color-Word Interference Test: Inhibition/Switching Condition						
NEPSY-II Speeded Naming						
NEPSY-II Visual-Motor Precision						
NEPSY-II Inhibition: Naming						
NEPSY-II Inhibition: Inhibition						
NEPSY-II Inhibition: Switching						
PAL-II RW: RAS Words and Digits						
TEA-Ch Sky Search: # Correct & Time Per Target						
TEA-Ch Creature Counting: # Correct & Timing Score						

The clinician is encouraged to put an X in the box that describes the performance of the student on any of these administered measures. See the chart in Figure 15.5 for an interpretation guide based on the profile of scores. Interpreting below average completion time with a high number of errors is more complex. The examiner needs to know the neurocognitive demands of the respective task to generate a hypothesis for the poor performance. For example, on the Speeded Naming subtest, slow but inaccurate work may reflect a word retrieval problem or an oromotor articulation problem. The examiner needs to look to other portions of the NEPSY-II test results and reported educational history to verify the causes of some slow and inaccurate task performances.

Figure 15.5 Interpretation of the Completion Time—Accuracy Interaction

	Low Number of Errors	**High Number of Errors**
Fast completion time	Indicates that the child has excellent processing speed and accuracy.	Reflective of impulsive behaviors.
Average completion time	Indicates a child with good inhibitory skills.	The child is attempting to balance speed with control but lacks the inhibitory skills to keep his or her error rate within normal limits.
Slow completion time	Indicates that the child may have chosen to slow down to increase accuracy or may have slow processing speed.	Indicates that despite the child slowing down accuracy did not improve; usually indicative of low ability in the tested area.

Chapter Summary

In this chapter the facilitators/inhibitors of speed, fluency, and efficiency of processing were reviewed. Measures of performance fluency, retrieval fluency, acquired knowledge fluency, and the interaction between fluency and accuracy are all related to the automaticity and efficiency of processing. When these measures are impaired it may be due to an overall speed of information processing deficit or may be related to an underlying processing deficit (e.g., visual-spatial weakness) or skill deficit (e.g., phonological decoding). The clinician needs to conduct a thorough school neuropsychological evaluation to ascertain the reasons for deficits in these speed, fluency, and efficiency of processing areas.

Test Yourself

1. All of the following are examples of second order classifications of performance fluency, except one. Which one?

a. Perceptual fluency

b. Naming fluency

c. Semantic fluency

d. Psychomotor fluency

2. What part of neuroanatomy is most closely related to the speed of information processing?

a. The brain's myelination

b. The corpus collosum

c. The frontal lobes

d. The cerebellum

3. True or False? Measuring rapid phonological decoding skills is the only method of measuring reading fluency.

4. Which of the performance fluency measures has been found to be a good predictor of reading disabilities?

a. Psychomotor fluency

b. Naming fluency (rapid automatized naming)

c. Figural fluency

d. Perceptual fluency

5. With the NEPSY-II's assessment of oral fluency, there is a qualitative behavior that measures muscle tone that could affect the oral production of speech. What is that qualitative behavior called?

a. Stable misarticulations

b. Stuttering

c. Confabulations

d. Oral motor hypotonia

6. True or False? Difficulty with verbal retrieval fluency has been associated with left dorsolateral prefrontal circuit damage or dysfunction.

7. Which test provides a broader assessment of reading fluency beyond just rapid phonological decoding?

a. KTEA-II

b. WJIII ACH NU

c. PAL-II RW

d. WIAT-III

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

Chapter Sixteen

Acquired Knowledge: Acculturation Knowledge and Language Abilities

Comprehension-Knowledge (*Gc*), Domain-Specific Knowledge (*Gkn*), Reading and Writing (*Grw*), and Quantitative Knowledge (*Gq*) are all classified as acquired knowledge within CHC theory because "they all involve the acquisition of useful knowledge and understanding of important domains of human functioning" and all of "these factors represent information stored in long-term memory" (Schneider & McGrew, 2012, p. 122). This chapter reviews two components of acquired knowledge; acculturation knowledge and language abilities. The next chapter reviews the academic achievement areas within acquired knowledge.

Acculturation Knowledge

The term *acculturation knowledge* was used by Horn and Blankson (2012) to describe *Gc* and is synonymous with the label *comprehension-knowledge.* In the Integrated SNP/CHC Model, the label acculturation knowledge was used as a broad classification. The term *semantic memory*, first used by Miller (2007) in the original SNP Model, is a second-order classification within acculturation knowledge. Semantic memory has three third-order classifications within the Integrated SNP/CHC Model: verbal comprehension, general information, and domain-specific knowledge. In CHC nomenclature, semantic memory is a measure of comprehension-knowledge (*Gc*), verbal comprehension measures lexical knowledge (*VL*), and language development (*LD*), general information measures, general verbal information (*KO*), and domain-specific knowledge measures that same label (*Gkn*).

When to Assess Semantic Memory

Semantic memory is encyclopedic information retrieved from long-term memory storage. Young children, ages 4 to 6 with learning and memory difficulties, may initially appear to have average to slightly below average scores on measures of semantic memory. Early measures of semantic memory are largely dependent on information that most children learn through watching television. However, when learning and memory problems persist into middle childhood and adolescence, semantic memory scores often drop significantly because the student is not able to acquire new information to add to his or her encyclopedic knowledge base. Children who are not yet fully acculturated into our society may also achieve low scores on measures of semantic memory, not due to poor semantic memory, but due to lack of acculturation. Generally when there are concerns about a student's long-term memory, it is good clinical practice to assess the student's semantic memory.

Assessing Semantic Memory

Rapid Reference 16.1 restates the second- and third-order classifications of semantic memory within the Integrated SNP/CHC Model. Tests designed to measure these second- and third-order classifications of semantic memory are presented in this section.

In terms of the neuroanatomy associated with semantic memory, these processes are severely impaired by damage to the anterolateral temporal lobe (Levy, Bayley, & Squire, 2004). Rapid Reference 16.2 presents a list of the major tests designed to measure semantic memory.

Rapid Reference 16.1

Integrated SNP/CHC Model Classifications of Acquired Knowledge: Acculturation Knowledge

Broad Classifications	Second-Order Classifications	Third-Order Classifications
Acculturation knowledge	• Semantic memory	• Verbal comprehension • General information • Domain-specific knowledge

Rapid Reference 16.2

Tests of Semantic Memory

Test–Subtest: Description	Age/Grade Range	Publisher
Verbal Comprehension		
KABC-II—Riddles: Pointing or naming a concrete or abstract verbal concept based on verbal characteristics (riddles) provided by the examiner.	3 to 18 years	Pearson
WJIII-COG NU—Verbal Comprehension: Four parts (Picture Vocabulary, Synonyms, Antonyms, and Verbal Analogies) that measures semantic memory.	2–0 to 90+ years	Riverside
WJIII-COG DS—Bilingual Verbal Comprehension: Four parts (Picture Vocabulary, Synonyms, Antonyms, and Verbal Analogies) that measure semantic memory in Spanish.		
General Information		
KABC-II—Verbal Knowledge: Selecting one picture that corresponds to a vocabulary word or answering a general question.	3 to 18 years	Pearson
SB-V—Nonverbal Knowledge: Ability to recall from the accumulated fund of nonverbal general information.	2 to 85+ years	Riverside
SB-V—Verbal Knowledge: Ability to recall from the accumulated fund of verbal general information.		
WISC-IV—Information: Answering questions about a wide range of general knowledge topics.	6–0 to 16–11 years	Pearson
WJIII-COG NU—General Information: Depth of verbal knowledge based on "where" and "what" questions.	2–0 to 90+ years	Riverside
Domain-Specific Knowledge		
WJIII-ACH NU—Academic Knowledge: Knowledge of basic academic areas (e.g., science, humanities).	2–0 to 90+ years	Riverside
See Appendix for the full names of the tests and their references.		

Language Abilities

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 onto the next generation (Carlson, 2010). Language skills are essential for a child to achieve academic success. Language development (*LD*) is considered to be a narrow ability within *Gc* in CHC Theory (Schneider & McGrew, 2012). Within the Integrated SNP/CHC Model, language abilities are viewed as a separate but equal broad classification of acquired knowledge.

Neuroanatomy of Language

This section of the chapter reviews the neuroanatomy of language functions, including the lateralization of language, the areas of the brain which are activated during oral expression and receptive language, and the right hemispheric involvement in language functions.

Lateralization of Language

Language skills are lateralized in the left side of the brain in 90% of the total population (Carlson, 2010). Knecht et al., (2001) found that left-hemispheric speech is dominant in 96% of healthy, right-handed people; 85% of ambidextrous people, and 73% of left-handed people. Vikingstad et al., (2004) 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.

Oral Expression

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.

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, Palumbo, Helm-Estabrooks, Stiassny-Eder, & Albert, 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, 2010). *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 many alter the sequence of the sounds (Carlson, 2010).

Receptive Language or Listening Comprehension

Justin has difficulty producing understandable oral language. He even has difficulty repeating oral directions. When he writes, his words often consist of letter combinations that look like real words, but are in fact nonsense words. Justin exhibits symptoms of a type of disorder called receptive aphasia.

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, 2010). 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, 2010). The posterior language area plays a major role in interchanging information between the auditory representation of words and the meaning of these words, stored as memories in the rest of the sensory association cortex (Carlson, 2010). 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, 2010).

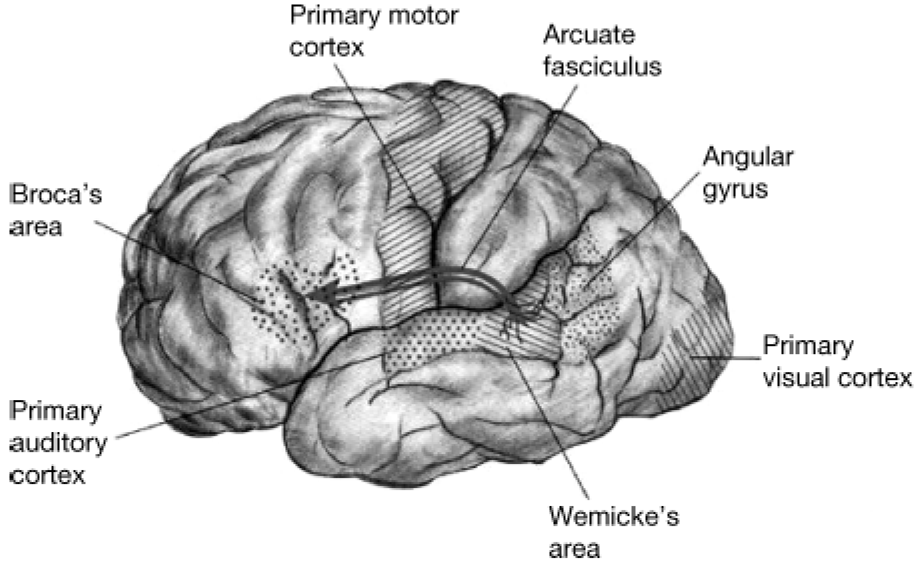
Rapid Reference 16.3 summarizes the various forms of aphasias, their neuroanatomical bases, and their associated characteristics. Figure 16.1 illustrates the major brain structures involved with expressive and receptive language.

Rapid Reference 16.3

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. • Comprehends speech much better than produces 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 fasciculus 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 cannot comprehend the meaning of what they hear nor produce meaningful speech on their own.

Figure 16.1 **Wernicke-Geschwind Model of Language**



Right Hemispheric Language Involvement

Although the various forms of language disorders described above 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, 2010). Prosody appears to be a right hemispheric function. Rapid Reference 16.4 provides a list of neuropsychological terms associated with language impairments.

Rapid Reference 16.4

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.

When to Assess for Language Abilities

The most common entry for a child into special education services is related to language delays, which are often associated with articulation difficulties. Language disorders are different from articulation disorders and encompass oral expressive skills and receptive language skills. When a student is having severe oral expressive or receptive language difficulties a referral for additional formal assessment to help guide targeted interventions is probably warranted. It is also important to refer students suspected of having ADHD for a thorough language evaluation to rule out an auditory or receptive language disorder. Often students with auditory processing difficulties look to the untrained observer as if they are not paying attention and get misdiagnosed as ADHD—Inattentive Type.

Language deficits have been shown to be related to a wide variety of neurodevelopmental disorders including autism (Lang, 2010), nonspecific developmental delays (Dooley, 2010), externalizing disorders (Jiron, 2010), internalizing disorders (J. Miller, 2010), deaf and hard of hearing (Metz, Miller, & Thomas-Presswood, 2010), reading disabilities (Feifer, 2010), written language disabilities (Berninger, 2010), some types of math disabilities (Maricle, Psimas-Fraser, Muenke, & Miller, 2010), some chronically ill disorders (see Colaluca & Ensign, 2010, for a review), some types of brain tumors (see Begyn & Castillo, 2010, for a review), some types of seizure disorders (see Youngman, Riccio, & Wicker, 2010, for a review), and some types of traumatic brain injury (see Morrison, 2010, for a review).

Identifying Language Ability Concerns

It is suggested that the *Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition* (NPCC-3; Miller, 2012) be completed by the parent/guardian and at least one teacher of the student being referred for a comprehensive assessment (see the supplemental CD for the complete NPCC-3). The questions on the NPCC-3 that pertain to language problems are shown in Rapid Reference 16.5. Any endorsed items in the moderate to severe range should be followed up with formal assessment measures in the school neuropsychological assessment.

Assessing Language Abilities: Oral Expression

Rapid Reference 16.6 restates the second- and third-order classifications of language processes within the Integrated SNP/CHC Model. Tests designed to measure these second- and third-order classifications of language abilities are presented in this section.

Rapid Reference 16.5

Language Ability Items from the Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition (NPCC-3; Miller, 2012)

Oral expression difficulties:

- Slow labored speech.
- Limited amount of speech.
- Distorts sounds (e.g., slurring, stuttering).
- Difficulty finding the right word to say.

Receptive language difficulties:

- Trouble understanding what others are saying.
- Does not do well with verbal directions.
- Loses track of what he/she was told to do.
- Does not follow conversations well.

Tests of Oral Expression: Vocabulary Knowledge

Rapid Reference 16.7 presents a list of commonly used measures of vocabulary knowledge. Vocabulary tests are difficult to categorize in the SNP Model because they can measure multiple cognitive processes and may be influenced by environmental and cultural factors. Many of the vocabulary tests require the student to name pictures of common objects or to define word meanings. All of these tests in Rapid Reference 16.8 require an oral response of some kind, which is why these tests are classified as a subclassification of oral expression. However, the trained examiner needs to be aware that a student may have a limited vocabulary due to being raised in a verbally impoverished environment with lack of educational opportunity. In these cases, the clinician would not want to attribute poor vocabulary skills to an oral expressive disorder.

Rapid Reference 16.6

Integrated SNP/CHC Model Classifications of Acquired Knowledge: Language Abilities

Broad Classifications	**Second-Order Classifications**	**Third-Order Classifications**
Language abilities	• Oral expression	• Vocabulary knowledge • Qualitative behaviors
	• Receptive language	• Receptive language with verbal response. • Receptive language with nonverbal response qualitative behaviors

Rapid Reference 16.7

Tests of Vocabulary Knowledge and Retrieval

Test–Subtest: Description	**Age/Grade Range**	**Publisher**
CREVT-2—Expressive Vocabulary: Ability to define a word spoken by the examiner.	4 to 89–11 years	PRO-ED
DAS-II—Naming Vocabulary: Naming pictures.	2–6 to 8–11 years	Pearson
DAS-II—Word Definitions: Explaining the meaning of each word.		
DWSMB—Naming Pictures of Objects: Measures knowledge of semantic labels for pictures of common objects.	4 to 90 years	Riverside
EOWPVT-4: Ability to name objects, actions, or concepts illustrated in pictures.	2 to 80+ years	Academic Therapy Publications
EOWPVT-SBE—English Expressive language: Naming in English colored pictures on common objects, actions, or concepts.	2 to 80+ years	
EOWPVT-SBE—Spanish Expressive language: Naming in Spanish colored pictures on common objects, actions, or concepts.		
EVT-2: Ability to define vocabulary words.	2–6 to 90+ years	Pearson
KABC-II—Expressive Vocabulary: Naming pictures.	3 to 18 years	
NEPSY-II—Body Part Naming Total: Naming of body parts.	3 to 4 years	
SPELT-P 2: Assesses expressive vocabulary related to everyday situations and objects.	3–0 to 5–11 years	Janelle Publications
SPELT-3: Assesses expressive vocabulary related to everyday situations and objects.	4–0 to 9–11 years	
WIAT-III—Oral Expression (Expressive Vocabulary): Naming the concept shown in a picture or saying words from a given category and repeating sentences.	4 to 50–11 years	Pearson
WISC-IV—Vocabulary: Naming pictures that are displayed in the stimulus book or giving definitions for words that the examiner reads aloud.	6 to 16–11	

Test–Subtest: Description	Age/Grade Range	Publisher
WISC-IV Integrated—Vocabulary Multiple Choice: A multiple-choice version of the Vocabulary subtest. Lesser verbal and recall memory demands.	6–1 to16–11 years	
WISC-IV Integrated—Picture Vocabulary Multiple Choice: Same items as the WISC-IV Vocabulary test except with reduced memory and verbal expression demands.		
WJIII-ACH NU—Picture Vocabulary: Recognize and name pictured objects.	2–0 to 90+ years	Riverside
See Appendix for the full names of the tests and their references.		

Poor performance on measures of vocabulary may also be due to retrieval deficits. The student may exhibit signs of anomia, or word retrieval difficulties, on these types of tasks. For example, a student may be shown a picture of a rose and asked to name it. The student proceeds to say “it has petals, you smell it, it is red,” but cannot come up with the name “rose. “Poor vocabulary knowledge could be related to poor initial encoding of the word (an memory deficit) or poor retrieval of the word (an executive function), rather than an oral expressive deficit. Clinicians need to interpret the student's performance on these vocabulary tests carefully and interpret the results in light of the types of errors made on the tests.

Oral Expression Qualitative Behaviors

The Oromotor Sequences test on the NEPSY-II (Korkman et al., 2007) provides the clinician with three supplemental qualitative behaviors to aid in interpretation: oral motor hypotonia, rate change, and stable misarticulations. The Oromotor Sequences test requires the student to repeat a set of tongue twisters orally. Oral hypotonia is a qualitative behavior that reflects low muscle tone, which affects the oral motor production of speech. If the student performing the task changes the rate of speech multiple times, the qualitative behavior of rate change is noted. Stable misarticulations are noted on this test as well as on the NEPSY-II's Repetition of Nonsense Words test. All of these qualitative behaviors are represented as cumulative percentile ranks, which reflect the percentage of students in a normative sample, typically based on the student's age, that also had one of the qualitative behaviors. If only a small percentage (≤ 10%) of students the same age exhibited any of these qualitative behaviors, a referral to a speech and language pathologist may be warranted.

The Twenty Questions test on the D-KEFS (Delis et al., 2001) measures the ability to efficiently ask yes/no questions to search for a correct answer. The Spatial Questions qualitative score from the Twenty Questions test reflects the number of yes/no questions asked by the student in an attempt to eliminate objects based on their location on the stimulus page (e.g., "Is it in the bottom two rows?"). Asking a spatial question, rather than a verbal question on this test is highly unusual with only 2.7% of the normative sample asked these kinds of spatial questions (Delis et al., 2001). A high number of spatial questions could indicate an oral language deficit such as developmental or acquired aphasia. A student with a high number of spatial questions asked may or may not have intact problem-solving skills but the verbal expression deficits are interfering with the normal performance of the task. Students with this type of response style may try to approach the majority of learning tasks using visual strategies, while avoiding verbal strategies.

Assessing Language Abilities: Receptive Language

Rapid Reference 16.8 presented a list of commonly used measures of receptive language or measures of listening comprehension. Receptive language tests can be subclassified based on the output demands of the task, either verbal response or nonverbal, motoric response. These tasks require the student to listen to orally presented content and then answer questions or view visual stimuli and point to various aspect of the stimuli based on verbal prompts.

As previously mentioned in this chapter, children with receptive language deficiencies are often misdiagnosed with ADHD-Inattentive type. Differential diagnosis for ADHD and Auditory Processing Disorder is very important. Children with receptive language difficulties will look like they are not paying attention when, in fact, they are just having difficulty processing language.

Qualitative Behaviors for Receptive Language

Asking for a repetition of verbally presented material is a qualitative behavior on several NEPSY-II tests including Comprehension of Instructions, Phonological Processing, Sentence Repetition, and Word List Interference. These asking for repetitions qualitative behaviors are represented as cumulative percentile ranks, which reflect the percentage of students in a normative sample, typically based on the student's age, that also had one of the qualitative behaviors. If only a small percentage (≤ 10%) of students the same age exhibited any of these qualitative behaviors, a referral to a speech and language pathologist may be warranted.

Rapid Reference 16.8

Tests of Receptive Language

Test–Subtest: Description	Age/Grade Range	Publisher
Receptive Language with Verbal Response		
CAS—Sentence Questions: Responding to content from verbally read sentences.	5–0 to 17–11 years	PRO-ED
KTEA-II—Listening Comprehension: Listening to passages and then responding to questions.	6–0 to 18–11 years	Pearson
ROWPVT-4: Ability to match verbally or by pointing a word spoken by the examiner to a picture of an object, action, or concept.	2–0 to 80+ years	Academic Therapy Publications
ROWPVT-SBE—English Receptive Language: Ability to match verbally or by pointing a spoken English word by the examiner to a picture of an object, action, or concept.	4–0 to 12–0 years	
ROWPVT-SBE—Spanish Receptive Language: Ability to match verbally or by pointing a spoken Spanish word by the examiner to a picture of an object, action, or concept.		
TAPS-3—Auditory Comprehension: Listening to an oral passage and then answering questions.	4 to 18–11 years	
WIAT-III—Listening Comprehension: Listening to a word and pointing to a picture that illustrates the word, then listening to passages and answering questions about each one.	4–0 to 50–11 years	Pearson
WJIII-ACH NU—Oral Comprehension: Listening to passages and then orally providing a one-word response to fill in a missing last word.	2–0 to 90+ years	Riverside
WJII ACH NU—Understanding Directions: Listening to a sequence of audio instructions then following them.		
Receptive Language with Nonverbal Motor Response		
CAS—Verbal-Spatial Relations: Matching a spatial configuration of objects to a verbal description.	5–0 to 17–11 years	PRO-ED
CREVT-2—Receptive Vocabulary: Pointing to one of four pictures that corresponds to a spoken word.	4 to 89–11 years	
DAS-II—Verbal Comprehension: Following oral instructions to point to or move pictures and toys.	6–0 to 18–11 years	Pearson

Test–Subtest: Description	Age/Grade Range	Publisher
NEPSY-II—Body Part Identification Total: Pointing to body parts on self on command.	3 to 4 years	
NEPSY-II—Comprehension of Instructions Total: Respond quickly to verbal instructions of increasing complexity.	3 to 16 years	
OWLS-II—Listening Comprehension: Pointing to a picture that matches the corresponding word spoken by the examiner.	3 to 21 years	Western Psychological Services
PPVT-IV—Total Score: Pointing to one of four pictures that corresponds to a spoken word.	2–6 to 90+ years	Pearson
WJIII-ACH NU—Understanding Directions: Pointing to various objects in a picture after listening to a sequence of recorded instructions.	2–0 to 90+ years	Riverside
See Appendix for the full names of the tests and their references.		

Tests for Speech and Language Pathologists

Brief descriptions of the following tests were included in this section (see Rapid Reference 16.9), even though school neuropsychologists probably will not administer them. This is not a complete list of all of the assessments available for speech and language pathologists. 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).

Rapid Reference 16.9

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, 1999)	• 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	2–21 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; P. C. Lindamood & P. Lindamood, 2004)	• Ability to perceive and conceptualize speech sounds using a visual medium	5–0 to 18–11 years
• *Test of Word Finding—Second Edition* (TWF-2; German, 2000)	• Expressive word finding	4–0 to 12–11 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)—Third Edition* (TOLD-3; Hammill & Newcomer, 1997)	• Expressive language	4–0 to 8–11 years

Test	What Is Measured	Age Range
• *Test of Language Development (Intermediate)—Third Edition* (TOLD-3; Hammill & Newcomer, 1997)	• Expressive language	8–0 to 12–11 years
• *Utah Test of Language Development* (Mecham, 2003)	• Expressive language	3–0 to 9–11 years

Chapter Summary

In this chapter two broad classification types of acquired knowledge, acculturation knowledge and language abilities were reviewed. The neuroanatomy of language functions is reviewed along with a discussion of when to assess for language abilities. As mentioned in the chapter, much of what is taught in schools has a language basis. School neuropsychologists should work in collaboration with the speech and language pathologist to evaluate for expressive and receptive language disorders as warranted.

Test Yourself

1. Examples of third-order classifications of semantic memory include all of the following except for one. Which one?

a. Procedural memory

b. Verbal comprehension

c. General information

d. Domain-specific knowledge

2. Language skills are lateralized in the left hemisphere for approximately what percentage of all people?

a. 65%

b. 70%

c. 80%

d. 90%

3. 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

4. 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

5. True or False? Prosody of speech is a right hemispheric function.

6. 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

7. 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-II Language Domain subtests

d. *Kaufman Test of Educational Achievement—Second Edition* (KTEA-II)

8. 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. a; 2. d; 3. b; 4. c; 5. true; 6. a; 7. b; 8. a

Chapter 17

Acquired Knowledge

Academic Achievement

Chapters 10 through 13 present information about essential cognitive elements required for success in school and in life, ranging from baseline sensory-motor functions to higher-order executive functions. Chapters 14 and 15 review the cognitive facilitators/inhibitors, which influence cognitive processes and measures of acquired knowledge. In Chapter 16, the acquired knowledge skills of acculturation knowledge and language abilities are presented. In this chapter, the acquired knowledge areas of reading, writing, and mathematics achievement are discussed.

Academic achievement is often the "measuring stick" used by school personnel to determine a child's progress in school. Academic achievement is closely related to a student'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 reviews (1) when to assess for academic functioning; (2) a glossary of neuropsychological terms used for academic disorders; (3) the neuropsychology of reading disorders; (4) the neuropsychology of written language disorders; (5) the neuropsychology of mathematics; and (6) a listing of the common achievement tests subdivided by academic area.

When to Assess for Academic Functioning

The National Center for Education Statistics (U.S. Department of Education, 2011) reported that in the 2008 to 2009 academic year, 5% of total enrollments of children in public schools were classified as having a specific learning disability (SLD). The prevalence rate for reading and writing disabilities appears to be between 2% and 8% of school-age children. About 7% of school-age children have a specific learning disability in mathematics (Geary, Hoard, & Bailey, 2011). These prevalence rates are estimates of students with significant problems in reading, writing, or mathematics to warrant a SLD diagnosis, but does not include a larger number of students who struggle with these academic areas on a daily basis, but to a lesser degree than those with SLD. 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 disabilities requires the school neuropsychologist to understand the neuropsychological terms associated with academic impairments (see Rapid Reference 17.1), and the characteristics of the subtypes associated with each of the academic areas. Proper identification of the neuropsychological subtypes of reading, writing, and mathematics disabilities cannot be determined by administering an individual achievement test alone. A school neuropsychologist must do error analyses, miscue analyses, and evaluate qualitative behaviors to fully understand the type of academic problems a child may be experiencing. The next few sections of this chapter review the disability subtypes associated with reading, writing, and mathematics.

Rapid Reference 17.1

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 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.
  - *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”).
  - *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.
  - *Mixed dyslexia*—Poor reading because of an overreliance on semantic cues. Auditory and visual processing of reading is impaired.
  - *Surface dyslexia*—Poor reading because of difficulty recognizing symbols of language. Having an overreliance on auditory cues.

Sources: Ayd, 1995; Loring, 1999.

Reading Disorders

Tyron is in the second grade and he has difficulty reading. Tyron can read familiar words but he has difficulty reading unfamiliar words or pronounceable nonwords. He had a tendency to over rely on the visual representation of words because of his difficulty sounding out words. His reading comprehension is poor, particularly when there are many words in the passages that he does not recognize.

Tyron has a subtype of reading disorder called *dysphonetic dyslexia*, which is one of several types of reading problems that children may experience. This section of the chapter reviews the relationship between reading and language disorders, the neuroanatomical circuitry of reading, and the subtypes associated with reading disorders.

Neuroanatomical Circuitry of Reading

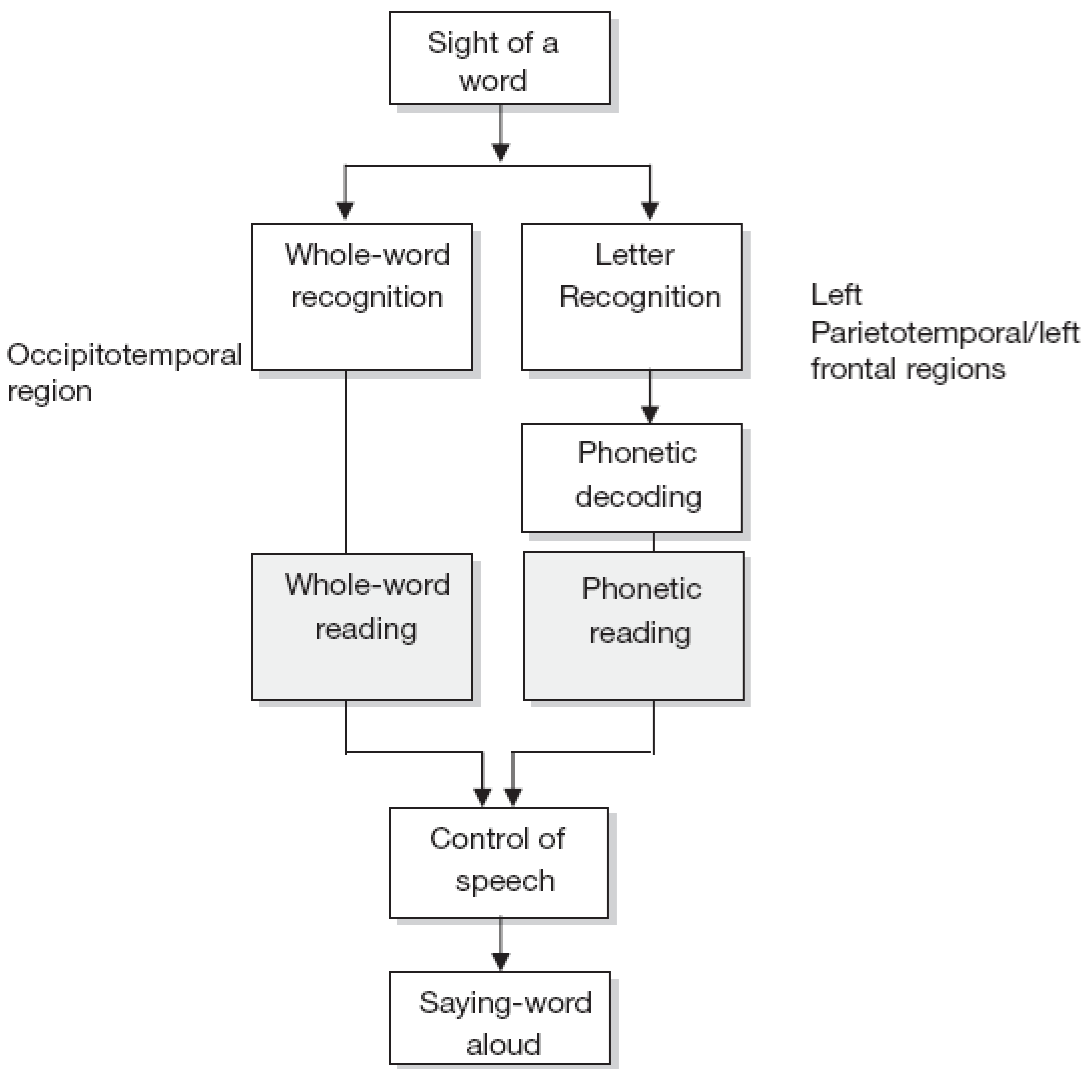
Shaywitz (2003) and S. Shaywitz and Shaywitz (2005) reviewed several major studies that used functional brain imaging techniques (e.g., fMRI) to study reading in efficient and inefficient readers. The studies revealed two slower and more inefficient pathways used by the dyslexic readers and one quicker 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 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 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 17.1 illustrates a model of reading then speaking a word based on either the parieto-temporal or the occipito-temporal pathways in the brain.

Figure 17.1 A Model of Reading a Word Aloud Following a Whole-Word or Phonetic Approach

Source: Adapted from Carlson (2010).



There is a third reading 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; S. Shaywitz & Shaywitz, 2005). 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, 2010, 2011). Second, dyslexics often show an overactivation 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 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) and S. Shaywitz and Shaywitz (2005) 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; S. 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 (S. Shaywitz & Shaywitz, 2005). These slower pathways, which over rely 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 the school neuropsychological assessment model, the following reading subtypes are 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 17.2.

Rapid Reference 17.2

Subtypes of Reading Disorders

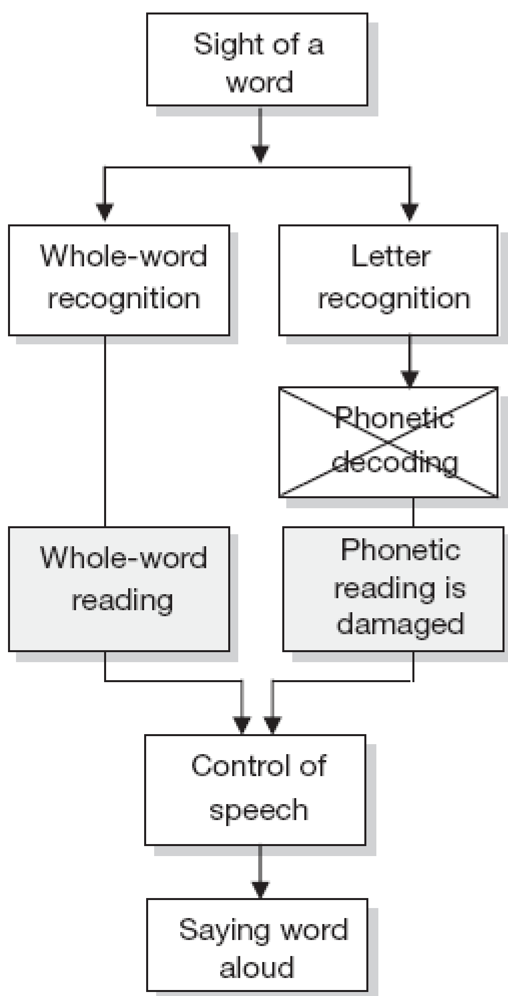
Reading Disorder Subtype	Symptoms
• Pure alexia	• A perceptual disorder in which the child has difficulty with visual input. • Also referred to as *word blindness* or *alexia without agraphia.* • Limited writing capability if writing skills were present prior to an acquired pure alexia.
• Phonological dyslexia	• Good whole-word reading. • Poor phonetic reading. • Overrely 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,”).

Pure alexia, also referred to as *word blindness* or *alexia without graphia*, 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, 2010). 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, 2010). A model that illustrates the phonological dyslexia impairment is shown in Figure 17.2. 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 overrely on memorizing whole words as they are visualized in space because they cannot phonetically sound out the word.

Figure 17.2 A Reading Model Showing Phonological Dyslexia. Phonetic Reading Is Damaged While Whole-Word Reading Remains Intact

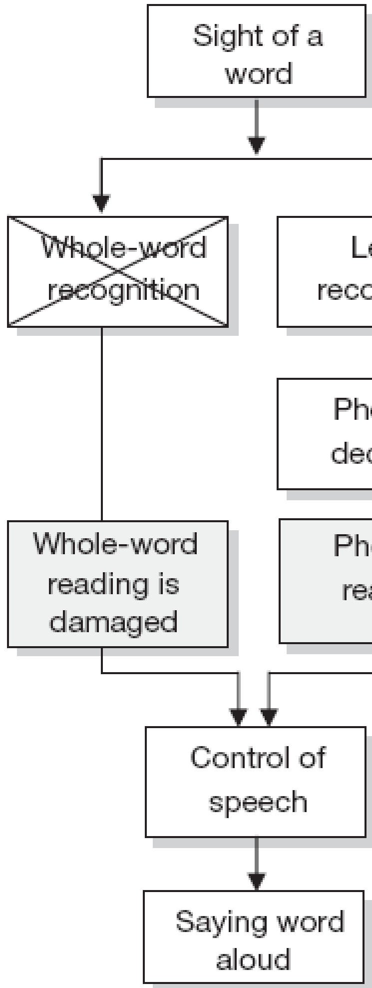
Source: Adapted from Carlson (2010).



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, 2010). The term *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 over rely on phonetically sounding out almost every word. Over relying 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 17.3.

Figure 17.3 A Reading Model Showing Surface Dyslexia. Whole-Word Reading Is Damaged While Phonemic Reading Remains Intact

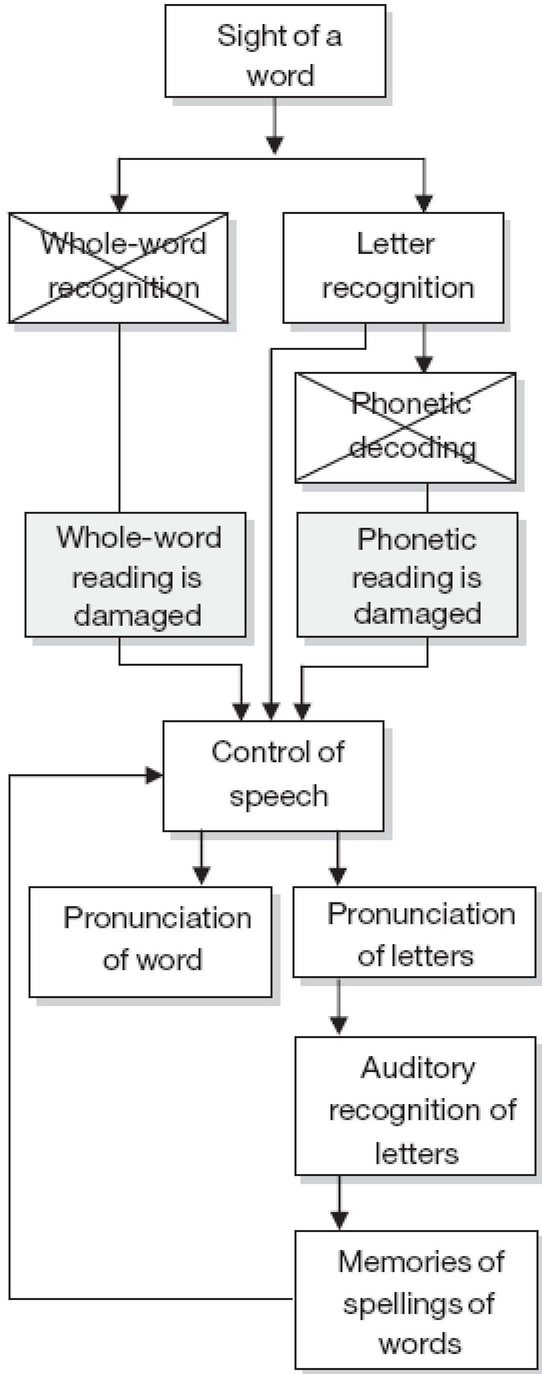
Source: Adapted from Carlson (2010).



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 word form 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 word form dyslexia impairment is illustrated in Figure 17.4.

Figure 17.4 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 (2010).



Direct dyslexia is a language disorder caused by brain damage in which the person can read words aloud without understanding them (Carlson, 2010). In Chapter 16, a type of aphasia, transcortical sensory aphasia, was described, in which a child can repeat what others say to the child, but can comprehend neither the meaning of what they hear, 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 not spoken (Carlson, 2010).

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 and semantic cues

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, 2010, 2011). 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 on matching the reading subtype with the proper intervention. See Feifer (2010) and Mather and Wendling (2012) for subtype based reading interventions.

Identifying Reading Achievement Concerns

It is suggested that the *Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition* (NPCC-3: Miller, 2012) be completed by the parent/guardian and at least one teacher of the student being referred for a comprehensive assessment (see the supplemental CD for the complete NPCC-3). The questions on the NPCC-3 that pertain to reading problems are shown in Rapid Reference 17.3. Any endorsed items in the moderate to severe range should be followed up with formal assessment measures in the school neuropsychological assessment.

Rapid Reference 17.3

Reading Achievement Items From the Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition (NPCC-3: Miller, 2012)

Reading decoding difficulties:

- Over relies on sounding out most words when reading; even familiar words.
- Over relies on memorizing what words look like rather than sounding them out.
- Substitutes words that sound like the target word (e.g., reading “pear” for “bear”).
- Substitutes words that mean the same as the word being read, but not the word itself (e.g., reading “truck” for “car”).

Reading comprehension difficulties:

- Difficulty understanding what is read.
- Difficulty identifying main elements of a story.
- Appears distracted while reading.
- Misses important details while reading.

Attitudinal issues:

- Avoids reading activities.
- Appears anxious/uptight/nervous while reading.
- Shows no interest in reading for information or pleasure.

Assessing Reading Achievement

Rapid Reference 17.4 restates the second- and third-order classifications of reading processes within the Integrated SNP/CHC Model. Tests designed to measure these second- and third-order classifications of reading achievement are presented in Rapid Reference 17.5.

Written Language Disorders

David has difficulty spelling words that are new to him. He does well in copying words or writing words told to him by his teacher. Peter has trouble with written expression as well but his difficulties with writing are different. Peter has difficulties with putting writing on paper. He is a very slow writer and seems to have trouble sequencing the proper motor acts to write successfully. Both David and Peter have written language disorders but they represent two different subtypes: phonological dysgraphia for David, and ideational dysgraphia for Peter.

Rapid Reference 17.4

SNP Model Classifications of Reading Achievement

Broad Classifications	**Second-Order Classifications**	**Third-Order Classifications**
Acquired Knowledge: Reading achievement	• Basic reading skills	• Phonological decoding • Orthographic coding • Morphological/syntactic coding
	• Reading comprehension skills	

Rapid Reference 17.5

Tests of Reading Achievement

Test–Subtest: Description	Age/Grade Range	Publisher
Basic Reading Skills: Phonological Decoding		
GORT-5—Accuracy: Ability to pronounce each word in the story correctly.	6–0 to 18–11 years	Pearson
KTEA-II—Letter and Word Recognition: Identifying letters and pronouncing words of gradually increasing difficulty.	4–6 to 25 years	
KTEA-II—Nonsense Word Decoding: Application of phonics and structural analytic skills to decode made-up words.		
PAL-II RW—Pseudoword Decoding Accuracy: Ability to phonologically decode pseudowords.	Grades K to 6	
TOWRE-2—Reading Efficiency Index: An overall indicator of reading efficiency.	6 to 24–11 years	PRO-ED
WIAT-III—Early Reading Skills: Basic letter identification and phonemic awareness skills.	Grades Pre-K to 3	Pearson
WIAT-III—Pseudoword Decoding: Ability to phonologically decode pseudowords.	Grades 1 to 12	
WIAT-III—Word Reading: Reading words in isolation.		
WJIII ACH NU—Letter-Word Identification: Reading words in isolation.	2–0 to 90+ years	Riverside
WJIII ACH NU—Word Attack: Reading phonetically regular nonsense words orally.		
WIST—Sound-Symbol Knowledge: Ability to produce the appropriate sounds associated with specific letters.	7–0 to 18–11 years	PRO-ED
WIST—Word Identification: Ability to read words aloud accurately.		
Basic Reading Skills: Orthographic Coding		
PAL-II RW—Orthographic Coding: Ability to code whole words into memory and then relate units of these words to corresponding units.	Grades K to 6	Pearson

Test–Subtest: Description	Age/Grade Range	Publisher
• **Expressive Coding:** Ability to code whole written words into memory and then reproduce the words in whole or part in writing,		
• **Receptive Coding:** Ability to code whole written words into memory and then to segment each word into units of different sizes.		
Basic Reading Skills: Morphological/Syntactic Coding		
PAL-II RW—Morphological/Syntactical Coding Composite: Assesses knowledge of word structure that conveys meaning, especially suffixes that code meaning and part of speech.	Grades K to 6	Pearson
• **Are They Related?** Ability to understand morphemes that are presented both orally and in writing.		
• **Does It Fit?** Ability to understand morphemes and syntax (parts of speech) when presented both orally and in writing.		
• **Sentence Structure:** Ability to understand morphemes and syntax (parts of speech) when presented both orally and in writing.		
Reading Comprehension Skills		
GORT-5—Comprehension: Appropriateness of responses to questions about the content of each story read.	6–0 to 18–11 years	Pearson
KTEA-II—Reading Comprehension: Different levels of tasks designed to measure reading comprehension.	4–6 to 25 years	
WIAT-III—Reading Comprehension: Reading passages aloud or silently under untimed conditions, then answering open-ended questions about each one.	Grades 1 to 12	

Test–Subtest: Description	Age/Grade Range	Publisher
WJIII ACH NU—Passage Comprehension: Reading a passage silently and providing the missing word.	2–0 to 90+ years	Riverside
WJIII ACH NU—Reading Vocabulary: Orally producing synonyms, antonyms, or verbal analogies.		
PAL-II RW—Sentence Sense Accuracy: Ability to coordinate silent word recognition and sentence comprehension when reading for meaning under timed conditions.	Grades K to 6	Pearson
See Appendix for the full names of the tests and their references.		

The writing process is very complex and involves the coordination between language, thought and motor acts (Mather & Wendling, 2011). This section of the chapter reviews the subtypes associated with writing disorders, reviews the neuroanatomical circuitry of writing, and presents the major tests of written language that fit within the Integrated SNP/CHC Model.

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 17.6 presents the common subtypes of written language disorders classified as *aphasic dyslexic disorders* (language-based), *apraxic dysgraphia* (nonlanguage based), and *mechanical dysgraphia.*

Rapid Reference 17.6

Subtypes of Written Language Disorders

Writing Disorder Subtype	**Symptoms**
Dyslexic Dysgraphia (Language-Based Disorder)	
• Phonological dysgraphia	• Characterized by impaired phonetic decoding. • Spelling of unfamiliar words, nonwords, and phonetically irregular words is impaired. • Good skills in copying words, writing from dictation, and spelling relatively familiar words.
• Orthographic dysgraphia	• Characterized by an overreliance on phonetics, cannot visually recall words. • Can spell phonetically regular words. • Has difficulty spelling phonetically irregular 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 dysgraphia	• Poor sequential motor processing. • Slow writing output. • Can copy. • Mild difficulty with dictation. • Cannot write well spontaneously.
• Constructional dyspraxia	• Visuospatial difficulty. • Cannot copy.
Mechanical Dysgraphia	

Writing Disorder Subtype	Symptoms
• 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).

Dyslexic Dysgraphias

Phonological dysgraphia is a writing disorder in which the person cannot sound out words and write them phonetically (Carlson, 2010). Children with 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.

Orthographic dysgraphia is a disorder of visually based writing (Carlson, 2010). Children with this subtype of writing disorder over rely on sounding out words, thus they can spell phonetically regular words but not phonetically irregular ones. Children with orthographic dysgraphia can only sound out a word 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*). Children with orthographic dyslexia are also at-risk for poor handwriting and orthographic spelling and may have difficulty processing serial finger movements (Berninger, 2010).

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 is 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, 2010).

Apraxic Dysgraphias

The term *apraxia* refers to a variety of motor skill deficits in which the child has 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 dysgraphia is the failure to carry out a motor act or gesture in response to a verbal command. A child with ideomotor dysgraphia 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 dysgraphia 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 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 10 for a list of assessments).

Handwriting and Spelling

In IDEA (U.S. Department of Education. 2004), written expression is one of the eight areas of eligibility for a specific learning disability (SLD). Difficulties with spelling and handwriting are often symptomatic of a writing disorder but are not sufficient alone for a diagnosis of a SLD (Mather & Wendling, 2011). Berninger (2010) pointed out that the IDEA written expression SLD criteria is based on qualifying children for special education services and not on evidence-based differential diagnoses. Fayol, Zorman, and Lété (2009) found that individuals with dysgraphia almost always have difficulties with handwriting with or without related spelling problems. Therefore, while handwriting and spelling deficits will not by themselves qualify a student for special education services school neuropsychologists should not ignore them.

Motor output problems in writing can include a poorly developed pencil grip, illegible writing, or stopping writing due to fatigue (Mather & Wendling, 2011). Berninger (2010) suggests that aspects of legibility, automaticity, speed, and sustained writing over time should be assessed as subcomponents of handwriting. The *Process Assessment for the Learner—Second Edition: Diagnostics for Reading and Writing* (PAL-2 RW: Berninger, 2007) was specifically designed to measure all three subcomponents of handwriting. Berninger and Wolf (2009) have developed specific lesson plans for the treatment of dysgraphia, including handwriting.

Spelling has a strong relationship to sound-symbol associations. As in reading, some children over rely on sounding out words when spelling and have not learned to memorize the whole word visually. Children with this type of spelling problem have difficulty spelling irregular words. Other children over rely on the orthographic representations of spelling words and cannot apply phonetic rules to assist them in spelling. A student with poor spelling may have limited written expression, as they choose only familiar, and often simpler words in writing (Mather & Wendling, 2011).

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, 2010). 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, 2010).

Identifying Written Language Achievement Concerns

It is suggested that the *Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition* (NPCC-3: Miller, 2012) be completed by the parent/guardian and at least one teacher of the student being referred for a comprehensive assessment (see the supplemental CD for the complete NPCC-3). The questions on the NPCC-3 that pertain to written language problems are shown in Rapid Reference 17.7. Any endorsed items in the moderate to severe range should be followed up with formal assessment measures in the school neuropsychological assessment.

Assessing Written Language Achievement

Rapid Reference 17.8 restates the second- and third-order classifications of written language processes within the Integrated SNP/CHC Model. Tests designed to measure these second- and third-order classifications of written language achievement are presented in Rapid Reference 17.9.

Rapid Reference 17.7

Written Language Achievement Items From the Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition (NPCC-3: Miller, 2012)

Spatial production functions:

- Demonstrates uneven spacing between words and letters.
- Trouble staying on the horizontal lines.
- Others have difficulty reading what the child has written.
- Trouble forming letters and words.
- Writes overly large letters and words.

Expressive language functions:

- Limited vocabulary for age; uses lots of easy words.
- Difficulty putting ideas into words.
- Uses simple sentence structure and lacks variety.
- Produces poor spelling in writing.
- Poor grammar in writing.

Graphomotor output functions:

- Difficulty holding the pencil or pen correctly.
- Presses too soft with the pencil/pen while writing.
- Writes overly small letters and words.
- Presses too hard with the pencil/pen while writing.
- Shows preference for printing over cursive writing.

Attitudinal issues:

- Avoids writing activities.
- Appears anxious/uptight/nervous while writing.
- Shows no interest in writing activities.

Qualitative Behaviors of Writing

The PAL-II RW (Berninger, 2007) provides several qualitative behaviors from the writing subtests, including: alignment on baseline, letter sizing, overall consistency of sizing, and process observations for expository note taking and report writing. All of these qualitative behaviors are scored as base rates, or the percentage of same-age peers that evidence these types of behaviors. These process scores aid in clinical interpretation.

Rapid Reference 17.8

SNP Model Classifications of Written Language Achievement

Broad Classifications	**Second-Order Classifications**	**Third-Order Classifications**
Acquired Knowledge: Written language achievement	• Written expression • Expositorycomposition	
	• Orthographic spelling	
	• Handwriting skills	
	• Qualitative behaviors	

Rapid Reference 17.9

Tests of Written Language Achievement

Test–Subtest: Description	Age/Grade Range	Publisher
Written Expression		
KTEA-II—Written Expression: Measures writing skills at all levels.	4–6 to 25 years	Pearson
OWLS-II—Written Expression: The examiner presents oral, written, and pictorial prompts, and examinees write their responses in a booklet.	6–0 to 21–11 years	PRO-ED
WIAT-III—Written Expression: Measures writing skills at all levels.	Grades K to 12	
WJIII ACH NU—Written Expression: Measures writing skills at all levels.	2–0 to 90+ years	Riverside
Expository Composition		
PAL-II RW—Expository Note Taking and Report Writing: Ability to take notes for up to 5 minutes after reading some text, plan a composition, and compose a report.	Grades K to 6	Pearson
PAL-II—Cross-Genre Compositional and Expository Writing: A composite score based on the total number of words, correctly spelled words, and complete sentences in writing samples.		
WIAT-III—Sentence Composition: Combining information from two or three sentences into single sentences that mean the same thing, then writing meaningful sentences that use specific words.	Grades 1 to 12	
WIAT-III—Essay Composition: Writing an essay within a 10-minute time limit.	Grades 3 to 12	
WJIII ACH NU—Writing Samples: Producing meaningful written sentences.	2–0 to 90+ years	Riverside
Orthographic Spelling		
KTEA-II—Spelling: Writing words from dictation.	4–6 to 25 years	Pearson

Test–Subtest: Description	Age/Grade Range	Publisher
PAL-II RW—Orthographic Spelling: Measures word choice accuracy and fluency in spelling.	Grades K to 6	
TOC—Orthographic Ability: Measures orthographic abilities in reading and writing.	PRO-ED	
• **Sign and Symbols:** Ability to identify a series of signs and symbols.	6 to 7 years	
• **Grapheme Matching:** Ability to identify two of five objects in a row that are identical.	6 to 7 years	
• **Homophone Choice:** Ability to choose the correct spelling of a word from several choices related to a visual picture of that word.	6 to 12 years	
• **Conventions:** Understanding of basic English usage conventions.	8 to 17 years	
• **Punctuation:** Ability to apply the correct punctuation in sentences.	6 to 17 years	
• **Abbreviations:** Ability to write what each abbreviation means.	8 to 17 years	
• **Spelling Speed:** Spelling fluency.	8 to 17 years	
• **Letter Choice:** Ability to write in missing letters in words.	8 to 17 years	
• **Word Scramble:** Ability to unscramble letters to form words.	8 to 17 years	
• **Spelling Accuracy:** Accuracy of spelling.	8 to 17 years	
• **Sight Spelling:** Ability to listen to a spoken word and fill in the missing letter or letters.	8 to 17 years	

Test–Subtest: Description	Age/Grade Range	Publisher
• **Word Choice:** Ability to listen to a spoken word and circle the correct spelling of that word from several choices.	13 to 17 years	
WIAT-III—Spelling: Writing single words that are dictated within the context of a sentence.	Grades K to 12	Pearson
WIST—Spelling: Ability to spell words from dictation.	7–0 to 18–11 years	PRO-ED
Handwriting Skills		
PAL-II RW—Alphabet Writing: The automatic printing of lowercase letters in alphabetical order from memory.	Grades K to 6	Pearson
PAL-II RW—Copying a Sentence (Task A): Ability to copy a sentence containing all letters of the alphabet.		
PAL-II RW—Copying a Paragraph (Task B): Ability to sustain copying a paragraph.		
PAL-II RW—Handwriting Errors: Quantifies handwriting errors such as reversals, inversions, omissions.		
See Appendix for the full names of the tests and their references.		

Mathematics Disorders

Patrice has difficulty with math. She has trouble with correctly aligning a column of numbers and even with the visual perception of numbers. She is able to remember basic math facts and has no trouble reading numbers. Patrice has a subtype of mathematics disorder called *visual-spatial dyscalculia.*

The neuropsychology of mathematics was not as widely researched nor was as much attention paid to it as reading and writing until recent years. In 2008, the National Mathematics Advisory Panel (U.S. Department of Education, 2008) stressed the importance of mathematics education in industrialized nations such as the United States. This section of the chapter reviews the subtypes associated with mathematics disorders, reviews the neuroanatomical circuitry of mathematics, and presents the major tests of mathematics that fit with the Integrated SNP/CHC Model.

Definitions

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 neurological insults. Hale and Fiorello (2004) pointed out that the likelihood of finding a "pure" dyscalculia in children is rare.

Subtypes of Mathematics Disorders and Neural Substrate

The neuropsychological explanations and neuroimaging evidence for subtypes of mathematics disorders is still evolving and lacks consensus (Maricle, Psimas-Fraser, Muenke, & Miller, 2010). Geary (1993, 2003) and Mazzocco (2001) suggested three subtypes of dyscalculia: semantic, procedural, and visuo-spatial. Wilson and Dehaene (2007) identified three subtypes of dyscalculia in adults, which were verified by lesion evidence and neuroimaging studies. These three dyscalculia subtypes included: number sense, verbal-symbolic, and spatial attention. Wilson and Dehaene (2007) pointed out that these same subtypes might not be present in children during developmental acquisition of mathematics. They suggested that in children there could be several other subtypes of dyscalculia including:

- A deficit in verbal symbolic representation of numbers
- A deficit in executive function.
- A deficit in spatial attention.

Hale, Fiorello, Dumont et al. (2008) examined the neuropsychological processing differences among typical children and children with a math specific learning disability on the Differential Ability Scales—Second Edition (Elliott, 2007). Hale, Fiorello, Miller et al. (2008) examined similar math and nonmath disabled children on the WISC-IV (Wechsler, 2004) and the WIAT-II (Wechsler, 2001). These authors described five developmental subtypes of dyscalculia:

1. Numeric Quantitative Knowledge
2. Dyscalculia/Gerstmann Syndrome
3. Mild Executive/Working Memory
4. Fluid/Quantitative Reasoning
5. Nonverbal Learning Disability/Right Hemisphere

The deficits and strengths of these dyscalculia subtypes, along with their neural substrates, are presented in Rapid Reference 17.10.

Rapid Reference 17.10

Subtypes of Mathematics Disorders and Related Neural Substrate

Math Disorder Subtype	**Symptoms**	**Neural Substrate**
• Number Sense Dyscalculia(Wilson & Dehaene, 2007) or Numerical-Quantitative Knowledge(Hale, Fiorello, Dumont et al., 2008; Hale, Fiorello, Miller et al., 2008)	• Deficits in: ▪ Understanding the meaning of numbers ▪ Comparison and approximation of dots ▪ Numerical comparison, addition, and subtraction ▪ Automatic activation of quantity from number words and digits	• Horizontal intraparietal sulcus within the parietal cortex
	• Strengths in: ▪ Counting ▪ Fact retrieval	
• Verbal-Symbolic Dyscalculia(Wilson & Dehaene, 2007) or Dyscalculia-Gerstmann Syndrome(Hale, Fiorello, Dumont et al., 2008; Hale, Fiorello, Miller et al., 2008)	• Deficits in: ▪ Counting ▪ Rapid number identification ▪ Retrieval of stored facts ▪ Addition and multiplication facts ▪ Numerical reasoning ▪ Possible coexisting reading/writing difficulties	• Left angular gyrus • Inferior frontal and/or temporal language areas • Left basal ganglia

Math Disorder Subtype	Symptoms	Neural Substrate
	• Strengths in: ▪ Number qualities ▪ Comparisons between numbers ▪ Understanding basic concepts ▪ Visual Spatial skills	
• Visual-Spatial Dyscalculia (Geary, 1993, 2003; Mazzocco, 2001; Wilson & Dehaene, 2007)	• Deficits in: ▪ Aligning a column of numbers ▪ Visual perception of numbers ▪ Spatial attributes (e.g., size, location) ▪ Magnitude comparisons	• Posterior superior parietal lobe
	• Strengths in: ▪ Retrieval of stored facts ▪ Reading numbers ▪ Math algorithms ▪ Verbal strategies	

Math Disorder Subtype	Symptoms	Neural Substrate
• Executive Memory Dysfunction(Wilson & Dehaene, 2007) or Mild Executive/Working Memory Dysfunction(Hale, Fiorello, Dumont et al., 2008; Hale, Fiorello, Miller et al., 2008)	• Deficits in: ▪ Fact retrieval ▪ Strategies and procedure usage • Strengths in: ▪ Numerical operations ▪ Math reasoning	• Frontal-striatal dysfunction

Number Sense or Numerical Quantitative Knowledge Dyscalculia

Hale, Fiorello, Miller et al. (2008) referred to this subtype of mathematics as numerical quantitative knowledge dyscalculia, which describes similar symptomology as Wilson and Dehaene's (2007) number sense dyscalculia. Number sense seems to be an implicit and possibly inherent ability in children (Butterworth & Reigosa, 2007). Number sense is the “understanding of the exact quantity of small collections of objects and of symbols (e.g., Arabic numerals) that represent these quantities..., and of the approximate magnitude of larger quantities” (Geary, Hoard, & Bailey, 2011, p. 46). The ability to determine the quantity of small sets of items without counting is called *subitizing*. There is evidence that children with specific learning disabilities in mathematics have deficits in both subitizing and the ability to represent approximate quantities (Geary, Hoard, Nugent, & Byrd-Craven, 2008). The neural substrate for number sense is the horizontal intraparietal sulcus (HIPS) within the parietal cortex.

Some clinicians believe that deficits in mathematics equate to a nonverbal specific learning disability (Maricle et al., 2010). Hale, Fiorello, Miller, et al. (2008) found that a group of mathematics SLD children performed below average on the Digits Forward, Arithmetic, and Processing Speed tests of the WISC-IV. Hale and his colleagues pointed out that these scores suggest that some children with deficiencies in mathematics have comorbid language, writing, and reading SLDs.

Verbal-Symbolic Dyscalculia or Dyscalculia-Gerstmann Syndrome

Verbal-Symbolic Dyscalculia was a mathematics subtype identified by Wilson and Dehaene (2007). Hale and his colleagues (Hale, Fiorello, Dumont, et al., 2008; Hale, Fiorello, Miller, et al., 2008) have used the label Dyscalculia-Gerstmann Syndrome to describe similar mathematic deficiencies. Children with this subtype of dyscalculia have difficulty with the verbal representations of numbers and use of language-based procedures for the retrieval of arithmetic facts.

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.

Dyscalculia-Gerstmann Syndrome is a neurological impairment that is associated with damage or dysfunction in the left parietal lobe, specifically within the regions of the angular gyrus, left inferior frontal, and/or temporal language areas, or the left basal ganglia (Maricle et al., 2010). Hale, Fiorello, Miller, et al. (2008) found that children with this subtype of dyscalculia achieved low scores on the Information, Arithmetic, Block Design, Picture Completion, and the Processing Speed subtests on the WISC-IV. This pattern of low scores suggested that children with this mathematics subtype had generalized left hemispheric deficits that can co-occur with reading disorders.

Visual-Spatial 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, organization, 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. Visual-spatial dyscalculia is due to dysfunction within the posterior superior parietal lobe (Wilson & Dehaene, 2007).

Executive Memory or a Mild Executive/Working Memory Dysfunction

Hale and Fiorello (2004) suggest there might be two separate visual-spatial dyscalculia subtypes: one involving right posterior area deficit that causes visual-spatial problems of poor alignment and attention to detail (visual-spatial dyscalculia as described above), and one involving the right frontal area that disrupts problem solving skills and novel concept formation. Wilson and Dehaene (2007) refer to this subtype of mathematics as *Executive Memory Dysfunction.* Hale, Fiorello, Miller, et al. (2008) include executive dysfunction as well as working memory deficits to explain this subtype of mathematics disorder and label it as mild executive/working memory dysfunction.

Children with executive functions and working memory deficits do well on numerical operations and math reasoning. Hale, Fiorello, Miller et al. (2008) report that children with these processing deficits achieved low scores on Information, Digits Backwards, Arithmetic, and Matrix Reasoning. Typically, children with this subtype have only mild deficits in math compared to the other subtypes. Frontal-striatal dysfunction is the neural substrate for this math subtype.

Identifying Mathematics Achievement Concerns

It is suggested that the *Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition* (NPCC-3; D. Miller, 2012) be completed by the parent/guardian and at least one teacher of the student being referred for a comprehensive assessment (see the supplemental CD for the complete NPCC-3). The questions on the NPCC-3 that pertain to math problems are shown in Rapid Reference 17.11. Any endorsed items in the moderate to severe range should be followed up with formal assessment measures in the school neuropsychological assessment.

Rapid Reference 17.11

Mathematics Achievement Items From the Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition (NPCC-3; Miller, 2012)

Computational and procedural difficulties:

- Forgets what steps to take when solving math problems (e.g., carrying in addition or borrowing in subtraction).
- Makes computational errors.
- Slow in solving math problems.
- Makes careless mistakes while solving math problems.
- Does not always pay attention to the math problems signs.

Visual-spatial difficulties:

- Difficulty aligning a column of numbers.
- Difficulty understanding spatial attributes such as size and location of numbers.
- Difficulty recognizing visual differences in magnitude (e.g., which group of objects has more items than another group).

Verbal difficulties:

- Difficulty with retrieval of basic math facts.
- Difficulty solving story problems.
- Difficulty with counting.
- Slow in number identification.

Attitudinal issues:

- Avoids math activities.
- Appears anxious/uptight/nervous when working with math.
- Shows no interest in math.

Assessing Mathematics Achievement

Rapid Reference 17.12 restates the second- and third-order classifications of mathematics processes within the Integrated SNP/CHC Model. Tests designed to measure these second- and third-order classifications of mathematics achievement are presented in this section. Tests designed to measure these second- and third-order classifications of mathematical achievement are presented in Rapid Reference 17.13.

Rapid Reference 17.12

SNP Model Classifications of Written Language Achievement

Broad Classifications	**Second-Order Classifications**	**Third-Order Classifications**
Acquired Knowledge: Mathematics achievement	• Oral counting • Fact retrieval • Mathematical calculations • Mathematical reasoning • Qualitative behaviors	

Rapid Reference 17.13

Tests of Mathematic Achievement

Test–Subtest: Description	Age/Grade Range	Publisher
Oral Counting		
PAL-II M—Oral Counting: Ability to orally produce numbers along the internal number line.	Grades K to 6	Pearson
Fact Retrieval		
PAL-II M—Fact Retrieval: The accuracy and speed in retrieving basic math facts, depending on different combinations of input and output modes.	Grades K to 6	Pearson
Mathematical Calculations		
KTEA-II—Math Computation: Performing a variety of math calculations.	4–6 to 25 years	Pearson
KeyMath3—Operations: Written and mental computation skills.	4–6 to 21–11 years	
PAL-II M—Computation Operations Composite: Evaluation of the visual-spatial and temporal-sequential processes underlying the student's application of computational algorithms.	Grades K to 6	
PAL-II M—Place Value Composite: Evaluation of understanding of the place value concept when representing numbers orally and in writing.	Grades K to 6	
PAL-II M—Part-Whole Relationship Composite: Evaluation of the understanding of the relationships between relative and absolute size of parts of wholes, fractions and mixed numbers, and the measurement system of time.	Grades K to 6	
WIAT-III—Numerical Operations: Performing a variety of math calculations.	Grades K to 12	
WJIII ACH NU—Calculations: Performing a variety of math calculations.	2–0 to 90+ years	Riverside
Mathematical Reasoning		

Test–Subtest: Description	Age/Grade Range	Publisher
KeyMath3—Applications: Ability to identify the key elements of math problems and the operations and strategies necessary to solve problems.	4–6 to 21–11 years	Pearson
KeyMath3—Basic Concepts: Conceptual understanding of basic math concepts.		
KTEA-II—Math Concepts and Applications: Analyzing and solving practical math problems.	4–6 to 25 years	
PAL-II M—Finding the Bug: Ability to detect computational or fact retrieval errors.	Grades K to 6	
PAL-II M—Multistep Problem Solving: Ability to understand the question a math word problem is asking and to plan the calculation steps necessary to solve it.		
SB5—Nonverbal Quantitative Reasoning: Ability to solve nonverbal problems with numbers or numerical concepts.	2 to 85+ years	Riverside
SB5—Verbal Quantitative Reasoning: Ability to solve verbal problems with numbers or numerical concepts.		
WIAT-III—Math Problem Solving: Analyzing and solving practical math problems.	Grades K to 12	Pearson
WJIII ACH NU—Applied Problems: Analyzing and solving practical math problems.	2–0 to 90+ years	Riverside
WJIII ACH NU—Quantitative Concepts: Measures mathematical knowledge and quantitative reasoning.		
See Appendix for the full names of the tests and their references.		

Qualitative Behaviors of Mathematics

The PAL-II M (Berninger, 2007) provides qualitative behaviors for numeral writing errors. These qualitative behaviors are scored as base rates, or the percentage of same-age peers that evidence these types of behaviors. These process scores aid in clinical interpretation.

Chapter Summary

In this chapter the theories, terminology, neuroanatomy, and major tests associated with the academic achievement areas are reviewed. 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, thus academic achievement measures are typically included in the majority of school neuropsychological assessments. For more comprehensive reviews of achievement tests see Naglieri and Goldstein (2009) or Flanagan, Ortiz, Alfonso, and Mascolo (2006). For a review of evidence-based academic interventions see Wendling and Mather (2009).

Don't Forget

A major contribution of a neuropsychological perspective in assessment is the ability to subtype disorders of reading, writing, and mathematics, which can lead to more targeted, evidence-based interventions.

A major contribution of a neuropsychological perspective in assessment is the ability to subtype disorders of reading, writing, and mathematics, which can lead to more targeted, evidence-based interventions. School neuropsychologists are trained not to stop at a generic diagnosis of a reading disorder, but to specify through differential diagnosis, the potential subtype of a reading disorder. The same principle applies to the identification of specific learning disabilities in writing and mathematics. Ongoing research is needed to continue to validate the linkage between the efficacy of prescriptive interventions based on specific subtypes of reading, writing, and mathematics.

Test Yourself

1. 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

2. 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. Mixed dysgraphia

d. Direct dysgraphia

3. What subtype of a written language disorder is characterized by an inability or difficulty with sequencing letters accurately in words?

a. Phonological dysgraphia

b. Surface dysgraphia

c. Mixed dysgraphia

d. Direct dysgraphia

4. What subtype of a written language disorder does not involve a cognitive component but results in poor penmanship?

a. Phonological dysgraphia

b. Surface dysgraphia

c. Mixed dysgraphia

d. Motor dysgraphia

5. What subtype of a mathematics disorder results in difficulties with poor alignment of number columns?

a. Visual-spatial dyscalculia

b. Semantic-memory dyscalculia

c. Procedural dyscalculia

d. Verbal-symbolic dyscalculia

6. What subtype of a mathematics disorder is associated with dysfunction or damage with the horizontal intraparietal sulcus within the parietal cortex?

a. Visual-spatial dyscalculia

b. Number sense dyscalculia

c. Verbal-symbolic dyscalculia

d. Executive memory dysfunction

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

Chapter Eighteen

Future Directions of School Neuropsychological Assessment

"Prediction is difficult, especially about the future!" This quote has been attributed to a wide variety of people including Yogi Berra, the baseball player and manager, Neils Bohr, a Nobel laureate physicist, and Mark Twain, a humorist. The purpose of this chapter is to humbly peek into the near future, perhaps 5 to 10 years from now, and speculate about the future of school neuropsychology. This chapter discusses the need for the continued refinement of the school neuropsychological conceptual model, the emergence of neuroeducation and role of school psychologists and school neuropsychologists, the influences of neuroimaging on the practice of school neuropsychology, future trends in school neuropsychological assessment, and finally training issues.

Continued Refinement of the School Neuropsychology Conceptual Model

The school neuropsychological conceptual model has been updated regularly in tandem with the evolution of the overall field of school neuropsychology. As the theoretical foundations for neuropsychological constructs are validated over time, the school neuropsychological conceptual model will continue to evolve. As an example, CHC theory has served as the theoretical foundation for several major tests of cognitive functions and this theory continues to be refined. As cited previously in this book, Schneider and McGrew (2012) stated:

> The most active CHC "spillover" has been in the area of neuropsychological assessment....It is our opinion that CHC-based

> neuropsychological assessment holds great potential....However, more CHC-organized factor-analytic studies of joint neuropsychological and CHC-validated batteries are needed before such a synthesis is possible....Even more crucial are studies that describe the functioning of the brain (e.g., with functional magnetic resonance imaging) during performance on validated tests of CHC abilities. (p. 109)

In this book, an attempt is made to further integrate CHC theory with the school neuropsychological conceptual model. This Integrated SNP/CHC Model needs to be validated over the coming years using a variety of statistical techniques including factor analytic studies and structural equation modeling.

A challenge for researchers and theorists is to strive for a common set of nomenclature for research and applied practice. It would be ideal if there could be a consensus established for what constitutes a cognitive process, versus a cognitive function, versus a cognitive skill, and so on. If the field of school psychology is going to embrace the notion of cognitive processing deficits being the basis for specific learning disabilities and other neurodevelopmental disorders, better clarity in the terminology we use as a discipline should be a goal for our profession.

Another challenge for school psychology and school neuropsychology remains the continued validation of assessment data with evidence-based interventions. School neuropsychologists can identify subtypes of reading, writing, and mathematics disabilities based on a fairly high degree of scientific rigor. However, the same degree of scientific rigor is not yet established for the treatment efficacy of the prescriptive interventions that are often recommended based on these neuropsychological subtypes. For the field of school neuropsychology to legitimately progress as a subspecialization in psychology, continued validation research is warranted.

Neuroeducation and School Neuropsychology

Since the early part of the 21st century, there has been a growing interest in translating brain research into applied practice. "Neuroscientific research has been integrated in most of the industries of the world (e.g., medicine, manufacturing, business practices); however, the application of neuroscientific knowledge into educational practice is lagging" (Maricle, Miller, Hale, & Johnson, 2012). Bruer (2008) referred to brain-based education as an emerging discipline and labeled it as "*neuroeducation.*" Neuroeducation emphasizes the focus of education on transdisciplinary connections (Battro, Fischer, & Léna, 2008a; 2008b). Fischer, Gaowami, and Geake (2010) referred to this integration of neuropsychology and education as "educational neuroscience", which they defined as "a new field that brings together biology, cognitive neuroscience, developmental science, and education to investigate brain and genetic bases of learning and teaching" (p. 68).

School psychologists are the only professional educators within the schools who have formal training in psychology. School psychologists should be a part of neuroeducation or educational neuroscience as it becomes more mainstream, but practitioners will need to enhance their professional skills in neuropsychology and broaden their knowledge base in the biological bases of behavior. School neuropsychologists, already training in the biological bases of behavior, are uniquely poised to be a part of this next revolution in education. The need to place more emphasis on the biological bases of behavior in school psychology training programs will be discussed in the final section of this chapter.

With the emergence of neuroeducation, some researchers warn school-based practitioners to exercise caution in overgeneralizing brain research into educational practice (Miller & DeFina, 2010). It is easy to state the claim that "research shows", which potentially misleads the public (Bruer, 1997). Swanson (2008) stated that:

> Although correlational research between brain and behavior has a long history in the field of specific learning disabilities (SLD), there is a gap in the application of this research to instruction. Recent work with the advent of fMRI procedures and treatment outcomes is beginning to bridge this gap. However, the bridge between brain studies and education is not well developed (e.g., Bruer, 1997). Knowing precisely

> which brain centers are activated over time and how they are associated with instruction is rudimentary. (p. 30)

School neuropsychologists have an ethical and professional responsibility to keep abreast of the emerging research in several fields including school psychology, neuropsychology, and neuroscience. It is recognized that this is becoming no easy task with the explosion of empirically based research in each one of these fields. However, it does fall on the school neuropsychologist to endorse or recommend only those assessment techniques and interventions, which have proven to be valid and effective.

Neuroimaging and School Neuropsychology

On a 10-year horizon, if not sooner, neuroimaging techniques will help reshape the practice of school neuropsychology. Advances in neuroimaging techniques have allowed cognitive neuroscientists a window into brain functions (Miller & DeFina, 2010). Through the use of functional neuroimaging, one can look not only at brain structure but also can also examine cognitive functions. As neuroimaging becomes more accessible, it will be more routinely used as a tool to validate what neuropsychological tests were designed to measure (Miller, 2008). Reynolds (2008) speculated that neuroimaging could help school neuropsychologists by creating functional profiles for children that would predict the presence or absence of learning disorders and guide us toward specific interventions. Finally an exciting application of neuroimaging, is to measure brain functioning pre- and postintervention as a means of verifying the effectiveness of the intervention. See Miller and DeFina (2010) for a review of the major neuroimaging techniques (e.g., magnetic resonance imaging) and their potential applications to assessing everyday neurodevelopmental disorders.

Future Trends in School Neuropsychological Assessment

This section of the chapter will present some of the future trends in school neuropsychological assessment, including advances in computerized assessment and the inclusion of more qualitative assessment data to aid clinicians in interpretation.

Computerized Assessment

The test publishing industry has not kept up with the rapid advances in personal computing technologies. It is important to realize that from a business standpoint, the field of school psychology is relatively small. With a market base of approximately 35,000 school psychology practitioners, test publishers have to make sure that their investments in product development will be sufficiently profitable.

Another limiting factor in the transitioning to computerized assessment has been the forced choice of which software platform for application development (Widows™ or Macintosh OS™). In the past it has been very expensive to develop and maintain product software for two or more platforms. With the advent of Cloud computing, where the software program is stored on the servers and accessible to any users through the Internet, the underlying programming issue becomes a moot point.

The future of computerized neuropsychological assessment is promising. Practitioners of the near future may not have to treat their personal vehicles as a test library and continually cart test kits in and out of schools. Instead, practitioners may carry a computer or tablet that presents stimulus items directly on a screen and allows students to respond. Responses to stimulus items could be captured through touch by a finger, through a stylist for a written response, or through voice-recognition.

There are several advantages of computerized assessment. The first advantage is the increased standardization of assessment. Directions for tests could be recorded and presented to the examinee, thus reducing examiner errors. Computerized assessment would also allow for the collection of additional test measurements such as the average time the examinee took to respond to items on a test. Finally, computerized assessment would create opportunities to capture assessment data across multiple users for research purposes. With paper-and-pencil assessments it can take years to collect samples of sufficient size for small clinical groups. With computerized assessment, all data collected on clinical samples could be synthesized and provided back to clinicians in a broad-based dynamic normative database. There are obvious privacy issues that would need to be worked out, but computerized assessment holds the promise of providing clinicians more reliable and valid assessment data in the future.

Need for More Base Rates for Qualitative Behaviors

When school psychologists are trained in graduate school as to how to conduct individualized assessment, so much emphasis is placed on the standardization of the test directions and procedures. Sometimes, new and existing practitioners are so concerned about administering the directions in a standardized manner that they forget to observe the behavior of the student who is sitting in front of them. When faced with any cognitive or academic task, a student must engage in the proper cognitive processes and apply the proper skills to successfully complete the task. Although the test score itself is an important measure of the student's performance, equally important are the strategies employed by the student to accomplish tasks. This notion is at the heart of the process approach to assessment, which is an integral part of school neuropsychology. Test publishers in recent years have started to provide clinicians with base rate data for some qualitative behaviors that students exhibit during test performance (e.g., asking for repetitions). These data are highly valuable to supplement a clinician's interpretation of test performance and overall response style of a student. Test publishers are hopefully going to provide such quantification of qualitative behaviors in future editions of the major tests used in clinical practice.

Training Issues in School Neuropsychological Assessment

Maricle, Miller, Hale, and Johnson (2012) state several reasons why school psychology training programs should recognize the importance of the biological bases of behavior, including:

> (1) increased knowledge of the biological bases of neurodevelopmental disorders; (2) integration of neuropsychological constructs into school psychological assessment tools; (3) the current controversy surrounding the identification of specific learning disabilities; (4) the emerging fields of educational neuroscience and social neuroscience; and (5) the potential encroachment of other specialties into the traditional practice of school psychology (p. 71).

As this author and others (Castillo, 2008; Goldstein & Reynolds, 2010; Hale & Fiorello, 2004; Maricle, Miller et al., 2012; Miller, 2010; Riccio, Sullivan, & Cohen, 2010; Semrud-Clikeman & Teeter-Ellison, 2009) have pointed out, there is strong neurobiological evidence and known neuropsychological correlates of childhood disorders including specific learning disabilities, attention deficit hyperactivity disorder, autism spectrum disorders, internalizing and externalizing disorders, acquired neurological disorders, and genetic disorders affecting learning and behavior. School psychology training programs need to find methods of infusing this knowledge base into their curriculum to ensure that future practitioners will be adequately prepared.

Within the past decade, neuropsychological constructs such as executive functions, working memory, and processing speed have all appeared in mainstream school psychology practice. These neuropsychological constructs have been shown to play a major role in education. School psychology training programs need to emphasize the theoretical foundations and clinical applications of these neuropsychological constructs (Maricle, Miller et al., 2012).

For the identification of specific learning disabilities, a third method using a neuropsychological approach is allowable under IDEA and emerging into practice (Flanagan & Alfonso, 2011; Flanagan, Alfonso, Mascolo, & Sotelo-Dynega, 2012; Hale et al., 2010a, 2010b). School psychology trainers need to incorporate these methodologies into the training of their students.

Finally, the point needs to be made that if school psychologists do not become better trained to assess and treat the neuropsychological manifestations of common neurodevelopmental disorders, other professionals will come into the schools to meet that growing need. Hurewitz and Kerr (2011) stated that evaluations for special education have the basic elements of a forensic reporting "because the evaluation may be used, in part, to affix the rights and privileges of individuals, such as educational placement, reimbursement for services or school tuition, or removal from school for disciplinary infractions" (p. 1059). They noted "as the mandates for compliance with federal and state educational requirements have grown more complex, and in some cases integrated concepts of disability gleaned from research in cognitive psychology and neuropsychology, there has been a call for an increase in the application of neuropsychological methods" (p. 1059). Maricle, Miller, and colleagues concur with the statement that advances within cognitive psychology and neuropsychology are reshaping how we should view the identification and treatment of disabilities; however, they believe that school psychologists should take the lead role in the translation of brain research, cognitive neuroscience, and neuropsychological research related to neurodevelopmental disabilities into educational practice.

Chapter Summary

In this chapter an attempt is made to make some predictions about potential influences on the future of school neuropsychology. The school neuropsychological conceptual model continues to evolve based on validation research and advances in theory. General educators are growing increasingly interested in translating brain research into educational practice and school psychologists training in the integration of neuropsychological principles into their practice will be uniquely prepared to contribute to this new educational effort. Computerized assessment will become more mainstream in years to come, which will be beneficial to school neuropsychology practice, and the type of clinical data provided to clinicians will increase in sophistication. Finally, the rationale for why school psychology training programs need to make sure that the biological bases of behavior is emphasized are highlighted.

Test Yourself

1. True or False? According to the author, it would be ideal if there could be a consensus established for what constitutes a cognitive process, versus a cognitive function, versus a cognitive skill, and so on.

2. What term(s) have been used to describe the emerging integration of neuroscience and education?

- **a.** Neuroeducation
- **b.** Educational neuroscience
- **c.** Neither a nor b
- **d.** Both a and b

3. All of the following are benefits of computerized assessment except for one. Which one?

- **a.** Easier portability
- **b.** Easier accessibility
- **c.** Increased privacy protection
- **d.** Access to additional performance measures

4. True or False? Clinicians do not see much value in the base rates provided by test publishers for qualitative behaviors.

5. Neuroimaging in the future will be used for what?

- **a.** Monitoring the effectiveness of interventions
- **b.** Creating functional profiles that would predict the absence or presence of learning disorders
- **c.** Validation of neurocognitive constructs being measured by tests
- **d.** All of the above

Answers: 1. true; 2. d; 3. c; 4. false; 5. d

Appendix

Referenced Tests, Abbreviations, and Publishers

Test Abbreviation	Test Name	Citation
BASC-2	*Behavior Assessment System for Children—Second Edition*	Reynolds & Kamphaus, 2009
Beery VMI	*Beery-Buktenica Developmental Test of Visual-Motor Integration—Sixth Edition*	Beery, Buktenica, and Beery, 2010
Bender II	*Bender Visual-Motor Gestalt Test—Second Edition*	Brannigan and Decker, 2003
Boehm-3	*Boehm Test of Basic Concepts—Third Edition*	Boehm, 2000
Boehm-3 Preschool	*Boehm Test of Basic Concepts—Third Edition Preschool*	Boehm, 2001
CAS	*Das-Naglieri Cognitive Assessment System*	Naglieri and Das, 1997
CAVLT-2	*Children's Auditory Verbal Learning Test—2*	Talley, 1994
CMS	*Children's Memory Scale*	Cohen, 1997
CREVT-2	*Comprehensive Receptive and Expressive Vocabulary Test—Second Edition*	Wallace and Hammill, 2002
CTONI-2	*Comprehensive Test of Nonverbal Intelligence—Second Edition*	Hammill, Pearson, and Wiederholt, 2009
CTOPP	*Comprehensive Test of Phonological Processing*	Wagner, Torgesen, and Rashotte, 1999
CVLT-C	*California Verbal Learning Test—Children's Version*	Delis, Kramer, Kaplan, and Ober, 1994
DAS-II	*Differential Ability Scales—Second Edition*	Elliott, 2007
DWSMB	*Dean-Woodcock Sensory-Motor Battery*	Dean and Woodcock, 2003
D-KEFS	*Delis-Kaplan Executive Function System*	Delis, Kaplan, and Kramer, 2001
DTAP	*Developmental Test of Auditory Perception*	Reynolds, Voress, and Pearson, 2008
ECFT	*Extended Complex Figure Test*	Fastenau, 1996
EOWPVT-4	*Expressive One-Word Picture Vocabulary Test—Fourth Edition*	Brownell, 2010
EOWPVT-SBE	*Expressive One-Word Picture Vocabulary Test: Spanish-Bilingual Edition*	Brownell, 2000
EVT-2	*Expressive Vocabulary Test—Second Edition*	Williams, 2006

Test Abbreviation	Test Name	Citation
GORT-5	*Gray Oral Reading Test—Fifth Edition*	Wiederholt and Bryant, 2012
KABC-II	*Kaufman Assessment Battery for Children—Second Edition*	A. Kaufman and Kaufman, 2004
KeyMath3	*KeyMath3 Diagnostic Assessment*	Connolly, 2011
KTEA-II	*Kaufman Test of Educational Achievement—Second Edition*	A. Kaufman and Kaufman, 2004
NEPSY-II	*NEPSY-II: A Developmental Neuropsychological Assessment*	Korkman, Kirk, and Kemp, 2007
OWLS-II	*Oral and Written Language Scales—Second Edition*	Carrow-Woolfolk, 2011
PAL-2 M	*Process Assessment of the Learner: Diagnostics for Math*	Berninger, 2007
PAL-2 RW	*Process Assessment of the Learner: Diagnostics for Reading and Writing*	Berninger, 2007
PPVT-IV	*Peabody Picture Vocabulary Test—Fourth Edition*	L. Dunn and Dunn, 2006
RAN/RAS	*Rapid Automatized Naming and Rapid Alternating Stimulus Tests*	Wolf and Denckla, 2005
RIAS	*Reynolds Intellectual Assessment Scales*	Reynolds and Kamphaus, 2003
ROWPVT-4	*Receptive One-Word Picture Vocabulary Test—Fourth Edition*	Brownell, 2010
ROWPVT-SBE	*Receptive One-Word Picture Vocabulary Test: Spanish—Bilingual Edition*	Brownell, 2000
SB5	*Stanford-Binet Intelligence Scales—Fifth Edition*	Roid, 2003
SPELT-P 2	*Structured Photographic Expressive Language Test—Preschool 2*	Dawson, Stout, Eyer, Tattersall, Fonkalsrud, and Croley, 2005
SPELT-3	*Structured Photographic Expressive Language Test 3*	Dawson, Stout, and Eyer, 2003
TAPS-3	*Test of Auditory Processing Skills—3*	Martin and Brownell, 2005
TEA-Ch	*Test of Everyday Attention for Children*	Manly, Robertson, Anderson, and Nimmo-Smith, 1999
TOC	*Test of Orthographic Competence*	Mather, Roberts, Hammill, and Allen, 2008
TOMAL-2	*Test of Memory and Learning—Second Edition*	Reynolds and Voress, 2007

Test Abbreviation	Test Name	Citation
TOPA-2+ KE	*Test of Phonological Awareness—Second Edition Plus—Kindergarten Edition*	Torgensen and Bryant, 2004
TOPA-2+ EEE	*Test of Phonological Awareness—Second Edition Plus—Early Elementary Edition*	Torgensen and Bryant, 2004
TOPAS	*Test of Phonological Awareness Skills*	Newcomer and Barenbaum, 2003
TOSWRF	*Test of Silent Word Reading Fluency*	Mather, Hammill, Allen, and Roberts, 2004
TOWRE	*Test of Word Reading Efficiency—Second Edition*	Torgensen, Wagner, and Rashote, 2012
TPAS	*Test of Phonological Awareness in Spanish*	Riccio, Imhoff, Hasbrouck, and Davis, 2004
TVPS-3	*Test of Visual Perceptual Skills*	Martin, 2006
UNIT	*Universal Nonverbal Intelligence Test*	Bracken and McCallum, 1998
WCST	*Wisconsin Card Sorting Test*	Heaton, Chelune, Talley, Kay, and Curtiss, 1993
WIAT-II	*Wechsler Individual Achievement Test—Second Edition*	Wechsler, 2001
WIAT-III	*Wechsler Individual Achievement Test—Third Edition*	Wechsler, 2009
WISC-IV	*Wechsler Intelligence Scale for Children—Fourth Edition*	Wechsler, 2004
WISC-IV Integrated	*Wechsler Intelligence Scale for Children—Fourth Edition Integrated*	Wechsler et al., 2004
WMS-IV	*Wechsler Memory Scale—Fourth Edition*	Wechsler, 2009
WIST	*Word Identification and Spelling Test*	Wilson and Fenton, 2004
WNV	*Wechsler Nonverbal Scale of Ability*	Wechsler and Naglieri, 2006
WRAML2	*Wide Range Assessment of Memory and Learning—Second Edition*	Sheslow and Adams, 2003
WRAVMA	*Wide Range Assessment of Visual-Motor Abilities*	Adams and Sheslow, 1995
WJIII-ACH NU	*Woodcock-Johnson III Tests of Achievement—Normative Update*	Woodcock, McGrew, and Mather, 2001, 2007b
WJIII-COG NU	*Woodcock-Johnson III Tests of Cognitive Abilities—Normative Update*	Woodcock, McGrew, and Mather, 2001, 2007a
WJIII-COG DS	*The Diagnostic Supplement to the Woodcock-Johnson III Tests of Cognitive Abilities*	Woodcock, McGrew, Mather, and Schrank, 2003, 2007

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About the CD-ROM

Introduction

This appendix provides you with information on the contents of the CD that accompanies this book. For the latest information, please refer to the ReadMe file located at the root of the CD.

System Requirements

- A computer with a processor running at 120 Mhz or faster
- At least 32 MB of total RAM installed on your computer; for best performance, we recommend at least 64 MB
- A CD-ROM drive
- Adobe Flash Player 9 or later (free download from Adobe.com).

Make sure that your computer meets the minimum system requirements listed in this section. If your computer doesn't match up to most of these requirements, you may have a problem using the contents of the CD.

Note: Many popular spreadsheet programs are capable of reading Microsoft Excel files. However, users should be aware that formatting might be lost when using a program other than Microsoft Excel.

Using the CD with Windows

To access the content from the CD, follow these steps:

1. Insert the CD into your computer's CD-ROM drive. The license agreement appears (Windows 7 > Select Start.exe from the AutoPlay window or follow the same steps for Windows Vista.)

The interface won't launch if you have autorun disabled. In that case, click Start > Run (For Windows Vista, Start > All Programs > Accessories > Run). In the dialog box that appears, type D:\Start.exe. (Replace D with the proper letter if your CD drive uses a different letter. If you don't know the letter, see how your CD drive is listed under My Computer.) Click OK.

2. Read through the license agreement, and then click the Accept button if you want to use the CD. The CD interface appears. Simply select the material you want to view.

Using the CD on a Mac

To install the items from the CD to your hard drive, follow these steps:

1. Insert the CD into your computer's CD-ROM drive.

2. The CD icon will display on your desktop; double-click to open it.

3. Double-click the Start button.

4. Read the license agreement, and then click the Accept button to use the CD.

5. The CD interface will display. The interface provides a simple point-and-click way to explore the contents of the CD.

Note for Mac users: the content menus may not function as expected in newer versions of Safari and Firefox; however, the documents are available by navigating to the Author Files folder.

What's on the CD

The following sections provide a summary of the software and other materials you'll find on the CD.

Content

Major Tests Classified According to the Integrated SNP/CHC Model

The CD contains a spreadsheet for use with Microsoft Office Excel. The spreadsheet contains the following fields:

- New Broad Classifications:
  - Sensorimotor Functions
  - Visuospatial Processes

    - Auditory/Phonological Processes
    - Learning and Memory Processes
    - Executive Processes
    - Allocating and Maintaining Attention Facilitators/Inhibitors
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    - Acquired Knowledge: Reading Achievement
    - Acquired Knowledge: Written Language Achievement
    - Acquired Knowledge: Mathematics Achievement
- New 2nd Order Classifications—Varies based on the broad classification.
- New 3rd Order Classifications—Varies based on the broad classification and 2nd order classification.
- Test Name.
- Abbreviation—Abbreviation of the tests name (e.g., Wide Range Assessment of Memory and Learning—Second Edition = WRAML2).
- Subtest—A specific subtest name that would be classified according to the Integrated SNP/CHC Model.
- Description—A description of what the subtest is designed to measure.
- Score Type—The type of score reported (e.g., standard score).
- Age-Grade Range—The suitable age or grade range of the subtest.
- Publisher—The principle test publisher.

The purpose of this spreadsheet is to find subtests from across multiple test batteries that are all designed to measure a similar broad or narrow construct.

The filter feature within Excel has been enabled, which will allow a user to perform a variety of sorts:

1. Find subtests that are designed to measure processes/functions/skills within a particular broad or narrow classification with the Integrated SNP/CHC Model:

a. In Row 1—Column A of the spreadsheet there is a down arrow in the right side of the field. Click on that arrow and a list of the

Broad Classifications appear.

b. Click on the box to the left of the Select All option to deselect all broad classifications.

c. Choose one of the Broad Classifications by clicking the check box to the left of the label, then click on OK.

d. What is displayed in the spreadsheet are all of the subtests from across the major test batteries that are classified according to the Integrated SNP/CHC Model that are designed to measure the broad classification that you have chosen.

e. You can narrow your search further by clicking on the arrow in the cell Row 1—Column B (New 2nd Order Classifications). You can choose a narrower classification among this list following the same procedures as outlined above to find the subtests that match more specific selection criteria.

f. You can then narrow down your list of subtests even further by selecting the subtests that match the Broad Classification—2nd Order Classifications—3rd Order Classifications criteria that the user selects. Note that not all 2nd Order Classifications have 3rd Order Classifications.

Note: To start a new sort, the user must go back to each field (e.g., Broad Classification) and choose the Select All option.

2. Find a particular test and see how the individual subtests are classified according to the Integrated SNP/CHC Model.

a. In Row 1—Column D, the field is labeled as Test Name and has a down arrow in the right-hand corner of the field.

b. Click on the box to the left of the Select All option to deselect all broad classifications.

c. Choose one of the test names by clicking the check box to the left of the label, then click on OK.

d. What is displayed in the spreadsheet are all of the subtests from that chosen test classified according to the Integrated SNP/CHC Model.

An online searchable database of the major tests classified according to the Integrated SNP/CHC Model is available on the www.schoolneuropsych.com website and is kept current as new tests are published.

Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition (NPCC-3)

The CD contains both English and Spanish Versions of the *Neuropsychological Processing Concerns Checklist for Children and Youth—Third Edition* (NPCC-3). Both versions of the NPCC-3 are saved as portable document files (.pdf). The NPCC-3 (English and Spanish) are copywritten by Dr. Daniel C. Miller at KIDS, Inc.; however, users of this book are granted permission to use these forms in clinical practice free of charge.

School Neuropsychology Report Shell

The CD contains a copy of the School Neuropsychology (SNP) Report Shell (version 19.0) that operationalizes the Integrated SNP/CHC Model presented in this book. At the time of the publication of this book, this was the most recent version of the SNP Report Shell. The SNP Report Shell is updated regularly as new tests are published and as a result of ongoing validation research studies.

The SNP Report Shell is saved as a portable document file (.pdf) and is presented as an example of how a comprehensive School Neuropsychological Assessment Report could be constructed. In practice, the clinician will delete all of the extraneous tests that were not administered to the student while leaving the tests that were administered.

The SNP Report Shell is included on the CD for illustration purposes only. If a clinician wants to use the SNP Report Shell in practice, the clinician needs to obtain formal training and supervised practice in school neuropsychology (see Chapter 3 for training options).

Learning Curve Graphs

In Chapter 12 in this book, the importance of plotting the learning curves for samples of learning is discussed. Several samples of learning curves for the major tests of memory and learning are included on the CD.

These learning curve graphs were created and saved in a Microsoft Excel format (.xls). Users may enter data into the spreadsheet for a particular subtest and the respective learning curve is automatically updated. The graph may be cut and pasted into a Word document as part of an assessment report.

Sample Reports

The CD contains two sample school neuropsychological case study reports. Many referrals for school neuropsychological assessments involve complex medical histories and multiple previous diagnoses. The first case study is an example of an adolescent who had many medical challenges at birth, which have affected his growth and development. The second case study is an example of 10-year-old boy, who had his left hemisphere surgically removed when he was 5 years old due to severe seizures caused by Rasmussen's Encephalitis. These case studies illustrate how the Integrated SNP/CHC Model may be used in practice.

Summary of School Neuropsychology Assessment Results Forms

SummaryForm1.doc—A single-page document that can be used to display an overview of the student's strengths and weaknesses based on the school neuropsychological assessment findings.

SummaryForm2.pdf—A multiple-page document that can be used to show the student's normative strengths and weaknesses compared to the student's intra-individual strengths and weaknesses based on the school neuropsychological assessment findings.

Applications

Adobe Reader

Included on this CD is a link to download Adobe Acrobat Reader for viewing PDF files. For more information and system requirements, please go to www.adobe.com.

OpenOffice.org

Included on this CD is a link to download OpenOffice.org for viewing spreadsheet files. For more information and system requirements, please go to www.openoffice.org.

OpenOffice.org is a free multiplatform office productivity suite. It is similar to Microsoft Office or Lotus SmartSuite, but OpenOffice.org is absolutely free. It includes word processing, spreadsheet, presentation, and drawing applications that enable you to create professional documents, newsletters, reports, and presentations. It supports most file formats of other office software. You should be able to edit and view any files created with other office solutions.

Shareware programs are fully functional, trial versions of copyrighted programs. If you like particular programs, register with their authors for a nominal fee and receive licenses, enhanced versions, and technical support.

Freeware programs are copyrighted games, applications, and utilities that are free for personal use. Unlike shareware, these programs do not require a fee or provide technical support.

GNU software is governed by its own license, which is included inside the folder of the GNU product. See the GNU license for more details.

Trial, demo, or evaluation versions are usually limited either by time or functionality (such as being unable to save projects). Some trial versions are very sensitive to system date changes. If you alter your computer's date, the programs will “time out” and no longer be functional.

Troubleshooting

If you have difficulty installing or using any of the materials on the companion CD, try the following solutions:

- Turn off any anti-virus software that you may have running. Installers sometimes mimic virus activity and can make your computer incorrectly believe that it is being infected by a virus. (Be sure to turn the anti-virus software back on later.)

- Close all running programs. The more programs you're running, the less memory is available to other programs. Installers also typically update files and programs; if you keep other programs running, installation may not work properly.
- Reboot if necessary. If all else fails, rebooting your machine can often clear any conflicts in the system.

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