CHAPTER 9

ASSESSMENT OF NEUROPSYCHOLOGICAL FUNCTIONING

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Ebbinghaus's statement, "Psychology has a long past but a short history," applies to clinical neuropsychological assessment. The earliest recorded work in neuropsychological testing goes back to the work of Franz well over a century ago. Indeed, a review of psychology's two foundational books, Wundt's *Textbook of Physiological Psychology* (1904, English translation) as well as James's *Psychology* (1890), makes it clear that neuropsychology and neuropsychological assessment have been central to the mission of psychology since its founding as a discipline. In an attempt to bridge philosophical questions to scientific methodology, Wundt applied the scientific process, and the outgrowth was, ~~for all practical purposes,~~ neuropsychology. In a review of the total number of chapters of both Wundt's and James's books, the majority of the chapters discuss the use of "formal and informal" tests to understand the relationship of "psychic processes" to brain function. For example, chapter 2 of James's book provides a delineation of processes titled, "Functions of the Brain," and page 20, a portion of that chapter, is titled "General Notion of the Hemispheres."

Over the next 50 years, psychology drifted and operated from behaviorism as the main theoretical perspective to understand psychological processes. With the work of Watson, as outlined in *Psychology from the Standpoint of a Behaviorist* (1919), and, subsequently, Skinner, with *Science and Human Behavior* (1953), psychology became focused on understanding behavior primarily through the lens of behaviorism. The rise of clinical neuropsychology as a primary method for understanding human behavior and dysfunction over the past 30 years is, ~~in many ways,~~ a return to the roots of our discipline.

This chapter provides an overview of that return and a presentation of the basics of neuropsychological assessment and evaluation (terms that are used interchangeably in this chapter). After a brief historical overview, three sections are presented covering (a) clinical neuropsychology as a profession, (b) neuropsychological assessment, and (c) the future of neuropsychological assessment.

BRIEF HISTORY OF NEUROPSYCHOLOGICAL ASSESSMENT

Neuropsychological testing has a history of approximately half a century, although the first half is fraught with limited information, and the second is marked by very rapid growth and is well chronicled. For example, the first article on the history of clinical neuropsychology was published by Goldstein in 1985. Since this time, approximately 20 articles have been published on the topic. Puente (1989), Reitan (1989), Fitzhugh-Bell (1997), Puente and Marcotte (2000), Zillmer (2004), Puente (2005), and Hartlage and Long (2009) have provided some of the most comprehensive information about the history of clinical neuropsychology. A few authors (e.g., Reitan, 1989) focus almost exclusively on specific testing, whereas others (e.g., Benton, 1972) have provided more generic overviews. Other important "historical" works, such as the acclaimed work by Kurt Goldstein in 1942, *Aftereffects of Brain Injuries in War*, described injuries and outcomes rather than

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processes used to understand them or a truly historical presentation.

Probably the first book to address neuropsychological assessment was Franz's *Handbook of Mental Examination Methods*, published in 1920 and based on practices he began around 1910. This book contains a series of lectures involving "neurological and mental examination methods" he presented to interns at the Government Hospital for the Insane in Washington, DC. Several mental tests were listed, and methods to address both time and observational information were found. Suggested to be effective both for diagnostic and research purposes, his methods included assessment for the following: sensation, movement, language, attention apprehension and perception, memory, association, calculation, and general intelligence.

Russell, Neuringer, and Goldstein (1970) published what could be considered the first book exclusively devoted to neuropsychological testing in English: *Assessment of Brain Damage: A Neuropsychological Key Approach.* The book was an outgrowth of work since Goldstein's dissertation in 1963 on testing for brain damage. Although a good portion of the foundations for this approach was directed to psychiatric populations, this book was significant in that it addressed the application of such tests to neurological patients—a focus that has been maintained within neuropsychology to the present. Additionally, it presented a systematic approach to determine brain dysfunction. All three authors were heavily influenced by the work of Reitan, a student of Halstead at Chicago. Reitan took tests such as the Seashore Rhythm Test from vocational and related fields and applied them to understand brain dysfunction. It was not until 1974, however, that Reitan himself, with Leslie A. Davison, finally published another landmark book on neuropsychological testing, *Clinical Neuropsychology: Current Status and Applications*. In collaboration with Davison, Reitan published an overview of his battery and clinical neuropsychology for the psychometrically based North American audience with some "norms."

Before the publication of his first book, there were only two methods for learning Reitan's approach (i.e., the Halstead–Reitan Neuropsychological Battery): Study directly with him like the Reed brothers, or obtain the information from Reitan's workshops. The majority of individuals learned this method through the latter means. Typically, these colloquia were lengthy presentations of Reitan's ideas including theory, protocol, and application of a battery of tests. The only data available (e.g., normative information) on these tests were, for many years, presented at these workshops, and until the National Academy of Neuropsychology (NAN) annual conference in Orlando in 1988, only a small portion of clinical neuropsychologists had attended. Thus, although some understood Reitan's approach and battery, most practitioners were unable to appreciate the evolution of Reitan's thinking.

Although assessment of brain damage was increasing, there was relatively little written that was comprehensive in terms of using psychological tests rather than batteries. The works of Reitan as well as of Goldstein focused on a very limited approach. However, in 1972 while at the University of Iowa, Benton wrote a seminal chapter titled "Psychological Tests for Brain Damage," which presented a more comprehensive approach to understanding brain dysfunction using psychological tests. Benton suggested that an evaluation could include a variety of psychological tests rather than just a battery. From this perspective, a more robust and comprehensive understanding of the brain and the potential set of impairments could be achieved. Benton outlined the first reported survey of neuropsychological tests for adults and children, including measures of the following domains: general intelligence, reasoning, memory and orientation, language functions, perceptual and perceptuomotor performance, response speed and flexibility, and attention and concentration.

After this introduction of multiple tests came an era focusing on the application of those tests to understand specific syndromes. An excellent and early example of this approach appears in Parsons and Butters's (1987) *Neuropsychology of Alcoholism: Implications for Diagnosis and Treatment*. This book, as an example of many others to this day (e.g., Goldstein, Incagnoli, & Puente, 2011), used the different approaches proposed by Reitan, Benton, and others to begin systematic analysis of specific syndromes.

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The value of such descriptions has been based on the value of the neuropsychological instruments used to understand those syndromes. As a result, over the past ~~2~~ decades, an ever-expanding list of neuropsychological tests has appeared in the literature focusing on specific disorders.

CLINICAL NEUROPSYCHOLOGY

Clinical neuropsychology was formed as a result of scientific evolution and amalgamation of several disciplines (e.g., neurology and clinical psychology; Sperry, 1995). In 1996, after much work on the part of individuals such as Meier, clinical neuropsychology was formally recognized by the American Psychological Association (APA) as a specialty in psychology, joining the existing specialties of clinical, counseling, and school psychology (Boake, 2008). Clinical neuropsychology is a specialty that uses assessment and intervention to understand brain–behavior relationships and applies this knowledge to human problems (APA Commission for the Recognition of Specialties and Proficiencies in Professional Psychology, 1996). The fundamental goal of clinical neuropsychology is to determine psychological problems (e.g., behavior, cognition, and mood) affected by central nervous system dysfunction (Meier, 1997).

A clinical neuropsychologist is a professional within the field of psychology with ~~special~~ expertise in the applied science of brain–behavior relationships (Barth et al., 2003). Neuropsychologists use expertise in brain–behavior relationships to assess, diagnose, and provide effective interventions (e.g., therapy and rehabilitation) for individuals of all ages with neurological, medical, and psychiatric conditions (APA Division 40 Executive Committee, 2006; Barth et al., 2003). Barth et al. stated, "The clinical neuropsychologist uses psychological, neurological, physiological, cognitive and behavior principles, techniques and tests to evaluate patients' neurocognitive, behavioral, and emotional strengths and weaknesses and their relationship to normal and abnormal central nervous system functioning" (p. 554). Clinical neuropsychologists are practitioners; have a doctoral degree from an accredited university program ~~and~~ an internship in professional psychology, ~~the equivalent of 2 full-time years of specialized training at the postdoctoral level in the study and practice of clinical neuropsychology~~; and have a license to practice psychology in their respective state/province or are employed as neuropsychologists by an exempt agency (Barth et al., 2003).

Neuropsychologists engage in several professional activities, but neuropsychological assessment accounts for the largest amount of professional time (Rabin, Barr, & Burton, 2005; Sweet, Peck, Abramowitz, & Etzweiler, 2002). The ontogeny of clinical neuropsychology is suggested to be due to its utility in localization, lateralization, and lesion detection—the so-called "three Ls" (Hartman, 1991). This contribution was accomplished with comprehensive assessments, which included mood, cognitive, personality, and behavioral instruments.

What contribution?

The advent and improvement of neuroimaging have decreased the necessity of neuropsychological evaluations for the three Ls (Beaumont, 2008; Marcotte, Scott, Kamat, & Heaton, 2010). Nonetheless, these technological advancements have not made clinical neuropsychology obsolete; rather, they have refined its purpose. Lezak, Howieson, and Loring (2004) have suggested that neuropsychological assessments are often obtained for the following:

- Diagnosis
- Patient care
- Treatment planning
- Treatment evaluation
- Research
- Forensics

Historically, neuropsychological assessments were most frequently sought for assistance with diagnostic concerns and remain the most frequent referral question (Marcotte et al., 2010). However, the improvement of neurodiagnostic techniques has decreased the need of neuropsychological assessment for diagnosis (Beaumont, 2008; Lezak et al., 2004). Nonetheless, the use of neuropsychological assessment as a diagnostic method is frequently used in differential diagnosis, often to distinguish between psychiatric and neurogenic and between different neurological conditions (Lezak et al., 2004; Meier, 1997) as well as to determine possible localization of dysfunction (Tonkonogy & Puente, 2009).

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Neuropsychological assessment allows for an in-depth analysis of functional limitations associated with brain dysfunction and is required for diagnosis by some diagnostic criteria for neurological disorders such as Alzheimer's Disease given that biomarkers are not yet reliable (McKhann et al., 1984; Storey, Slavin, & Kinsella, 2002).

Utility of neuropsychological assessment is not limited to clinicians but also benefits academicians and others interested in research. The use of neuropsychological assessments for this purpose is often attributed to Halstead, as he is credited with applying the "test battery" approach to investigate brain–behavior relationships of normal and brain-damaged participants in a systematic and standardized format (Reitan, 1994). Neuropsychological assessments are frequently used in research to better understand the effects of mood disorders (Porter, Bourke, & Gallagher, 2007), psychotic disorders (Palmer, Dawes, & Heaton, 2009), neurodegenerative diseases (Libon et al., 2007), physical conditions (e.g., hypertension; Elias, Elias, Sullivan, Wolf, & D'Agostino, 2003), and psychological and medical treatments (e.g., psychotherapy, chemotherapy, and heart surgery; McClintock, Husain, Greer, & Cullum, 2010; Tully, Baker, Knight, Turnbull, & Winefield, 2009; Vardy, Rourke, & Tannock, 2007). Additionally, using neuropsychological assessment for "basic" research also helps develop new assessment techniques and instruments as well as norms that help to increase sensitivity and specificity of neuropsychological dysfunction (Ostrosky-Solís, Ardila, & Rosselli, 1999).

Assessing neuropsychological functioning in clinical settings has proven increasingly beneficial and common, and the use of neuropsychological assessment in forensic settings has become increasingly valuable (Horton, 2010). In contrast to clinical neuropsychology, assessment in forensic settings often has different goals, questions, clients, and techniques (e.g., the decision-making process; Prichard, 1997; see also Chapter 16, this volume). Regardless, neuropsychological evidence in forensic settings assists third parties (e.g., judges and juries) in making just legal decisions (Horton, 2010) and has been elaborated extensively by Sbordone (e.g., Sbordone & Saul, 2000) as well as by McCaffrey and colleagues (McCaffrey, Williams, Fisher, & Laing, 1997).

NEUROPSYCHOLOGICAL ASSESSMENT

Although there is variability in how neuropsychological assessments are conducted, the basic purpose is to acquire, analyze, and integrate neurological and neuropsychological data from multiple sources (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999). Typically, a neuropsychological assessment involves records review, interview, testing, and report writing. Records possibly provide the neuropsychologist with a general idea of what the presenting problem will be, and the interview is vital to gather a large and varied amount of data and clarify uncertainties in the clinical record and initial presentation. Testing involves the administration of various procedures and measures to patients and is based on and follows record review and interview.

The following sections provide an overview of the basic elements and processes comprising neuropsychological assessments. Although there is one assessment approach that is more prevalent and favored among neuropsychologists, both major approaches (i.e., fixed and flexible battery) are discussed in the sections that follow as well as the measures and norms associated with these procedures. After this discussion, some general considerations that affect neuropsychological assessment are examined. For example, technicians have become particularly important in neuropsychological assessments; therefore, this topic deserves attention. Finally, norms and time spent in a neuropsychological evaluation is covered, and the neuropsychological report is briefly explained.

Records Review

With records acquired before ~~the interview as well as information gathered during it,~~ the neuropsychologist is able to develop hypotheses and administer tests to confirm or disprove various working hypotheses (Yochim, 2010). Typically, records are the first type of information available. However, in some cases, especially Social Security disability determination cases~~, for example,~~ few or no records are available. In these situations, important records (e.g., educational) are not available, as is often the

case when the individual has attended school in other countries. The reasons are varied, but typically such records are difficult to obtain, the number of personnel available to obtain such records is low, and the impact that the case carries is "limited" (as opposed to, e.g., death penalty cases).

In contrast, numerous challenges remain when records are obtained or available. In the example of an individual who has been educated in another country, the records are hard to equate to the United States, as educational attainment is not equivalent across countries. In other cases, such as complex forensic ones, large amounts of information are often available through extensive historical and laborious mining of records, sometimes done by mitigating "experts" such as paralegals, case managers, and social workers as well as neuropsychologists. Given these difficulties, historical information based on records is not always included in neuropsychological assessments even though it may comprise important and useful information.

Historical information outlined by existing records provide a wealth of data about past and present status, but synthesis of that information is necessary and can be challenging (Howieson & Lezak, 2010). This synthesis is best incorporated in a narrative format as a part of the written report of the neuropsychological assessment or in tabular form. A table can visually summarize the salient points critical to that synthesis and provide a trajectory of neurobehavioral changes over time. The synthesized records provide the professional with a contextual framework of the client and allows for preliminary hypotheses about client's difficulties to be pursued in subsequent testing. However, having the records before the evaluation may bias the evaluation procedure as well as the findings and interpretation of evaluation data. Although record review could increase the likelihood of bias into the neuropsychological evaluation, this qualitative information often provides the professional with the most representative context for the individual's presenting problems. In addition to the interview, it is almost always used to determine the necessary neuropsychological procedures to implement that challenge the clinician's hypotheses. Generally speaking, the goal of the record review is to place the individual within a socio-historical-cultural context as a means of providing baseline information about neuropsychological functioning (Luria, 1973, 1980).

Interview

The interview, or Neurobehavioral Status Exam, in a neuropsychological evaluation is critical, given that it provides information for two of the components of an evaluation (i.e., history and behavioral observations). Although the neuropsychologist may have an accurate understanding of the client's functioning from records received previously, conducting an interview before testing is imperative to determine whether testing is ~~appropriate or~~ necessary and, if so, what types of tests should be administered (Yochim, 2010). For example, if the client is heavily medicated, actively psychotic, or physically unable, then testing may be inappropriate—or even unethical—because significant error would be introduced (Vanderploeg, 2000). The interview also provides the clinician with an initial understanding of the level of cooperation of the client and what, if any, accommodations or modifications for the evaluation are warranted (Strauss, Sherman, & Spreen, 2006).

Interviews differ among practitioners, typically in the amount of structure implemented and interpersonal style (for further discussion of structured and unstructured interviews, please refer to Chapter 7, this volume). Although there is variability, there are standard areas to cover in a neuropsychological interview, including demographics, medical/health, developmental, educational, social, and occupational history as well as current medical/health status and the effect of the disorder on the client's life (Strauss et al., 2006; Yochim, 2010). The interview provides the neuropsychologist a chance to educate the client about the evaluation and addresses client concerns. In essence, the interview is both a data-gathering activity and an educational one.

Interviewing is not limited to the client but also includes significant others, children ~~and~~ parents, even teachers and employers. If the availability arises, structured affidavits in forensic cases may be of value, especially in understanding premorbid levels of functioning and descriptions of more ecologically valid behaviors. Collateral interviews are best conducted without the patient being present to

enhance the validity of the information provided. It may be worthwhile to ask similar questions of the collateral interviewee and the patient to glean the patient's understanding of his or her difficulties.

Although interviews are typically semistructured, structured interviews are sometimes implemented to ensure that certain required information is obtained (Rogers, Bagby, & Dickens, 1992). This approach increases the likelihood that important information is included and that replication of the interview is more easily achieved. In contrast, unstructured interviews permit a glimpse into the patient's ability to develop themes and organize his or her thoughts, and they allow for additional information to be gathered about the individual's condition. Structured interviews are probably most beneficial for clinicians with less experience and in forensic cases where the obtained information will become available to a third party. At the same time, increased time and lack of fluidity may hamper the gathering of sensitive or subtle information. Ultimately, the most important aspect of the interview is to allow the clinician to formulate working hypotheses about a client's condition and implement measures to test his or her ideas as the interview sets the foundation (e.g., "medical necessity") for testing.

Testing Approaches

Generally speaking, there are two major approaches to neuropsychological assessment: fixed battery and flexible battery. The fixed battery, or standardized battery, approach uses the same battery of tests for every client, despite different presenting difficulties and referral questions (Fennell, 2000). The flexible battery approach uses a core battery of tests and techniques for clients with various syndromes (e.g., dementia and traumatic brain injury; Sweet et al., 2002), and, in contrast to fixed battery approaches, the tests implemented vary based on practitioner as well as context (e.g., inpatient/outpatient setting and syndrome). Given this variability, how tests are organized as well as the most frequently used tests in different contexts are discussed next.

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Fixed battery. Two well-known fixed batteries are the Halstead–Reitan Neuropsychological Test Battery (HRNTB) and the Luria-Nebraska Neuropsychological Battery (Golden, Hammeke & Purisch, 1978; Reitan & Wolfson, 2004). The HRNTB is the most researched and used fixed neuropsychological test battery (Horton, 2008; Reitan & Wolfson, 2004). The HRNTB is based on the ideas of Halstead, who believed that there were two types of intelligence: psychometric and biological (Reynolds, Castillo, & Horton, 2008). Psychometric intelligence is what is measured by intelligence tests (e.g., Stanford–Binet), whereas biological intelligence reflects the adaptive abilities of healthy central nervous systems (Reitan, 1994; Reynolds et al., 2008). To determine biological intelligence, Halstead selected 13 tests, given that the brain-damaged individuals whom he examined had a wide range of deficits and traditional intelligence tests were not always sensitive indicators of brain damage; some patients with significant damage did not exhibit deficits in functioning (Reitan & Wolfson, 2004; Reynolds et al., 2008). The HRNTB's frequency of use is attributed to the empirical evidence of its ability to evaluate brain-damaged individuals accurately as a battery, given both its comprehensive nature and its superior sensitivity for subtle deficits (Horton, 2008). It has evolved to distinguish accurately between normal and brain-damaged individuals, and, given that patients had a wide range of deficits, it was necessary to include numerous tests to examine these difficulties adequately (Reitan & Wolfson, 2004).

The battery of tests that constitute the HRNTB has been modified, as Reitan has added and removed several tests to improve the sensitivity to damage of the central nervous system (Reitan & Wolfson, 2004). Currently, the HRNTB includes 10 tests: the Speech–Sounds Perception Test (SSPT), Rhythm Test, Reitan–Indiana Aphasia Screening Test (AST), Tactual Performance Test (TPT), Tactile Form Recognition Test, Sensory-Perceptual Examination, Grip Strength Test, Finger Tapping Test, Category Test, and Trail-Making Test (TMT; Reitan & Wolfson, 2004). When the HRNTB is administered, the neuropsychologist may also include a traditional measure of intelligence (e.g., Wechsler Adult Intelligence Scale [WAIS], fourth edition) as well as a measure of academic achievement (e.g., Wide Range Achievement Test) and an objective personality

inventory such as the Minnesota Multiphasic Personality Inventory (MMPI; Horton, 2008).

The SSPT consists of 60 nonsense words with an "ee" sound presented on a recording and requires the individual to indicate which sound they heard out of four choices on an SSPT answer sheet (Reitan & Wolfson, 2004). It measures auditory memory, rhythmic discrimination, and attention ability; is designed to be relatively easy; and is one of two measures that evaluate the first level of central processing. The second measure in the HRNTB that measures the subject's attentiveness (i.e., first level of central processing) is the Rhythm Test (Reitan & Wolfson, 2004). Thirty pairs of rhythmic beats are presented to the client from a recording, and the individual is requested to determine whether the beats are the same or different. Although this test measures the client's attention, it specifically evaluates auditory perception and nonverbal auditory discrimination.

The AST measures different language functions, including naming, spelling, reading, writing, enunciating, identifying numbers and letters, and simple arithmetic (Reitan & Wolfson, 2004). This test identifies expressive or receptive language deficits, which is determined by the amount and type of errors committed (Johnson & D'Amato, 2011). In contrast to the AST, the TPT is a nonverbal test that examines an individual's ability to place 10 geometric blocks into 10 matching spaces on a board slanted 45° while blindfolded (Horton, 2008). The test is first performed with the subject's dominant hand, followed by the nondominant hand and, finally, both hands (Reitan & Wolfson, 2004). The time needed to complete each trial and errors are recorded and are interpreted to determine one's complex problem-solving skills. After completion of the task with both hands, the blindfold is removed and the examinee is requested to draw as many shapes as they can remember and place them in the accurate location. The number of correct shapes remembered and accurate location provide separate scores that can be used as measures of spatial learning (Horton, 2008).

Albeit similar, the Tactile Form Recognition Test is a separate test in the HRNTB that measures a client's ability to distinguish shapes by touching with their hands (Reitan & Wolfson, 2004). A board blocks the client's hand, and the client is requested to identify flat plastic shapes. The test is completed for both hands, and although other functions are involved, it is suggested to provide information about the contralateral parietal area and is a sensitive measure of brain damage (Reitan & Wolfson, 2004).

The Sensory-Perceptual Examination, (i.e., Reitan–Klove Sensory-Perceptual Examination) is a standardized and adjusted version of a behavioral neurologist's examination measuring the visual, auditory, and tactile sensory functions of the central nervous system (Horton, 2008; Reitan & Wolfson, 2004). Another basic ability, motor strength, is evaluated during the Grip Strength subtest. Grip strength is assessed with a hand dynamometer, the individual is requested to use each hand twice, and the mean score is recorded. Finger Tapping, a measure of motor speed, requires the client to press a lever attached to a small board and a counter as quickly as possible for 10 seconds with each hand on five consecutive trials.

In contrast to motor and sensory abilities, abstraction and problem solving are measured by how quickly the client is able to complete the TPT as well as the Category Test and the TMT (Reitan & Wolfson, 2004). The Category Test comprises seven subtests with a total of 208 items, requiring a client to choose the correct response out of four possibilities based on the principle of that particular set (Strauss et al., 2006). The client must deduce the underlying principle from the subtest with the feedback they received from their choices, as the examiner is not permitted to provide cues; rather, the examiner informs the client if the response is correct or incorrect. Originally, the Category Test was presented by means of a slide projector, but booklet and computer adaptations are now available (Strauss et al., 2006).

Although the Category Test is still widely used as a measure of abstract reasoning and problem solving, the TMT is more frequently administered (Ojeda & Puente, 2010). The TMT consists of two parts, A and B (Reitan & Wolfson, 2004). Trails A requests the client to draw lines that connect circles in numerical order from 1 to 25, whereas Trails B

requires the client to connect 25 circles by alternating between numbers and letters in sequence. The client is instructed to complete this task as quickly as possible. Errors are indicated by the examiner, and the examinee is redirected to the previous position (Reitan & Wolfson, 2004). The time taken to complete and errors produced generate separate scores and provide sensitive measures of cerebral functioning, and more specifically, frontal lobe functioning (Demakis, 2004).

The HRNTB provided an avenue and example for other neuropsychological test batteries to follow, such as the well-known and frequently administered Luria-Nebraska Neuropsychological Battery (Golden, 1982). The Luria-Nebraska Neuropsychological Battery, previously known as the Luria-South Dakota Neuropsychological Battery, evolved from the methods of Russian neuropsychologist, Alexander Luria (Goldstein, 2000). He endorsed qualitative procedures and was regarded as an intuitive genius, and he operated from deduction to determine the underlying deficit of an individual syndrome using a functional system approach (Golden, 1982). While he was a renowned clinician and theorist, his neuropsychological procedures were not standardized. Although controversial, Golden et al. (1978) standardized and validated Luria's procedures, which provided practitioners a comprehensive test battery built on his procedures. This battery now is supported by numerous empirical investigations and is widely administered by neuropsychologists (Goldstein, 2000). Although not as frequently used as previously, the battery allows for the development of a deficit analysis and an alternative fixed battery.

Golden and colleagues developed two forms of the Luria-Nebraska Neuropsychological Battery: Form I in 1980 and Form II in 1985 (Golden et al., 1978; Golden, Purisch, & Hammeke, 1985). Both have the same theoretical basis as they are a combination of Luria's qualitative procedures, with standardized and quantitative methods. These forms have separate administration materials but share 84 items in common. Form I has 269 items and 11 clinical scales, whereas Form II has 279 items and 12 clinical scales (Walker et al., 2008). The current battery takes approximately 1 1/2 to 2 1/2 hours to administer, which is considered an improvement, as it shorter than HRNTB (Golden et al., 1985).

Items are scored on a 3-point scale; 0, 1, and 2 indicate normal, borderline, and abnormal performance, respectively. Individual items are summed for each clinical scale and converted to T scores with a mean of 50 and standard deviation of 10 (Golden et al., 1978; Goldstein, 2000). The 12 clinical scales that make up Form II include the original 11 clinical scales plus Immediate Memory (Goldstein, 1985). The 11 original clinical scales are: Motor Functions, Rhythm, Tactile Functions, Visual Functions, Receptive Speech, Expressive Speech, Writing, Reading, Arithmetic, Memory, Intellectual Processes, and Immediate Memory.

The Motor Functions scale measures the ability to plan and complete simple motor abilities of the upper extremities and the face. This scale is similar to a standard neurological exam. It is the longest of the 12 clinical scales and organized for one to understand motor activity as a complex functional system (Golden, 1982). The Rhythm scale also requires motor abilities; however, it measures the ability to perceive and comprehend tones and rhythmic patterns accurately by requiring the client to reproduce words or rhythms or discriminate between tones. The Tactile Functions scale examines cutaneous and proprioceptive functions such as localizing touch, discriminating between two points and various degrees of pressure, perceiving the direction of a moving stimulus, and identification of various figures. Another sensory function thoroughly examined in the Luria-Nebraska Neuropsychological Battery is vision, evaluated with the Visual Functions scale. Golden (1982) indicated that this scale is "designed to evaluate a wide range of visual functions and is thus highly sensitive to right hemisphere dysfunction as well as dysfunction in posterior portions of the brain" (p. 60).

Comprehending and producing speech is measured by the Receptive Speech and Expressive Speech clinical scales. The examinee is required to choose pictures or verbal descriptions of what they heard on the Receptive Speech scale, whereas fluency and articulation ability is examined on the Expressive Speech scale by requiring the client to read and repeat verbal information (Walker et al.,

2008). The Writing scale evaluates an examinee's spelling, copying, and writing on a basic level. Similarly, the Reading scale examines basic reading ability by requesting the client identify sounds and read letters, words, sentences, and paragraphs. Fundamental and simple arithmetic skills such as calculation are examined on the Arithmetic scale, and the ability to encode and learn verbal and nonverbal information is measured by the Memory scale. The Intellectual Processes scale evaluates reasoning within different frameworks and contains similar items to measures of intelligence (Golden et al., 1985). The last clinical scale, Intermediate Memory, examines retrieval and maintenance of previously presented information.

Information can be organized into summary, localization, and factor scales using data obtained from the 12 clinical scales (Golden et al., 1985). There are five summary scales: Pathognomonic, Right Hemisphere, Left Hemisphere, Profile Elevation, and Impairment. The Pathognomonic scale contains items infrequently missed by healthy individuals and is sensitive to brain dysfunction (Goldstein, 2000). The Right Hemisphere and Left Hemisphere scales comprise items evaluating tactile and motor functioning of the respective side of the body. Profile Elevation and Impairment evaluate present functioning and degree of dysfunction, respectively (Tsushima, 2010).

As there are five summary scales, there are eight localization scales to best infer location of brain damage. The localization scales include Left Frontal, Left Sensorimotor, Left Parietal-Occipital, Left Temporal, Right Frontal, Right Sensorimotor, Right Parietal-Occipital, and Right Temporal (Golden et al., 1985). The factor scales comprise items representing different neuropsychological functions (Walker et al., 2008). Scores involve an age and education correction to determine whether performance is abnormal (Goldstein, 2000).

Although the development of the Luria-Nebraska battery was not without controversy (Adams, 1980; Spiers, 1981), it was an important landmark in neuropsychological assessment in that it provided a different fixed battery and introduced American neuropsychology to the ideas of Luria. It has been shown to discriminate between healthy and brain-damaged individuals, and compared with the HRNTB, it has been shown to be as equally effective in identifying brain-damaged individuals (Tsushima, 2010). Nevertheless, as a comprehensive battery, it has not maintained the frequency of use over time, perhaps because of the psychometric limitations (Walker et al., 2008).

Although the HRNTB and the Luria-Nebraska battery were the first and most significant of the neuropsychological test batteries, other batteries have become increasingly popular in recent years. Two examples are the Neuropsychological Assessment Battery (Stern & White, 2003) and A Developmental Neuropsychological Assessment—the NEPSY (Korkman, 1988). The former is an updated and psychometrically sophisticated version of the batteries discussed earlier. The NEPSY is an outgrowth of Luria's approach for assessing children. These and other efforts indicate that there may be a resurgence of the battery approach in neuropsychological assessment.

Although the HRNTB and the Luria-Nebraska battery were vital for the development of clinical neuropsychology, as they provided evidence for neuropsychological evaluations as valuable tools for individuals with central nervous system dysfunction, the implementation of fixed batteries have declined among practicing neuropsychologists and the use of the flexible battery approach has increased (Rabin et al., 2005; Sweet et al., 2002). Collectively, the majority of neuropsychologists prefer a flexible battery approach (Sweet et al., 2002). The decline of the fixed battery approach and increase of the flexible approach may be related to the amount of time reimbursed by managed care, which calls for more a focused and time-sensitive approach, as is reflected in the flexible battery (Rabin et al., 2005).

Flexible battery. An alternative approach to the fixed battery was first proposed by Kaplan (Kaplan et al., 1978). This approach is considered more patient centered, as the battery of tests is selected based on the clinician's hypotheses to elucidate the patient's syndrome (Mitrushina, Boone, Razani, & D'Elia, 2005). The flexible battery approach allows practitioners to select measures to best understand

the patient's functioning, which is not possible in a fixed battery approach, ~~as~~ clinicians cannot remove or add measures to the existing battery of tests. Given that neuropsychologists are able to target the problem with specific procedures and measures, it is suggested this approach is more time efficient and provides a more comprehensive understanding of the patient's difficulties (Bauer, 1999). The approach is influenced by a more European tradition in assessment, including Luria's approach, that does not have a specific set of tests or a rigid approach to understanding brain dysfunction.

The flexible battery approach is now favored by the majority of neuropsychologists, as it allows the professional to adjust and implement multiple measures and procedures to provide the most comprehensive understanding of the patient's difficulties (Bauer, 1999). Although the flexible battery approach is not without ~~its limitations,~~ it indeed has become the most popular assessment approach among neuropsychologists (Rabin et al., 2005) and involves the administration of individual tests in different domains. Variability exists in the tests administered ~~between~~ practitioners for neuropsychological domains (e.g., Executive Functioning and Memory) ~~of~~ interest in a flexible battery approach; however, there is typically commonality in neuropsychological domains assessed as well as tests administered.

Some writers, such as Faust (1991), have argued that the lack of standardization makes replication and acceptability in settings such as forensic ones ~~incomplete~~. Because each case presents a unique situation and because each evaluation is customized to that situation, the underlying scientific support becomes eroded and its erosion poses problems in the legal arena. Reed (1996) outlined how the fixed battery—in this case, the HRNTB—was considered scientifically more rigorous than two flexible approaches. As a consequence, the flexible battery did not hold up to the scientific standards in legal situations, referred to as the *Daubert* standard. One possible way to address the variability of such an approach, at least with regard to the interpretation of the data, is to use a statistical method for interpretation outlined by Miller and Rohling (2001). Despite the current popularity of the flexible approach, the continued development of significant scientific underpinnings was encouraged ~~2~~ decades ago and has yet to be realized (Kane, 1991; Russell, Russell, & Hill, 2005). Regardless, the backbone of the flexible approach is a compendium of neuropsychological tests.

Most neuropsychological tests are grouped according to domain. Although differences exist, and there has yet to be an agreed-upon format, there is typically consistency among practitioners and approaches to determining the essential domains of a neuropsychological assessment. According to one of the most commonly used books in neuropsychological assessment, *Neuropsychological Assessment* (Lezak et al., 2004), the main domains are orientation and attention, perception, memory, verbal functions and language skills, construction, concept formation and reasoning, and executive and motor functions.

A problem that arises is that the categorization is variable, as different labels are used and categories with the same label have variable meanings. For example, sometimes the construct of "executive functioning" includes reasoning and problem solving, whereas, in other situations, it does not; sometimes attention is matched with orientation; other times, not. At present, there is no commonly accepted set of domains, or names and definitions of the domains, that neuropsychological assessment comprises. However, one empirical investigation using clinical psychologists and neuropsychologists from several professional organizations (e.g., APA and NAN) found the following common domains of tests: adaptive–functional, aphasia, behavioral medicine, developmental, intellectual or achievement, neuropsychological, and personality–psychopathology. Of these, intellectual and neuropsychological tests, followed by personality–psychopathology tests, were the most commonly used types of measures (Camara, Nathan, & Puente, 2000).

Finally, there are theoretical models such as the approach suggested by Luria in 1973 in *The Working Brain* and *Higher Cortical Functions in Man* (1980). His model is based on an evolutionary and hierarchical system of behavior. Simpler behaviors, such as attention, are mediated by lower levels of the brain with more complex behaviors, such as executive functions, mediated by higher structures such

as the cerebral cortex. Domains are measured hierarchically, with the simpler or more fundamental behaviors measured first and more complex behaviors measured last. Thus, assessment of attention would precede executive functions, but if attention is impaired, the measurement of executive functions, in this case, would be fraught with error. Hence, assessing simpler functions may be necessary to make fundamental assumptions about more complex ones.

In a landmark book, Strauss et al. (2006) put together a compendium of neuropsychological tests. These authors reviewed and presented a large number of tests, allowing the neuropsychological community for the first time to have a comprehensive review of a larger number of individual instruments. Several studies have been published outlining what neuropsychological tests are used. One of the first articles on this topic appeared in 1987 when Peck outlined what he considered "essential" neuropsychological tests. The chapter indicated that it was not a survey, nor was it intended to be comprehensive.

Butler, Retzlaff, and Vanderploeg (1991) conducted one of the first comprehensive surveys through reviewing the *Journal of Clinical and Experimental Psychology*, *Neuropsychologia,* and the *International Journal of Clinical Neuropsychology* (no longer being published) between 1985 and 1989. A list of 116 neuropsychological tests was compiled, and the survey was mailed to 500 members of the International Neuropsychological Society (INS). In order of frequency, the following tests were reported as frequently being used: the WAIS (Wechsler, 1955), the Wechsler Memory Scale (WMS; Wechsler, 1945), the TMT (Reitan & Wolfson, 1985), the MMPI (Hathaway & McKinley, 1940), the Wide Range Achievement Test (Jastak & Jastak, 1965), the Bender–Gestalt test, portions of the HRNTB (Reitan & Wolfson, 1985), the Rorschach test (Exner, 1995), the Benton Visual Retention Test, the complete HRNTB (Reitan & Wolfson, 1985), the Wisconsin Card Sorting Test (Heaton, 1981), the Luria-Nebraska Neuropsychological Battery (Golden et al., 1978), and the Luria–Christenson Procedures. Finally, Butler et al. (1991) noted that the WAIS was used by 86% of the sample, and the next most frequently used measure, the WMS, was used half as often.

Camara et al. (2000) reported that the tests used by clinical neuropsychologists were not the same as those used by clinical psychologists (see Table 9.1). Overall, approximately 100 tests were frequently used, and most neuropsychologists used 25 tests very frequently and approximately another 25 "somewhat" frequently. The MMPI and the Wechsler scales, both intelligence and memory, were used by most of the sample. It is surprising that the MMPI was the most frequently used test by neuropsychologists.

At the 30th annual NAN conference in Vancouver, results from a national survey were presented (Ojeda & Puente, 2010). The study obtained a comprehensive list of neuropsychological tests that was based on a review of the literature, neuropsychological presentations, a review of the major test publishers, and a review of the *Buros Mental Measurements Yearbook*. A comprehensive list of 600 tests was obtained and sent to the members of the North Carolina Neuropsychological Society and the Pacific Northwest Neuropsychological Society as a limited sample test survey. Subsequently, an electronic list of these instruments was created and sent to members of Division 40 of APA and members of NAN. In order of prevalence, the most frequently used tests were as follows: the WAIS, the WMS, the TMT, the Wechsler Intelligence Scale for Children (WISC;

TABLE 9.1

Frequency of Tests Used by Clinical Neuropsychologists

Rank	Test
1	Minnesota Multiphasic Personality Inventory
2	Wechsler Adult Intelligence Scale—Revised
3	Wechsler Memory Scale—Revised
4	Trail-Making Test A and B
5	Finger Tapping Test
6	Grooved Pegboard Test
7	Hand Dynamometer
8	California Verbal Learning Test
9	Category Test
10	Wide Range Achievement Test—Revised and Third Editions

Wechsler, 1949), the Boston Naming Test (Kaplan et al., 1978), and the Rey-Oestereith Complex Figure Test (Rey, 1941). Although a total of 600 tests were reportedly being used, the frequency varied according to setting and not according to the geographical location.

Several specific test surveys have been conducted including for specific age groups, types of setting, and types of clients. In terms of specific age groups, Sellers (Sellars & Nadler, 1993) reported that the most frequently used tests for children were the WISC and the Wide Range Achievement Test—Revised (Jastak & Wilkinson, 1984). According to Sellers, the tests used with adults most frequently included portions of the HRNTB (e.g., the Category and Finger Tapping tests), the 1981 revised version of the WAIS, and the WMS. In terms of settings, the primary focus has been on determining whether neuropsychological test usage differs across clinical and forensic settings. Lees-Haley, Smith, Williams, and Dunn (1996) were the first to report that similar tests were used in both forensic and clinical settings, and Archer, Buffington-Vollum, Stredny, and Handel (2006) reported that frequently used neuropsychological tests in forensic setting were, in general, similar to those used in clinical ones. However, it appears that, although similar tests are used, the length of time involved in interpreting the tests is longer in the forensic setting.

Recent interest has arisen regarding the use of translated tests. Echemendia and Harris (2004) reported that similar tests were being used in English and Spanish and that the competency level of users varied considerably. Despite having access to almost 600 tests in Spanish, Ojeda and Puente (2010) reported that most neuropsychologists evaluating Spanish speakers used only approximately 50 of the available tests. Of those, approximately a dozen were frequently used. However, a NAN policy paper on testing Hispanics (Judd et al., 2009) warns about the simplistic translation and the use of North American norms for Spanish speakers. In Hong Kong, neuropsychological tests are used infrequently (Tsoi & Sundberg, 1989), and in China, Ryan, Dai, and Zheng collectively reported that, in 1994, the most frequently used tests were the WAIS, the Chinese version of the WISC, the MMPI, the WMS, and the HRNTB.

Start new sentence with "Additionally,"

A recent survey of 404 members of the NAN and the INS was conducted by Smith, Gorske, Wiggins, and Little (2010). The Beck Depression Scale (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) was the most commonly used test, followed by behavior ratings, and, subsequently, the Minnesota Multiphasic Personality Inventory–2 (Butcher, Dahlstrom, Graham, Tellegen, & Kaemmer, 1989). In general, younger patients were more likely to have personality tests administered. Furthermore, personality tests were used most often when the evaluations did not involve classically brain-injured patients. Personality tests were more frequently used for learning disabilities and for forensic and clinical evaluations.

In recent years, neuropsychological testing has become more focused on the measurement of effort. Effort is broadly defined as the amount of motivation applied by the test taker. If motivation does not correlate well to test responses, the validity and reliability of the entire evaluation may come into question. Effort tests include, but are not limited to, the following: the b test (Boone et al., 2000), the Computerized Assessment of Response Bias (Lyell, Conder, & Green, 1997), the Dot Counting Test (Boone & Lu, 2002), the Test of Memory Malingering (Tombaugh, 1996), thePortland Digit Recognition Test (Binder, 2002), the Rey Memory Test (Reznek, 2005), the Victoria Symptom Validity Test (Slick, Hopp, & Straus, 1997), and the Word Memory Test (Green, 2005).

Norms

One of the most complicated aspects of neuropsychological tests is that of norms. Many test developers lack sufficient funds and personnel to mount significant standardization studies. Often small sample sizes are used, a problem compounded by the fact that many of the samples are geographically restricted and based on a limited clinical sample (e.g., dementia only). If obtained, "normals" (i.e., nonclinical samples), are sometimes not well matched to the clinical sample. Some tests (e.g., all versions of the Woodcock–Johnson) present primarily, if not exclusively, "normals." Other tests, such as the HRNTB, focus primarily on clinical samples. Other times, the norms are not well described, and the interpreter has to use a leap of faith in their

interpretation of the results. Finally, problems arise in that different norms exist. The Heaton norms, which are applicable to the HRNTB as well as to other commonly used tests, are the most frequently used, but even then they are limited by the sample size as well as other aspects (e.g., geographic limitations; Heaton, Grant, & Matthews, 1991). A related problem is whether norms from one ethnic group (e.g., Caucasian residents of the United States) could be used or are transferable to another, non-U.S. majority, ethnic group (e.g., Hispanics). Some, such as Ardila, Rosselli, and Puente (1992) have made limited norms with Spanish speakers available for some common tests such as the mini-mental status exam, but even these norms have problems. What ends up happening is that, regardless of the sensitivity of the test, its specificity ends up being affected by norms. It is not unusual that raw scores of one test may result in a normal interpretation with one set of norms and impaired with another set. In essence, the value of the norms is based on the referral question as well as the quality of the norms themselves. If one assumes that all norms are equal or valuable, it could result in errors in interpretation.

Technicians as Test Givers

Technicians are frequently involved with neuropsychological assessments to administer neuropsychological measures. In examining the Medicare utilization data, technicians are widely used in neuropsychological testing and infrequently used in psychological testing. Specifically, in the 2010 American Medical Association (AMA) *Code Manager*, Medicare data reported indicated that psychological testing by a doctoral-level provider occurred 190,913 times, whereas psychological testing by a technician occurred in 13,009 instances. In contrast, neuropsychological testing by a doctoral-level provider occurred in 460,327 instances, whereas technicians provided the service 96,151 times.

Defining a technician is, ironically, both simple and difficult. According to the *Federal Register*, technicians are individuals who receive a 1099 form and, consequently, an employee or independent contractor and are persons who hold a Bachelor's degree from an accredited college or university with a major in appropriate social or biological sciences (with at least 12 college credit hours in psychology). Furthermore, the federal government indicates that such individuals provide services under supervision. They typically administer and score~~s~~ tests but do not interpret tests or integrate test data with other sources of data prescribed by the supervisor ~~and~~ are suggested to have training in ethics, neuropsychology, psychopathology, and testing.

Specific to students, Medicare has never reimbursed for services provided by students in training for any health disciplines. The assumption is that general medical education pays training programs, and double dipping would occur if Medicare and the Current Procedural Terminology (CPT) reimbursed for student activity. However, students can perform as technicians as long as they are not being trained and their activity is not part of their educational requirements (e.g., a neuropsychologist in the community employs the student as a technician in his or her practice). Supervision can only be performed if the professional holds a doctoral degree in psychology, is licensed or certified as a psychologist, and is contractually related to the carrier that is being billed as a "clinical psychologist" (Centers for Medicare and Medicaid Services, 2004, p. 47553). On the plus side, technicians may increase the objectivity of data collection, minimize the potential for bias, and expand services available.

Time

Time is broadly defined as what the professional does while completing a neuropsychological evaluation. For neuropsychological testing, time is pretest, intratest, and posttest administration. Pretest is broadly defined as the time required for selecting and preparing the test. Intratest involves the actual administration of the test; posttest involves the scoring, interpretation, and integration of the test with other materials. This interpretation applies to both the Neurobehavioral Status Exam (i.e., interview) as well as the testing done by the doctoral-level professional as well as the technician. For the technician, time that is billable is only face-to-face time (i.e., administration of the test). However, for purposes of payment for technician by the supervisor, time typically comprises test preparation, test administration,

and test scoring. Another way to determine time is to consider what it does not include: patient's completion of tests, scales, and forms; patient's waiting time; typing of reports; nonprofessional (e.g., clerical) time, and literature searches and learning new techniques.

Defining time specifically is based on "The Rounding Rule." According to the CPT, the following table would apply:

- 0 unit $<$ 31 minutes;
- 1 unit $\geq$ 31 minutes to $<$ 91 minutes;
- 2 units $\geq$ 91 minutes to $<$ 151 minutes;
- 3 units $\geq$ 151 minutes to $<$ 211 minutes;
- 4 units $\geq$ 271 minutes to $<$ 331 minutes, and so forth.

Another question is: How long is a neuropsychological battery of tests? The answer depends on the source of information. An examination of some of the previous studies reviewed (e.g., Sweet et al., 2002) found that the typical evaluation lasts well over 10 hours and, in some cases, upwards of over 15 hours. This reflects the earlier trends during the 1980s and 1990s, when evaluations were extremely lengthy, typically exceeding 10 and sometimes approaching 20 hours. Because of limitations imposed by managed care, the total amount of hours now typically do not exceed 10, largely because of industry caps on the total amount of time allocated. For forensic evaluations, however, these limits do not apply and may last up to 10 times longer than clinical assessments. In contrast, some evaluations are much shorter. For example, concussion evaluations onsite during sports activities (e.g., hockey and football) may last but a few minutes.

Also of importance is the ratio of time spent interviewing versus testing. In general, for every hour of interviewing, there are 5 hours of testing. According to Puente (2005), for every hour of test administration, a half hour of test scoring occurs, even though this varies considerably from test to test. For example, the TMT may take seconds to minutes to administer, whereas the Wechsler scales may take minutes to hours. Ball, Archer, and Imhof (1994) reported large differences for the 23 most commonly used tests based on administration, scoring, and time.

Interview and testing itself are typically reimbursable by insurance carriers, on average, for approximately 1–3 hours for interviewing and 6–10 hours for testing. Longer evaluations are often not reimbursed and may actually result in auditing by the insurance carrier. Typically, testing is part of direct patient contact and nondirect patient activity. The largest amount of time is the actual administration of tests as it consumes approximately two thirds of the total time. The final part includes scoring and interpretation of administered tests. For some tests, the scoring is easy and straightforward, but for others, the scoring can be laborious and time consuming. The most difficult portion is the interpretation or integration of test findings. In this portion, the qualified health professional integrates the results of the following sources of data for the final and integrated interpretation: record review, interview (direct and collateral), testing behavior, and test results. A written report provides a mechanism for documenting that the services were provided and, in turn, provides a method to communicate the information obtained to interested parties (e.g., referral source, patient, and collaterals).

Report

The standard written report contains several basic sections: Identifying Information, Reason for Evaluation, Evaluation Procedure, Tests and Testing Results, Integration, and Summary. A summary testing sheet providing specific numerical information sometimes accompanies the report as an appendix. Identifying Information contains data about the patient (age, gender, etc.). Reason for Evaluation identifies the referral source (e.g., neurologist) and purpose of the evaluation (e.g., assessment of memory). Evaluation Procedure explains what days (maybe even time of day) the work was performed and any aspect that would help replicate the study if one wanted to do so or if the case was to be audited. Tests and Testing Results vary as to whether a technician was involved or whether a professional did the entire testing. If a technician was involved, a section of specific information about the test administered is included as well as the actual results (e.g., number of errors on the Category test). The interpretation of that test in conjunction with other

this might need to be a separate challenge and listed as (b)

information (e.g., history, other test results) is then included in an integrative fashion under a separate section, Integration and Summary as well as performed by the professional. If the professional does the testing, then Testing Results, Integration, and Summary can be placed under one section. The reason for the division of sections when a technician is used is to assist in understanding the report when an audit is being completed. Readers are encouraged to consult Chapter 3 in this volume, given the brevity of this section and importance of report writing.

CHALLENGES FOR THE FUTURE OF NEUROPSYCHOLOGICAL ASSESSMENT

Clinical neuropsychological assessment has a long past but a short history. This history, however, has been explosive. With over 100 years of application since Wundt, neuropsychology as a specialty started formally around 1980 with the organization of Division 40 of APA and NAN. Other organizations, such as the INS, have been more scientifically, rather than professionally, focused. However, it was not until 1996 that APA recognized clinical neuropsychology as a specialty (APA Commission for the Recognition of Specialties and Proficiencies in Professional Psychology, 1996). During those years and since then, growth has been dramatic. Neuropsychology has grown to be the primary clinical assessment in psychology and the largest group of diagnosticians as well as clinical testers in psychology. With this growth, there has also been a drastic increase in tests and patterns of testing. There are probably well over 2,000 tests currently being used in clinical neuropsychology although probably only 50–100 are used with some regularity. The specialty has gone from relying almost exclusively on batteries (e.g., the HRNTB) to almost exclusively a composite of individual tests (e.g., the WAIS). Finally, neuropsychological testing has gone from being a strictly clinical enterprise, focusing initially on neurological and psychiatric patients, to addressing varied populations (e.g., sports, military, and health) as well as forensic ones. It appears, however, that this enormous growth may not be as strongly supported scientifically as it should, and its application to ethnic minority groups (e.g., Hispanics) remains relatively weak.

Three challenges lie ahead for neuropsychological assessment: (a) The scientific base needs to be expanded, and translational research needs to be a primary focus; (b) there needs to be an understanding of nonmajority group members, especially in light of shifting American demographics and the globalization of neuropsychological assessment increases; and (c) inclusion of neuropsychological assessment in wide-spectrum health and related fields (e.g., education, sports, law) needs to occur.

In addition to these three challenges, historical problems persist, including being perceived as overly political, inbred, and elitist. This perception, real or otherwise, may impede the generalizability of neuropsychological assessment to wider audiences, both geographically (e.g., to developing countries) and for other specialties within psychology (e.g., industrial psychology). These problems may prevent Wundt and James's beliefs about psychology from being heavily associated with underlying brain function and may limit the role that neuropsychological approaches play in answering traditional philosophical questions. Regardless, the explosive growth of clinical neuropsychology and neuropsychological assessment over the past 3 decades potentially signals a paradigm shift within the measurement of abnormal behavior.

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