Second Edition

PRINCIPLES OF NEUROPSYCHOLOGY

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BRIEF CONTENTS

Chapter 3

NEUROPSYCHOLOGICAL ASSESSMENT AND DIAGNOSIS

The teacher is faced with the eternal dilemma, whether to present the clear, simple, but inaccurate fact, or the complex, confusing, presumptive truth.

—*Karl Menninger*

Neuropsychology in Action

Keep in Mind

- What do clinical neuropsychologists do?
- How is clinical neuropsychology distinguishable from clinical psychology or from neurology?
- What makes a neuropsychological test reliable and valid?
- What different roles do neuropsychologists play?
- What individual differences influence neuropsychological test interpretation?
- How can a neuropsychologist improve a patient's quality of life?

Overview

Jeanne was a passenger on a motorcycle with her husband when at an intersection a car ran a stop sign and hit them. Although her husband received only minor injuries, Jeanne was thrown about 5 feet. Luckily, she was wearing a helmet. However, Jeanne thinks she must have been knocked out, because she does not remember anything until the ambulance arrived. Emergency department personnel attended to her knee injury. She also had a terrible headache. Magnetic resonance imaging (MRI) did not detect any contusions or lesions. The hospital released Jeanne that day and told her to see her general practitioner if she had any more problems.

Jeanne recovered for a week at home, and then went back to her job as a medical records clerk. She also returned to school to enroll in coursework for a nursing degree. First, she noticed that she often forgot a client's seven-digit medical record number between the time she looked at it and went next door to get the chart. Her grades also started slipping. Before the accident, she was earning As and Bs; but on her first biology test a month after the accident, she received a D. She also continued to have headaches, which she had not had before. Four months after her injury, after several visits to her general practitioner and a neurologist, neither of whom could find anything medically wrong with her, her practitioner referred her for a neuropsychological evaluation. The request was to evaluate Jeanne to determine whether she had suffered a brain injury as a result of her accident or if her symptoms might be a psychosomatic reaction, that is, related to increased stress in dealing with the accident and the aftermath.

What can neuropsychology offer Jeanne? Many people who have head injuries or suffer whiplash injuries in car accidents, sports injuries, or falls may have a brief lapse of consciousness. They may feel temporarily confused or disoriented. They may or may not go to a doctor or to the hospital, and if they do, they are usually released after a brief observation. Computed transaxial tomography (CT) or MRI results are quite likely to be negative for any small or microscopic contusions or lesions. Only after going home and trying to resume the normal tasks of working or going to school may someone such as Jeanne feel unable to concentrate or often forget things. The person may have other odd symptoms that he or she does not understand, such as becoming more easily frustrated or just not feeling "herself." If these problems do not resolve and the person is persistent, or the physician perceptive, then the physician should make a referral for neuropsychological testing.

General Considerations in Neuropsychological Testing

This chapter describes the most frequently used assessment techniques in neuropsychology and outlines the scientific and theoretical principles of neuropsychological measurement. We stress that clinical neuropsychologists use a number of different methods to evaluate and treat individuals with brain dysfunction. Simply put, neuropsychologists are foremost clinical psychologists who have specialized in neuropsychological conceptualizations and methods. For neuropsychologists to understand the individual, they must view psychology as the expression of neuropsychology. From this perspective, neuropsychology is a broad field, and the neuropsychologist's roles span

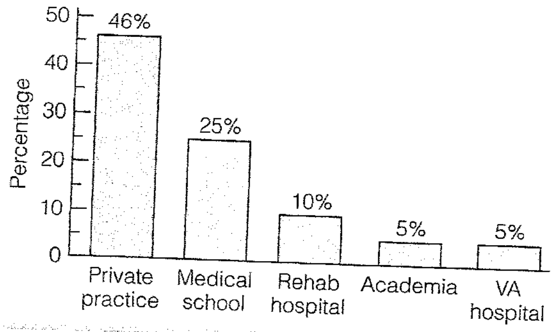


Figure 3.1 Distribution of neuropsychology practice, based on a survey of more than 2000 members of the National Academy of Neuropsychology. (Reproduced from Gordon, A., & Zillmer, E. A. [1997]. Integrating the MMPI and neuropsychology: A survey of NAN membership. *Archives of Clinical Neuropsychology, 4,* 325–326, by permission of Elsevier.)

the range from evaluation to rehabilitation to research. This provides flexibility for employment in diverse settings. Figure 3.1 outlines representative employment settings of clinical neuropsychologists. Almost half of all clinical neuropsychologists work in private practice, 24% in medical schools, 11% in rehabilitation hospitals, 5% in university settings, and 5% in Veterans Affairs (VA) medical centers. Other employment settings for clinical neuropsychologists include community mental health centers/clinics, school systems, military settings, and prisons/correctional facilities. Across all settings, the "average" clinical neuropsychologist devotes 63% of his or her professional time to neuropsychology, has approximately 12 years of experience in practicing neuropsychology, is 45 years of age, and is predominantly male (73%) (Gordon & Zillmer, 1997).

In private practice, the role of the neuropsychologist is perhaps the most varied and flexible, but also the most ambiguous, because the amount of time devoted to neuropsychology depends on the type of patient population. Thus, neuropsychologists in private practice may provide neuropsychological evaluation and diagnosis, as well as psychotherapy, family therapy, biofeedback, and other forms of traditional psychological services. Most often, clinical neuropsychologists in private practice are generalists; that is, they have grounding in clinical psychology with expertise in clinical neuropsychology. Some private practitioners have teaching or clinical appointments in universities or medical schools and participate to some degree in teaching and research.

In medical schools and hospitals, and in VA medical centers, clinical neuropsychologists most frequently work in psychiatry and rehabilitation departments and, to a lesser extent, in neurology or neurosurgery departments. The role of the neuropsychologist in the medical arena is typically neuropsychological diagnosis, evaluation, and intervention. The major difference compared with the private practice setting is the degree to which neuropsychologists participate in research. Particularly in medical schools, research plays an important role, and neuropsychologists are often important participants in multidisciplinary research. In rehabilitation hospitals, neuropsychologists are essential in interventions for and remediation of disabilities related to brain impairment. In the academic setting, neuropsychologists predominantly teach undergraduate students in psychology and graduate students in clinical psychology. Academic neuropsychologists typically run active research programs. Clinical service delivery may play a minor role. Neuropsychologists in university settings may treat patients in an integrated university neuropsychology clinic, or they may participate in a small private practice. Common to all employment settings is the emphasis on clinical diagnosis and evaluation, research, and rehabilitation and intervention. Figure 3.2 outlines the typical patient populations that clinical neuropsychologists serve. A combined total of more than 70% of the patients who neuropsychologists treat are rehabilitation, psychiatry, or neurology patients. To a lesser degree, neuropsychologists treat patients referred with learning disabilities, forensic issues, dementia, general medical conditions, and seizure disorders.

WHY TESTING?

In the past, the interest in clinical neuropsychology, specifically in assessment, reflected a perceived need to expand the clinical understanding of behavior to include

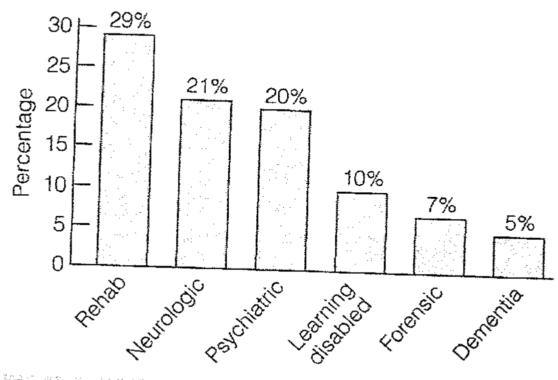


Figure 3.2 Types of patients treated by neuropsychologists. (Reproduced from Gordon, A., & Zillmer, E. A. [1997]. Integrating the MMPI and neuropsychology: A survey of NAN membership. *Archives of Clinical Neuropsychology, 4,* 325–326, by permission of Elsevier.)

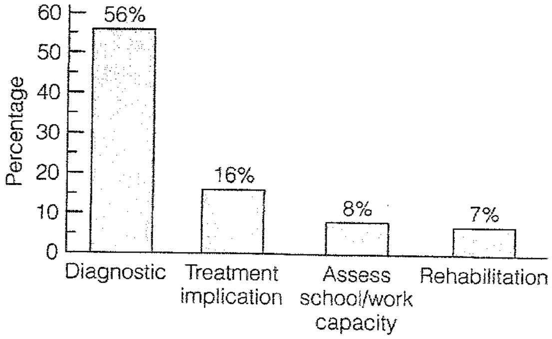


Figure 3.3 Overview of the neuropsychologist's role in assessment. (Reproduced from Gordon, A., & Zillmer, E. A. [1997]. Integrating the MMPI and neuropsychology: A survey of NAN membership. *Archives of Clinical Neuropsychology, 4,* 325–326, by permission of Elsevier.)

effects on human functioning caused by brain dysfunction. As a result, evaluation of brain functioning through the development of neuropsychological testing has been a major contribution to psychology. Clinical neuropsychologists, however, have often been—not undeservedly—pigeonholed as "brain damage testers" or reductionistic "lesion detectors." But this notion is outdated. Clinical neuropsychology is a quickly evolving field in which the neuropsychologist can play several roles. One of those roles traditionally has been conducting psychological evaluations of brain–behavior relationships. Understand that neuropsychologists gain expertise in neuropsychological assessment and diagnosis over years of study and clinical practice, which they usually pursue at predoctoral and postdoctoral levels. The purposes of administering psychological assessment instruments are to identify a patient's cognitive and behavioral strengths and weaknesses, to assist in the differential diagnosis of mental disorders, and to aid in treatment and discharge planning. Figure 3.3 reviews the neuropsychologist's role in assessment and diagnosis by summarizing the general purposes of neuropsychological assessments.

A majority (>50%) of all neuropsychological evaluations are diagnostic in purpose. In essence, the question to understand is whether there are indications of a decline in cognitive abilities and whether they suggest a specific diagnosis or neuropathologic condition. In many cases that involve obvious pathology (such as brain tumor and stroke), neuropsychological evaluations are a precursor or are complementary to more in-depth neurologic or neuroimaging procedures that can establish the exact medical or neurologic diagnosis. In other cases (such as learning disabilities, attention deficit disorder, dementia, or minor head injury), the medical diagnosis is much more obscure and cannot be verified precisely by medical imaging techniques. Neuropsychological evaluations play a major role in assessing such conditions, because the diagnosis often rests largely on behavioral symptoms. In some medical conditions (such as epilepsy, multiple sclerosis, and AIDS), neuropsychological assessments have only minor diagnostic value, but they are used for documenting the extent of cognitive strengths and weaknesses, to outline effective treatment strategies and appropriate placements for school or vocational settings. Thus, many neuropsychological evaluations are conducted with more descriptive purposes in mind. As a result, the neuropsychologist's role has evolved from that of a strict diagnostician to providing descriptions of cognitive functioning, current adaptation, and future prognosis.

RATIONALE OF THE NEUROPSYCHOLOGICAL EXAMINATION

You cannot determine whether a certain function of the brain is impaired unless you test that function. The **neuropsychological evaluation** is an objective, comprehensive assessment of a wide range of cognitive and behavioral areas of functioning, which the neuropsychologist typically integrates with intellectual and personality assessments and evaluates within the context of CT and MRI scans. When based on a thorough description of abilities and deficits, neuropsychological testing leads to recommendations for rehabilitation and treatment. In using such tests, clinical neuropsychologists are interested principally in identifying, quantifying, and describing changes in behavior that relate to the cognitive integrity of the brain. Serial assessments can demonstrate gradual improvement or deterioration in mental status over time, allow better differentiation of cognitive deficits, and assist in treatment and disposition planning (Lezak, Howieson, & Loring, 2004). Thus, the neuropsychologist may address issues of cerebral lesion lateralization, localization, and progress. Neuropsychological evaluations can provide useful information about the impact of a patient's limitation on his or her educational, social, or vocational adjustment. Because many patients with neurologic disorders, such as degenerative disease, cerebrovascular accidents, or multiple sclerosis, vary widely in the rate at which the illness progresses or improves, the most meaningful way to equate patients for severity of illness is to assess their behavior objectively, using neuropsychological procedures.

The neuropsychological evaluation has a number of advantages that many standard neurodiagnostic techniques do not share; for example, it is noninvasive and provides descriptive information about the patient. Specific tests used in neuropsychological assessment batteries may vary, although most assessments include objective measures of intelligence, academic achievement, language functioning, memory, new problem solving, abstract reasoning, constructional ability, motor speed, strength and coordination, and personality functioning (Zillmer & Greene, 2006).

You can conceptualize neuropsychological assessment as a method of examining the brain by studying its behavioral product. Because the subject matter of neuropsychological assessment is behavior, it relies on many of the same techniques and assumptions as traditional psychological assessment. As with other psychological assessments, neuropsychological evaluations involve the intensive study of behavior by means of standardized tests that provide relatively sensitive indices of brain–behavior relationships. Neuropsychological tests have been used on an empirical basis in various medical and psychiatric settings, are sensitive to the organic integrity of the cerebral hemispheres, and can often pinpoint specific neurologic or psychological deficits. Neuropsychological assessment has also become a useful tool for clinical service delivery and for research regarding the behavioral and cognitive aspects of medical disorders.

APPROPRIATE REFERRALS FOR NEUROPSYCHOLOGICAL EVALUATION

Because a neuropsychological workup may take from 30 minutes to 8 hours of professional time, health practitioners should request consultations with some discrimination for cost-effectiveness and utility. The interpretation and diagnosis of the patient's profile ultimately depends on the referral question, the neuropsychologist's test selection, and the process by which the neuropsychologist interprets the data. Referrals should specify exactly what questions or problems prompted the referral, what the referral source hopes to obtain from the consultation, and the purpose for which the referrer will use the information. The advanced student in neuropsychology often feels frustrated by the failure of medical professionals to give a clear referral question. Note, however, that generating appropriate referral questions, as well as questions from the patient about the goals of the evaluation, is the responsibility of the neuropsychologist. Thus, it is often necessary to educate the professional community about the purpose and goals of a neuropsychological evaluation. Having the patients themselves ask specific questions about the goals of the evaluation (e.g., whether they can go back to work) often makes the evaluation process more meaningful to patients, and typically motivates them to put forth a good effort.

In a medical setting, the neuropsychologist is most helpful to the treatment team as a neurobehavioral describer of functional strengths and weaknesses, as well as a provider of neurodiagnosis. As mentioned earlier, such disorders as mild head injuries, early stages of Alzheimer's dementia, or learning disabilities may show no symptoms beyond the cognitive dysfunction that formal neuropsychological testing assesses so well. Following is a listing of instances in which a neuropsychological consultation is generally useful:

- Differential neurologic diagnosis
- Acute versus static
- Focal versus diffuse
- Location of damage
- Establishment of a baseline for neuropsychological performance from which future evaluations can assess improvement or deterioration
- Descriptions of the effects of brain dysfunction on behavior
- Determinations of disability levels for compensation in personal injury litigation
- Evaluation of vocational potential
- Assessment of environmental needs after discharge from hospital (disposition planning)
- Development of remedial methods for rehabilitation of the individual brain-damaged patient
- Measurement of residual abilities during rehabilitation
- Patient management

Psychometric Issues in Neuropsychological Assessment

The success of psychological testing procedures to assess and select individuals to become officers and undertake special assignments in World War I was the impetus for some of the earliest recognition of psychology as a scientific field. Since then, the science of standardized clinical psychological testing has evolved to the point that there are now hundreds of psychological assessment instruments in use today. It is important for the neuropsychology student to understand the scientific principles of psychological measurement before examining neuropsychological assessment instruments in more detail.

Psychometrics, the science of measuring human traits or abilities, is concerned with the standardization of psychological and neuropsychological tests. A **standardized test** is a task or set of tasks administered under standard conditions and designed to assess some aspect of a person's knowledge or skill. Standardized psychological tests typically yield one or more objectively obtained quantitative scores, which permit systematic comparisons to be made among different groups of individuals regarding some psychological or cognitive concept. Most neuropsychologists agree that tests are rarely used alone and are not interpreted in a vacuum. Almost always, neuropsychological tests are only one of multiple components of information used to make important decisions about an individual. Neuropsychological assessment, therefore, depends on the complex interplay among the neuropsychologist, the patient, the context of the assessment, and the data from neuropsychological testing.

RELIABILITY

For any psychological test to be useful, it must be both reliable and valid. **Reliability** is the stability or dependability of a test score as reflected in its consistency on repeated measurement of the same individual. A reliable test should produce similar findings on each administration. If test scores show a great deal of variation when administered to the same individual on several occasions, the test scores are unreliable and there is concern about error. Interpretation of the scores becomes difficult. There are several different forms of reliability, including test-retest reliability, split-half reliability (the correlation between two halves of the test), or internal consistency (the degree to which items of a scale measure the same thing, also known as Cronbach's alpha). Thus, the concept of reliability is not as simple as it first appears, and test developers must present substantial detail when making claims of test reliability.

VALIDITY

The **validity** of a test is the meaningfulness of specific inferences made from the test scores; that is, does the test really measure what it was intended to measure? If a test is unreliable, it cannot be valid. For example, if you take the same language test on three different days and obtain three different scores, it is easy to conclude that there is no consistency and, therefore, the test cannot possibly be used to predict anything about your language abilities. A reliable test is not necessarily a valid one. Let us say a test was purported to measure how well you make organized extemporaneous speeches. The test requires you to generate as many words as you can in 1 minute. On three different days you took the test, and on three days you got a similar score. The test has high reliability. But is it telling us about your ability to make impromptu speeches? Not necessarily. An analysis of the test's validity may show that it is primarily measuring your ability to search and retrieve words from memory. It may have little to do with your ability to put your thoughts together and come up with a good speech.

Although the concept of a test accomplishing its purpose is easy to grasp, applying this concept often results in confusion. Many tests that neuropsychologists use originally were designed for purposes or diagnostic groups other than those for which they are used now. Rather than discuss validity in overgeneralized terms, scrutinize an evaluation of a test's validity in relation to the specific purpose and the specific population it is used in. That is, never consider a test *generically* "valid" or "invalid." The question to ask is: "Is this test valid for this particular purpose?"

You can use several different strategies for determining validity. **Construct validity** focuses primarily on the test score as a measure of the abstract, psychological characteristic or construct of interest (such as memory, intelligence, impulsiveness, and so forth). Construct validity would be most important if you wanted a demonstration of the cognitive or functional abilities a test measures (e.g., visuospatial problem solving or perceptual-motor functioning).

Content validity pertains to the degree to which a sample of items or tasks makes conceptual sense or represents some defined psychological domain. Various items of the test should correspond to the behavior the test is designed to measure or predict, such as measuring how fast someone can tap a finger, to assess upper extremity motor speed. Finally, **criterion validity** demonstrates that scores relate systematically to one or more outcome criteria, either now (concurrent validity) or in the future (predictive validity). Criterion-related validity traditionally has been an area of prime concern in neuropsychology related to the correct classification of diagnostic groups including brain-impaired, psychiatric, and normal individuals. There is also the issue of whether the test is being used as a measure to describe current everyday functioning. Criterion-related predictive validity is important if a test is designed to predict decline or recovery of function or future behavior of any type (such as medication management or ability to drive a car).

FALSE POSITIVES AND BASE RATES

A **false positive** (also known as a type I error or false alarm) is a case in which a neuropsychological test erroneously indicates a pathologic condition—such as "brain damage"—in an individual who is actually "normal." In setting a cutoff score on neuropsychological tests, statisticians attend to the percentage of false alarms (or false positives), as well as to the percentages of successes and failures within the selected group. In most medical (life-threatening) situations, statisticians set the cutoff point low enough to exclude all but a few false alarms (such as on tests that detect the presence of cancer). When the selectio n ratio is not externally imposed, the cutting score on a test can be set at a point yielding the maximum differentiation between criterion groups. You do so, roughly, by comparing the distribution of test scores in the two criterion groups, including the relative seriousness of false alarms and acceptances.

The validity resulting from the use of a test depends not only on the selection ratio but also on the base rate of the test. **Base rate** is the frequency with which a pathologic condition is diagnosed in the population tested. For example, if 10% of a psychiatric population of a hospital has organic brain damage, then 10% is the base rate of brain damage in this population. Although introducing any valid test improves predictive or diagnostic accuracy, the improvement is greater when the base rates are closest to 50% (closest to chance). With extreme base rates found in rare pathologic conditions (e.g., <1%), an improvement with a neuropsychological test may be negligible. Under those conditions, the diagnostic use of a neuropsychological test is unjustifiable when you take into account the cost of its administration and scoring. When the seriousness of a condition makes its diagnosis urgent, as in Alzheimer's disease (AD), neuropsychologists may often use tests of moderate validity in early stages of sequential decisions. Table 3.1 demonstrates a simple decision strategy for neuropsychological procedures. A single test is administered, and the decision to reject or accept a diagnosis is made with four possible outcomes.

Table 3.1 ***Decision Making in Neuropsychological Assessment***

Decision	Positive (presence of pathology)	Negative (absence of pathology)
CORRECT	Valid acceptance (hit)	Valid rejection (correct rejection)
INCORRECT	False positive (false alarm, type I error)	False negative (miss, type II error)

Table 3.2 ***Types of Tests Most Commonly Used by Psychologists***

Type of Test	Characteristics Measured
Achievement	Profit from past experience
Aptitude	Profit from future training and educational experiences
Behavioral/adaptive	Basic adaptive behaviors (e.g., self-care, communication, socialization)
Intelligence	Ability to adapt to novel situations quickly
Neuropsychological	Brain–behavior relationships
Personality	Psychopathology and ability to adapt and cope with stress
Vocational	Success in a specific occupation or profession

Neuropsychological Tests

Table 3.2 reviews the most frequently used types of neuropsychological measures currently in practice. Different types of tests have different goals and applications. **Achievement tests** measure how well a subject has profited by learning and experience, compared with others. Typically, achievement is most influenced by past educational attainment. Achievement tests are not designed to measure the individual's future potential, which is typically measured by aptitude tests. **Behavioral-adaptive scales** examine what an individual usually and habitually does, not what he or she can do. Neuropsychologists most frequently use such scales in evaluating the daily skills of individuals who are quite impaired (such as the mentally retarded or the severely brain injured). **Intelligence tests** are complex composite measures of verbal and performance abilities that are related, in part, to achievement (factual knowledge) and to aptitude (e.g., problem solving). **Neuropsychological tests** traditionally have been defined as those measures that are sensitive indicators of brain damage. Today, scientists consider a measure to be a neuropsychological test if a change in brain function is systematically related to a change in test behavior. Most available neuropsychological tests, therefore, have a broader function (see later in this chapter for a more detailed description of these tests). Another area of psychological testing concerns the nonintellectual aspects of behavior. Tests designed for this purpose are commonly known as **personality tests**—most often, measures of such characteristics as emotional states, interpersonal relations, and motivation. Finally, **vocational inventories** assess opinions and attitudes that indicate the individual's interest in different fields of work or occupational settings.

Neuropsychologists generally recognize that there is considerable overlap among all types of psychological tests. For example, it is difficult to measure aptitude without measuring achievement, to measure vocational interest without measuring personality, or to measure intelligence without measuring neuropsychology. One way to deal with this overlap is to reduce the complexity to two basic neuropsychological constructs: "crystallized" and "fluid" functions. Psychologists consider **crystallized functions** to be most dependent on cultural factors and learning. In contrast, they believe **fluid functions** to be culture free and independent of learning. Problem-solving and abstract reasoning abilities are considered fluid, whereas spelling and factual knowledge are considered crystallized. Nevertheless, even this simple differentiation of psychological test properties is controversial. For example, much discussion concerns whether intelligence tests tap mostly crystallized or fluid forms of behavior. Actually, it is nearly impossible to measure all aspects of a complex skill or group of skills with a single test. As a result, neuropsychologists prefer to administer a number of different tests, known as a *test battery,* that address different areas of brain–behavior functioning. After all, testing behavior, whether vocational or adaptive, is mediated by brain function. Thus, neuropsychologists use the preceding tests to some degree to evaluate specific questions about an individual. The neuropsychological interview is also an important part of the neuropsychological evaluation. The benefits of talking to the patient include an understanding of the patient's symptom presentation; the patient's awareness of his or her symptoms; and a review of the patient's educational, marital, social, and developmental histories.

The best way to understand the purpose of the neuropsychological assessment is to examine the evaluation process. Because neuropsychological assessment batteries typically evaluate a wide range of behaviors, they are considered multidimensional in their approach to measuring higher cortical functions. Thus, the neuropsychological examination involves accurately evaluating multiple cognitive abilities (Table 3.3). The usual categories of the neuropsychological examination include the following functional areas, which are listed hierarchically; that is, higher cognitive functions depend to a large degree on intact lower functions, which are listed first:

Let us examine each of these areas in greater depth. For each neuropsychological domain, we present an example to elucidate the construct measured and the method used to do so. In addition, we present examples of frequently used neuropsychological tests for each neuropsychological domain.

ORIENTATION (AROUSAL)

Brain impairment affects not only a person's intellect or muscle movement but all other aspects of performance as well, including his or her level of consciousness. Patients who are lethargic or tired all the time tend to perform poorly compared with patients who have good energy. Lethargy is sometimes a symptom of brain damage and sometimes a symptom of depression. It is the psychologist's job to determine which factors are at work in a given case.

Alertness is the most basic aspect of cognition. Patients who cannot demonstrate adequate arousal may have difficulty participating in a neuropsychological evaluation and are, perhaps, unlikely to benefit from rehabilitation or psychological intervention. **Orientation** describes a patient's basic awareness of himself or herself to the world around them. Specifically, in neuropsychology, orientation refers to an individual's knowledge of who he or she is (orientation to person), what the date is (orientation to time), and where he or she is (orientation to place). If a patient is fully oriented, the neuropsychologist will say that he or she is "oriented times three," meaning that those three areas of awareness are intact.

Neuropsychological Items (Orientation)

The neuropsychological assessment typically involves the common evaluation of orientation in the three spheres; for example, "What is your full name?" (both first and last names are required) "Where do you live?" (specific town or city is required), or "How old are you?" In addition, neuropsychologists may also ask additional questions that relate to an individual's ability to recall his or her specific whereabouts, the purpose of the hospitalization, and any part of his or her address: "What is the name of the place you are in now?" (a response indicating that the patient knows he or she is in a hospital is considered correct) and "What town or city are you in now?" (any response indicating adequate orientation to the hospital's location is scored). The following two examples are examples of the patient's orientation to well-known current facts involving famous individuals: "Who is President of the United States right now?" and "Who was president before him?"

Table 3.3 *Common Areas of Neuropsychological Assessment Grouped Hierarchically by Function*

Orientation
- Arousal
- Degree of confusion
- Disorientation
- Place
- Person
- Time
- Awareness of change/time

Sensation/Perception
- Recognition
- Familiarity of stimuli
- Relationship among features
- Visual acuity
- Auditory
- Taste/smell
- Tactile/proprioceptive
- Internal/environmental
- Awareness

Attention
- Span
- Selective attention
- Shifting
- Sustained attention
- Vigilance
- Neglect
- Fatigue

Motor
- Cerebral dominance
- Initiation and perseveration
- Manual dexterity
- Graphomotor skills
- Balance
- Ambulation
- Motor speed
- Speech regulation
- Motor strength

Visuospatial
- Construction
- Route finding
- Spatial orientation
- Facial recognition

Language Skills
- Receptive speech (following directions, reading comprehension)
- Expressive speech (verbal fluency, naming, writing, math)
- Articulation (stuttering, stammering, articulation voice, fluency)
- Speech production (articulation fluency, voice)
- Syntax and grammar
- Aphasias: Broca's, Wernicke's, conduction, fluent, transcortical, subcortical

Memory
- Verbal
- Visual
- Immediate
- Short term
- Long term
- Recognition
- Encoding
- Storage
- Retrieval
- Chunking
- Declarative
- Procedural

Abstract Reasoning/Conceptualization
- Comprehension
- Judgment
- Calculations
- Problem solving
- Organizational abilities
- Higher level reasoning
- Sequencing

Emotional/Psychological Distress
- Depression
- Attitude toward rehabilitation
- Motivation
- Locus of control
- Family relationships
- Group interaction
- One-to-one interaction
- Behavioral impulsivity
- Aggressive/confrontational

Activities of Daily Living
- Toileting
- Dressing
- Bathing
- Transferring
- Continence
- Feeding

Neuropsychological Tests (Orientation)

To measure orientation, neuropsychologists frequently use the Galveston Orientation and Amnesia Test (GOAT) (Levin, O'Donnell, & Grossman, 1979). This short mental status examination assesses the extent and duration of confusion and amnesia after traumatic brain injury. Like the Glasgow Coma Scale (GCS; see Chapter 13), it was designed for repeated measurements and can be used several times a day and repeated over days or week as necessary. The GOAT yields a score from 0 to 100, with a suggested cutoff score of 75 or better indicating relatively intact orientation and the capacity of the patient to undergo formal neuropsychological testing. Both the GCS and the GOAT are simple to administer; therefore, the treatment team often uses them. Because these scales quantify level of patient arousal, researchers have frequently used them in examining outcome of brain injuries that involve an alteration in consciousness.

SENSATION AND PERCEPTION

Sensation is the elementary process of a stimulus exciting a receptor and resulting in a detectable experience in any sensory modality; for example, "I hear something." **Perception** depends on intact sensation and is the process of "knowing"; for example, "I hear music, it is Pearl Jam." The perceptual process begins with arousal and orientation, sensation is the second stage, and perception the third. In assessing sensation and perception, the neuropsychologist is interested in quickly and grossly evaluating the patient's visual, auditory, and tactile functional levels. Screening for impaired sensation and perception yields important information by ruling out the contributions of dysfunctional visual or auditory sensation to test performance. In addition, discovering unilateral sensory deficits aids in diagnosis of lateralized brain injury. It is important to understand that neuropsychologists are interested in a more or less general assessment of a patient's sensory functioning. Specialists, including audiologists (hearing) or optometrist (visual), perform diagnostic evaluations.

Neuropsychological Items (Sensation and Perception)

Sample items of testing the sensory and perception domain may include assessing the intactness of the patient's left and right visual fields (see Chapter 8 for a description of visual field deficits). This is achieved by administering a visual field examination, common in a neurologic examination. For this procedure, the examiner must sit facing the patient, at a distance of approximately 3 to 4 feet, and ask, "I would like you to look straight at my nose. I am going to put my arms out like this, and I want you to tell me which finger I am moving. You can point to it if you like." The examiner extends the index finger of each hand in a vertical fashion with arms spread out at shoulder height and presents the stimuli by moving each finger slightly, waiting for the patient's response between trials. Discrimination of similar auditory, verbal stimuli may be tested by the examiner saying, "I am going to say two words, and I want you to tell me whether I am saying the same word twice or two different words," to assess auditory functioning:

house – house	(same)
people – peanut	(different)
bar – bar	(same)
first – thirst	(different)

To assess the patient's ability to sense or feel objects, the examiner may say, "I am going to place an object in one of your hands. I would like you to close your eyes, feel the object, and tell me what it is." This procedure measures stereognosis, recognition of objects by touch.

Neuropsychological Tests (Sensation and Perception)

Some neuropsychologists have standardized their procedures for examining sensory and perceptual functioning and developed scoring systems as well. For example, part of the well-known and often used Halstead–Reitan Neuropsychological Battery includes a sensory-perceptual examination that tests for finger agnosia, skin writing recognition, and sensory extinction in the tactile, auditory, and visual modalities (Reitan & Wolfson, 1993).

ATTENTION/CONCENTRATION

Attention is a critical requirement for learning. To remember, you first have to pay attention. Some patients are incapable of attending to their environment. Others may be able to attend to a learning task, but only for a limited amount of time. Still others may be able to attend to a task only if there are no distractions in the environment. Psychologists divide the concept of attention into separate categories such as sustained attention, paying attention to something over a prolonged period, and selective attention, paying attention to more than one thing at a time.

Neuropsychological Items (Attention/Concentration)

Tasks requiring mental control involve simple, overlearned information, but also require the person to maintain an adequate level of attention throughout the item. Errors in this area may indicate extreme fatigue or impairment in concentration skills. For example,

"Count from 1 to 20 as quickly as you can."
"Recite the days of the week backward beginning with Sunday."
"Say the alphabet *(A, B, C . . .)* all the way through."
"Count by threes, beginning with 1 and adding 3 to each number. For example, 1, 4, 7, and so on. (Stop when you reach 22.)"

Another form of attention in this cognitive skill area is attention span. Here, the examiner asks the patient to attend to various verbal stimuli, then repeat them. The stimuli become progressively more complex. In this manner, it is possible to evaluate a patient's span of attention for unfamiliar combinations of stimuli.

"I am going to say some numbers, and after I finish, I would like you to repeat them."

TRIAL 1	5	8	9		
TRIAL 2	9	2	7	5	
TRIAL 3	7	1	6	3	2

"Now I am going to say some more numbers; but this time when I finish, I want you to say them backward. For example, if I say 3 – 6, you say 6 – 3."

TRIAL 1	5	8	
TRIAL 2	2	6	1

Sustained attention is the ability to concentrate over a period of time. For example, you can assess verbal attention with the following task: "Tap on the table when you hear me say the number 4":

2	3	5	4	7	4	6	4	4	2
1	8	1	7	8	4	5	4	2	3

Neuropsychological Tests (Attention/Concentration)

Standardized tests of attention include the Symbol Digit Modalities Test (SDMT) (Smith, 1982), which requires the respondent to fill in blank spaces with the number that is paired to the symbol above the blank space as quickly as possible for 90 seconds. The SDMT primarily assess complex scanning, visual tracking, and sustained attention. An interesting test of selective attention is the d2 Test of Attention (Brickenkamp & Zillmer, 1998). The d2 Test is a timed test of selective attention and is a standardized refinement of a visual cancelation test. It has been translated into four languages and is the most frequently used test of attention in Europe. In response to the discrimination of similar visual stimuli, the test measures processing speed, rule compliance, and quality of performance, allowing estimation of individual attention and concentration performance (Figure 3.4). The test was originally developed in 1962 in Germany and Switzerland as an assessment tool for driving efficiency. Subjects who fail the d2 task tend to have difficulty concentrating, including difficulty in warding off distractions.

MOTOR SKILLS

Neuropsychologists are interested in assessing a person's ability to demonstrate motor control in the upper and lower extremities. Simple motor skills require little coordination, whereas more complex items tap into higher motor processes. As items progress in difficulty, the patient must show more integration of cognitive skills to perform the task successfully. The following neuropsychological procedures measure varied aspects of a patient's motor functioning. The hierarchic nature of the item presentation can yield clues to the patient's limits in motor functioning.

Neuropsychological items (motor) that involve gross-motor movement assess one of the most basic cortically mediated motor responses such as a response to a single command; for example, "Raise your right hand," or "Move your left leg." You can evaluate motor speed from the patient's ability to "touch your thumb to your forefinger as quickly as you can," and fine-motor ability can be evaluated from the command, "Touch your thumb to each finger, one after the other." These previous items assess the ability to perform a particular response; the following items tap the patient's ability to perform and inhibit motor behavior: "If I clap once, you clap twice." (Clap hands one time.) "Now, I clap twice, you clap once." (Clap hands two times.) Neuropsychologists consider this a higher level cognitive process, because it requires the patient to shift between initiating and inhibiting behavior.

Neuropsychologists often examine graphomotor skills. The following items assess the ability to copy shapes with increasing degrees of difficulty. They involve the integration of visual perception (input) and a complex motor response (output). "Copy these designs. Take your time and do your best." The patient's drawings are scored related to the correct shape, size, symmetry, and integration (Figure 3.5).

Motor apraxia items assess the intactness of common motor sequences. In general, the term *apraxia* refers to an inability to perform purposeful sequences of motor behaviors. Although basic motor skills may be intact, the patient may be unable to perform even overlearned motor sequences. The form of apraxia assessed here is **motor apraxia** or **ideomotor apraxia.** Impairments in this area may stem from an inability to access a stored motor

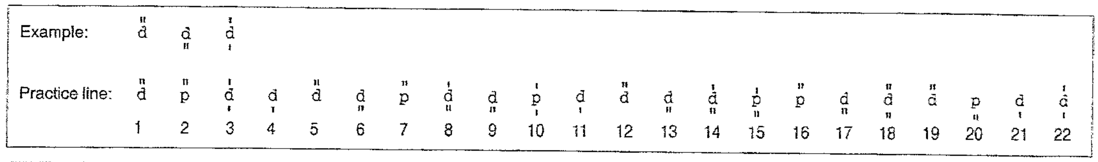


Figure 3.4 Practice line of d2 Test of Attention. The test items consist of the letters *d* and *p* with one to four dashes, arranged either individually or in pairs above and below the letter. The subject must scan across each line to identify and cross out each *d* with two dashes. In the manual, these items (correct hits) are called "relevant items." All other combinations of letters and lines are considered "irrelevant," because they should not be crossed out. The one-page d2 Test form provides sections for recording identifying data and test scores and provides a practice sample. On the reverse side is the standardized test, consisting of 14 lines, each with 47 characters, for a total of 658 items. The subject is allowed 20 seconds per line. (Reproduced from Brickenkamp, R., & Zillmer, E. A. [1998]. *d2 test of attention* [p. 7]. Göttingen, Germany: Hogrefe & Huber by permission.)

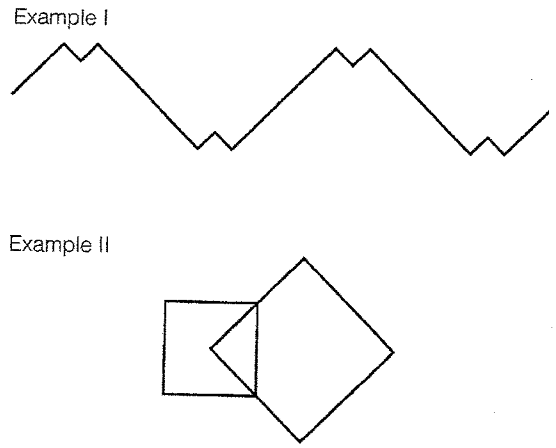


Figure 3.5 Visual integration examples. (Samples are from Zillmer, E. A., Chelder, M. J., & Efthimiou, J. [1995]. *Assessment of Impairment [AIM] Measure*. Philadelphia: Drexel University.)

sequence or an inability to relay that information to the motor association areas. An example to test this is, "Show me how you would make a telephone call from beginning to end."

Neuropsychological Tests (Motor)

Examples of standardized motor tests include a measure of grip strength and finger-tapping speed, both from the Halstead–Reitan Neuropsychological Battery. Grip strength simply measures the patient's ability to squeeze the dynamometer (Figure 3.6) as hard as he or she can. The Finger Oscillation or Finger Tapping Test requires the patient to tap as rapidly as possible with the index finger on a small lever attached to a mechanical counter (see Figure 3.6).

VERBAL FUNCTIONS/LANGUAGE

Neuropsychologists screen for intactness of language. Initial items test the patient's ability to understand simple spoken language. More complicated areas of expressive language are then evaluated by assessing word repetition, naming, and word production.

Neuropsychological Items (Language)

Receptive speech evaluates the patient's ability to comprehend simple spoken commands such as "Wave hello," or a more difficult, three-step command: "Turn over the paper, hand me the pen, point to your mouth." Expressive speech focuses on vocabulary knowledge and recognition of concepts and objects; for example, "Please tell me what the word *happiness* means." Additional tests involve word and phrase repetition ("Repeat: 'No if's, and's, or but's'") and sentence generation ("Make up a sentence using the word *vacation*"). Deficits in verbal fluency and naming are also tested; for example, "Name all the animals that you can think of as quickly as you can." Visual naming can be evaluated by pointing to a picture and saying, "Tell me what this object is" (Figure 3.7).

You can evaluate writing by assessing the quality of writing at the word and sentence levels. You can also assess deficits in the motor component of writing (dysgraphia), simple reading (dyslexia), and spelling skills (spelling dyspraxia): "Please write down the name of this picture" (Figure 3.8).

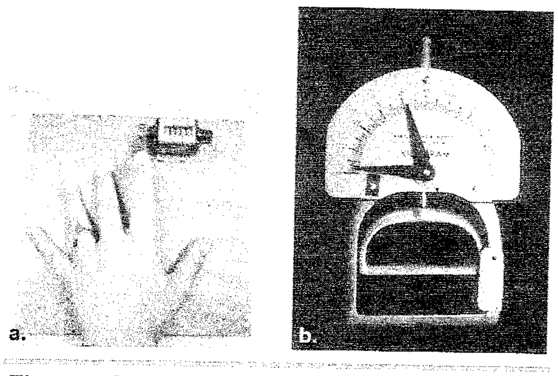


Figure 3.6 The Finger Tapping and Strength of Grip tests. (Courtesy Jeffrey T. Barth, University of Virginia, Charlottesville, VA.)

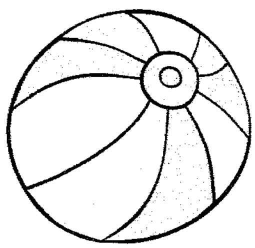


Figure 3.7 Naming example #1. (Reproduced from Zillmer, E. A., Chelder, M. J., & Efthimiou, J. [1995]. *Assessment of Impairment [AIM] Measure*. Philadelphia: Drexel University.)

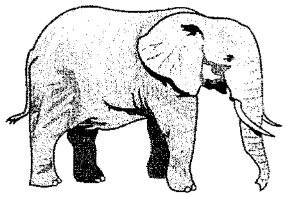


Figure 3.8 Naming example #2. (Reproduced from Zillmer, E. A., Chelder, M. J., & Efthimiou, J. [1995]. *Assessment of Impairment [AIM] Measure.* Philadelphia: Drexel University.)

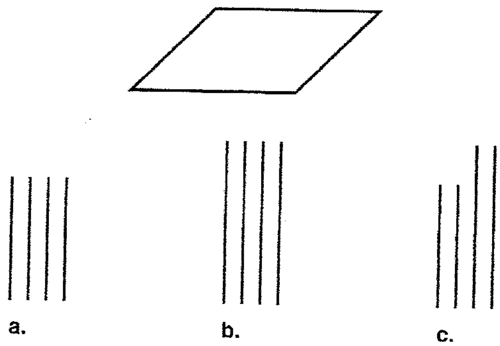


Figure 3.9 Visuospatial test item. (Reproduced from Zillmer, E. A., Chelder, M. J., & Efthimiou, J. [1995]. *Assessment of Impairment [AIM] Measure.* Philadelphia: Drexel University.)

Neuropsychological Tests (Language)

Many standardized neuropsychological tests assess verbal and language functioning. A simple but effective test of auditory comprehension (receptive language) is the Token Test (e.g., see Boller & Vignolo, 1966). Almost every non-aphasic person who has completed fourth grade should pass this test in its entirety. The test consists of a number of commands (such as "Touch the small yellow circle." or "Touch the green square and the blue circle.") that relate to plastic tokens, which come in different shapes, sizes, and colors. This test is sensitive to disrupted linguistic processes that are central to aphasic disability.

The Controlled Oral Word Association (COWA) test (Benton & Hamsher, 1989) assesses the subject's ability to use expressive speech. It measures verbal fluency by asking the subject to name as many words as possible that start with a specific letter. For example, within 60 seconds, an undergraduate or graduate student should be able to name 15 words that start with the letter *R*. In the COWA, examiners administer three word-naming trials using the letters *C*, *F*, and *L*. These letters were selected by English word frequency. That is, words beginning with *C* have a relatively high frequency; the second letter, *F*, a somewhat lower frequency; and the third letter, *L*, a still lower frequency. Word fluency is a sensitive indicator of general brain dysfunction and expressive language dysfunction.

VISUOSPATIAL ORGANIZATION

In the visuospatial domain, neuropsychologists assess various aspects of processing. They ask the patient to perform tasks of map skills, route finding, spatial integration and decoding, and facial recognition. The results of these neuropsychological tests can provide information about specific disorders of visuospatial organization.

Neuropsychological Items (Visuospatial)

Neuropsychologists can evaluate spatial orientation with simple directional skills and mazes, and then proceed through clock drawing and motor-free constructional tasks: "If this were a compass on a map and you were facing north, which direction would be behind you?" or "Draw the face of a clock, showing all the numbers, and set the hands to read 10 minutes after 11." Testers may evaluate visuospatial processing by asking, "Which of these sets of lines makes up this figure at the top: A, B, or C?" (Figure 3.9).

Facial recognition is the patient's ability to recognize a familiar face, as well as to compare similar faces and identify facial affect. For example, the examiner may ask, "Show me 'the happy face, the sad face, the angry face'" (Figure 3.10).

Visual sequencing also involves more integration and higher order processing. The person must comprehend the overall meaning of the activity, and then be able to correctly assemble the pictures to form the sequence of steps; for example, "This card has three pictures on it. If the pictures are put in the right order, they tell a story. Look carefully at the pictures, tell me the story, and point to the one you think comes first in the story. Now point to the one that would come second, and the picture that would finish the story" (Figure 3.11).

Neuropsychological Tests (Visual-Spatial)

The Bender Gestalt test consists of nine geometric designs, which the patient must reproduce exactly (Bender, 1938; Hutt, 1985). The "Bender," as it is often called, is a popular measure of visuospatial construction. It measures

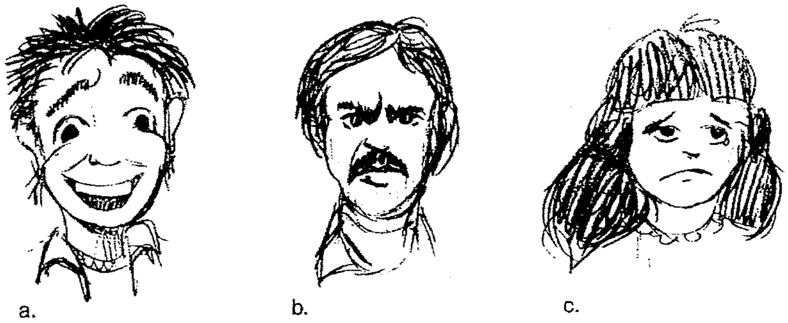


Figure 3.10 Test of facial recognition. (Reproduced from Zillmer, E. A., Chelder, M. J., & Efthimiou, J. [1995]. *Assessment of Impairment [AIM] Measure.* Philadelphia: Drexel University.)

a patient's ability to organize visuospatial material and has been shown to be sensitive to changes in neuropsychological status, particularly visual-graphic disabilities. Rey (1941) and Osterrieth (1944) devised another drawing test to investigate perceptual organization. The Rey–Osterrieth Complex Figure Test presents the subject with an intricate figure to reproduce. For both the Bender and the Rey–Osterrieth tests, scoring systems have been developed that evaluate specific copying errors.

MEMORY

You can look at memory in many ways. For example, as we noted earlier, to remember things, people must pay attention first. After paying attention, people must encode the information (do something meaningful with the information such as rehearsing it) to put it into more permanent storage. Once information is in storage, people must be able to retrieve the information as needed.

Neuropsychological Items (Memory)

Neuropsychologists assess general memory and new learning skills in a variety of modalities. There are immediate and delayed memory tasks in both verbal and visual formats. Performance on free recall and recognition tasks can help identify different aspects of memory function and dysfunction. Multiple trials of a list learning task can assess immediate verbal memory. For example, the examiner presents the patient with five words, repeated over four trials regardless of the patient's success on the item's initial trials: "I'm going to say a list of five words. Please try to remember them, and repeat them when I finish: *train, radio, apple, fork, chair.*"

You can assess delayed verbal memory by asking the patient, at a later point during the examination (such as 30 minutes), to say whether each word had been included in the list: "I am going to read a list of words. Tell me which of these words were in the earlier list I asked you to

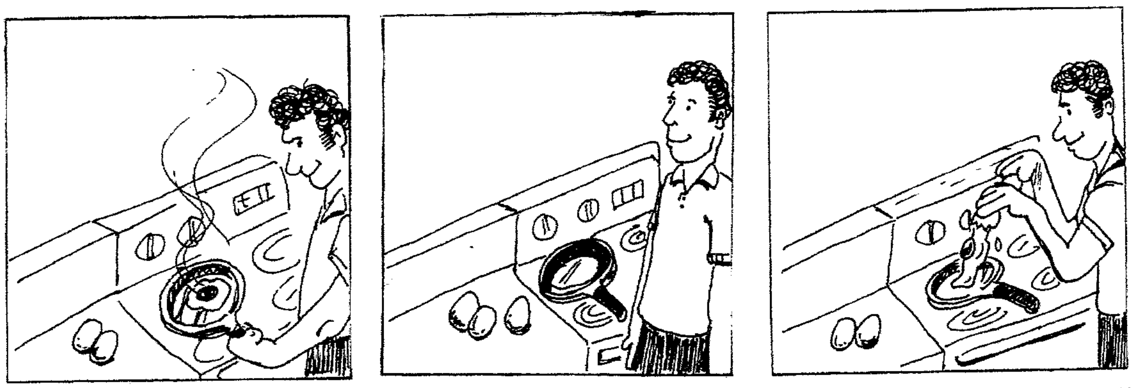


Figure 3.11 Example of picture arrangement. (Reproduced from Zillmer, E. A., Chelder, M. J., & Efthimiou, J. [1995]. *Assessment of Impairment [AIM] Measure.* Philadelphia: Drexel University.)

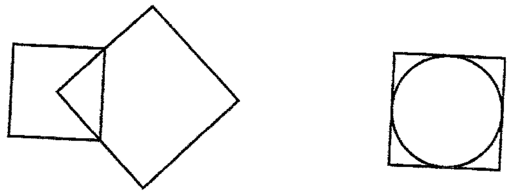


Figure 3.12 Example of design copy test.

recall several times: *clock,* ***apple,*** *book,* ***train,*** *table,* ***fork,*** *sandwich, truck,* ***radio, chair.***"

Delayed visual memory assesses the patient's ability to remember visual information the examiner presented earlier in the testing (an intermediate delay), as well as the ability to remember simple visual figures after a short delay. The examiner presents these items in a recognition format rather than a free recall format, so the patient chooses among similar stimuli, one of which is the correct figure. "Earlier I asked you to copy four designs. Which of these designs was it?" (Figure 3.12).

You can assess contextual or logical memory, immediate and delayed, by testing the patient's free recall ability. The examiner presents a short story to the patient, testing memory for information presented in a specific contextual structure. After an interference item, the examiner again asks the patient to tell the story. Slashes separate each unit of information in the following example.

I am going to read to you a short story. When I finish, I want you to tell me as much of the story as you can remember. Try to remember it in the same words as I have used: "Joseph / Green / left his house / and headed for the subway. / He was on his way / to the supermarket. / He purchased / wine, / steak, / and ice cream. / Later that day / he had dinner / with his boss / from the office." Now, tell me as much of the story as you can remember.

A completely verbatim response is not necessary, because neuropsychologists are mostly interested in whether the individual has formed a memory. For example, an acceptable substitution for /steak/ is "meat" or "beef."

Neuropsychological Tests (Memory)

To provide thorough coverage of the varieties of memory disabilities, researchers have developed batteries of memory tests. One of the memory assessment instruments most frequently used by neuropsychologists is the Wechsler Memory Scale (WMS; first introduced by Wechsler in 1945), which is now in its third revision (WMS-III). The WMS consist of seven subtests, which include personal and current information, orientation, mental control, logical memory (which tests immediate recall of two verbal stories), digit span, visual reproduction (an immediate visual memory drawing task), and associate learning (which requires verbal retention). The WMS is sensitive to memory disorders and memory defects associated with aging.

JUDGMENT/PROBLEM SOLVING

A patient's ability to use abstract reasoning relates, in part, to his or her capacity to understand concepts. In determining a patient's ability to use abstract reasoning, the neuropsychologist examines the patient's ability to generalize from one situation to another. This skill is known as "transfer of learning." For example, if a rehabilitation patient can learn to transfer from the mat to the wheelchair with minimal assistance during physical therapy, one would normally expect the same patient to be able to generalize that skill from the physical therapy wing of the hospital to the nursing wing. Otherwise, the patient's learning is circumstantial.

Often, neuropsychologists are interested in evaluating insight specific to the patient's capacity to realize the implications of his or her disorder. At times a patient presents to a neuropsychologist, and says, "I'll be fine as soon as I get home," or "There is nothing wrong with me, I can drive a car." Initially, the neuropsychologist will measure his or her own evaluation against those by other team members. For example, if the patient has had a mild stroke and is hindered only by his or her own dislike of the hospital setting, it may be true that the patient will be "fine" on discharge. If the patient has experienced a moderate or more severe brain injury, the patient's communication may be evaluated as demonstrating lack of insight. One of the jobs of the neuropsychologist is to evaluate the insight that a patient has regarding the nature and the implications of his or her own disability.

Neuropsychological Items (Problem Solving)

You can evaluate higher order cognitive functioning and abstract thinking skills by asking the patient to interpret proverbs, solve everyday problems, or perform mental arithmetic. For example, you can assess abstract reasoning by asking a patient to interpret a common proverb, scoring responses based on degree of abstraction. Proverb interpretations are a traditional feature of the neuropsychological examination, assessing the ability to reason beyond the concrete level. For example, "What does this saying mean: 'You can't judge a book by its cover?'" An abstract answer may be, "Don't judge a person by their looks"; a

Figure 3.13 Example of a visual absurdity. (Reproduced from Zillmer, E. A., Chelder, M. J., & Efthimiou, J. [1995]. *Assessment of Impairment [AIM] Measure.* Philadelphia: Drexel University.)

concrete answer may be, "You don't know what is inside the book just by looking at its cover."

A common way to assess concept formation is to use a similarities/differences paradigm or analogies. The following items involve the abstract categorization of objects and concepts. They assess whether the patient can determine the appropriate abstract links between the objects and discriminate form and function: "How are an eagle and a robin alike?" or "Please complete this sentence: 'Banana is a fruit, cat is an animal. Father is a man, mother is a . . .'"

Problem-solving tasks tap the patient's ability to formulate solutions to a common, everyday situation. Responses can often demonstrate impulsivity and poor social judgment, as well as decreased functional independence or a need for supervision. "What should you do if you can't keep an appointment?" Sometimes tests present absurdities to evaluate reasoning skills, attention to abstract details, and the ability to formulate an abstract verbal response: "What is strange about this sentence: 'When the cook discovered that he had burned the meat, he put it in the refrigerator to fix it'?" or "What is funny or strange about this picture?" (Figure 3.13).

Neuropsychological Tests (Problem Solving)

Neuropsychologists have been creative in developing assessment procedures that evaluate executive abilities, and literally dozens of tests measure this neuropsychological domain. Only a few are mentioned here. The Trail Making Test B, part of the Halstead–Reitan Neuropsychological Battery, requires the participant to draw lines to connect consecutively numbered and lettered circles by alternating the two sequences (1 to *A*, *A* to 2, 2 to *B*, and so on). This timed task necessitates complex visual scanning, motor speed, mental flexibility, and attention.

The Wisconsin Card Sorting Test (WCST) (Berg, 1948; Heaton, Chelune, Talley, Kay, & Curtis, 1993) is widely used to study "abstract behavior" and "shifting sets." The examiner gives the subject a pack of 64 cards on which are printed 1 to 4 symbols—triangle, star, cross, or circle, in red, green, yellow, or blue. No two cards are identical. The patient's task is to place them one by one under four stimulus cards according to a principle that the patient must deduce from the pattern of the examiner's responses to the patient's placement of the cards. For example, if the principle is color, the correct placement of a red card is under one red triangle, regardless of the number of symbols. Thus, the subject simply starts placing cards and the examiner tells him or her whether the placement is correct. After 10 cards have been placed correctly in a row, the examiner shifts the principle, indicating the shift only to the patient by the changed patterns of "right" and "wrong" statements. A poor performance on this test often suggests that the patient has trouble organizing his or her own behavior or has difficulty applying one set of rules to different situations. The WCST is a sensitive neuropsychological measure, particularly for injuries to the frontal lobes.

Culbertson and Zillmer (2005) designed the Tower of London–Drexel University (TOL^{dx}) as a neuropsychological measure of executive planning and problem solving based on the original Tower of London (Shallice, 1982). The TOL^{dx} measures executive planning that involves the ability to conceptualize change, respond objectively, generate and select alternatives, and sustain attention (Lezak et al., 2004). The frontal lobes, in systematic interaction with other cortical and subcortical structures, support executive planning. The TOL^{dx} test materials include two identical tower structures (Figure 3.14), one for the subject and one for the examiner to use. Each structure consists of three pegs of descending lengths and three colored beads that the patient can place on the pegs in different configurations or patterns. The examiner asks the subject to move the beads of his or her tower structure to match

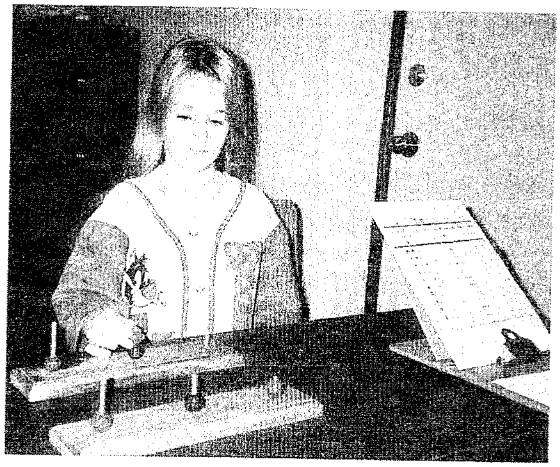


Figure 3.14 Administration of the Tower of London–Drexel University test, which evaluates frontal lobe functioning, that is, anticipatory-, pre-planning, and goal-oriented planning. (Courtesy Eric Zillmer.)

bead configurations that the examiner presents. In solving the bead patterns, the subject must adhere to two strictly enforced problem-solving rules: Only move one bead at a time, and do not place more beads than fit on each peg. The examiner records number of moves, rule violations, and time the subject uses in solving the bead patterns. Interpreting the subject's performance involves an analysis of both quantitative and qualitative variables. Empirical studies (Culbertson & Zillmer, 2005) show that the TOL^{dx} is sensitive to a complex set of cognitive processes, including planning computations, working memory, mental flexibility, attention allocation, and response inhibition.

Symptom Validity Testing in Forensic Neuropsychology

Unlike traditional therapy clients, the potential monetary compensation associated with personal injury or insurance claims may motivate patients tested to exaggerate or distort their symptoms. For example, individuals suffering from neuropsychological dysfunction as a result of trauma frequently report problems in attention and memory. Therefore, neuropsychologists learn to assess for a client's response bias. Psychologists have had a long and rich history of evaluating deception (e.g., polygraph procedures, assessing feigning of somatic symptoms). Through the use of their expertise in psychometrics and test theory, neuropsychologists have generated assessment procedures to measure symptom validity.

Although symptom validity tests are commonly referred to as malingering tests, **malingering** is just one possible cause of invalid or biased performance. Test bias on the part of the client may range from outright malingering and conscious distortion of test performance to subtler, nonoptimal approaches to his or her performance, such as exaggeration. Thus, the neuropsychologist must also be expert in evaluating the test-taking approach and motivation of each individual. In some instances, these biased test-taking approaches actually stem from the patient's neurologic symptoms. For example, patients with right parieto-occipital stroke often have limited insight into their condition.

According to the *Diagnostic and Statistical Manual of Mental Disorders,* Fourth Edition (DSM-IV) (American Psychiatric Association, 1994, p. 683), malingering is "the intentional production of false or grossly exaggerated physical or psychological symptoms, motivated by external incentives such as avoiding military duty, avoiding work, obtaining financial compensation, evading criminal prosecution, or obtaining drugs." Thus, it has become a standard procedure for neuropsychologists to perform an assessment of malingering when performing independent neuropsychological evaluations (Zillmer, 2004; Zillmer & Greene, 2006), for example, using the Test of Memory Malingering (TOMM) (Tombaugh, 1996, 2003).

NEUROPSYCHOLOGICAL DIAGNOSIS

With the advent of modern medical diagnostic procedures (see Chapter 2), including single-photon emission computed tomography (SPECT), MRI, CT, positron emission tomography (PET), angiography, and evoked potential, using behavior-based assessments to diagnose organic-functional causative factors has become less essential. It has become less important for neuropsychologists and psychologists to act in the capacity of "lesion detectors" and more important to document the precise effects of brain dysfunction on behavior for purposes of remediation and treatment (Zillmer & Perry, 1996). Nevertheless, clinical neuropsychologists continue to figure prominently in uncovering the behavioral syndromes that correspond to impaired brain regions and neuronal circuits and may play an important role in diagnosing neuropathologic conditions (e.g., see Goldman-Rakic & Friedman, 1991).

Medical teams still ask clinical neuropsychologists to aid in diagnosis, not merely confirming what might appear on PET or MRI images, but adding behavioral and descriptive information about a patient's cognitive strengths and weaknesses. If a neurologist wants to know whether a patient has had a left hemisphere stroke, a CT scan or an MRI can show this. Neuropsychological testing would be redundant and not as precise as sophisticated imaging equipment for exactly locating the lesion within the brain. Imaging technology, however, does not provide information about how brain damage may affect behavior. Clinical neuropsychologists provide invaluable and unique diagnostic information in areas where behavioral information provides an important piece of the diagnostic puzzle. Those areas include the diagnoses of mild head injury, attention-deficit/hyperactivity disorder, learning disability, or AD. Currently available imaging techniques are not sufficient to diagnose AD. Brain biopsy after death is the only certain method. Thus, Alzheimer's dementia is a diagnosis largely determined by behavioral methods. Through careful observation and history taking with the patient and family, the neuropsychologist documents the extent and probable progression of the behavioral deterioration. Then, through repeated evaluations spread out over time, the neuropsychologist charts the severity and course of the neuropsychological impairments. If the team can rule out all other medical causes of dementia, then the person can be diagnosed as having "possible" or "probable" AD. In fact, the diagnosis of most dementia subtypes requires close collaboration between neurologists and neuropsychologists (see Chapter 14).

Mild-to-moderate head injuries also present diagnostic issues that neuropsychology can help clarify. With many head injuries, particularly of the mild variety (such as concussion), it is not immediately evident whether the person has actually sustained a brain injury. In many cases, the diagnostic aim of the neuropsychological evaluation is to determine the presence and severity of brain injury. The diagnosis is made, not to answer the outdated question, "Is this patient 'organic'?" but to answer the question, "Does this neuropsychological profile fit with what is known about the neuropsychological pattern of impairment after closed head injury?" CT and MRI may not show microscopic shearing, tearing, stretching, and bruising of axons. Even if they did, you could not predict clear behavioral symptoms from looking at radiologic or imaging data. As in AD, behavioral testing largely determines the diagnosis and severity of brain damage after closed head injury. Thus, neuropsychologists play an important role in determining patterns of neuropsychological dysfunction characteristic with a variety of central nervous system disorders. In addition, and to address the entire diagnostic picture, many neuropsychologists conduct comprehensive examinations of emotion and personality, to understand how the patient is adapting. For example, they not uncommonly diagnose depression or significant deficits in stress tolerance in patients who have experienced a head injury. The neuropsychologist's diagnostic skills as a psychologist helps differentiate between the impact of emotional/personality problems and brain dysfunction.

Neuropsychological diagnosis remains an important component of the neuropsychologist's role. However, diagnosis usually is not the only question of interest when a patient seeks neuropsychological testing. The next section discusses certain other issues that practicing neuropsychologists address.

DESCRIBING FUNCTION, ADAPTATION, AND PROGNOSIS

Describing behavioral functioning—that is, a patient's cognitive strengths and weaknesses—puts the "psychology" into neuropsychology. Psychology is the science of behavior; neuropsychology is the science of brain–behavior functioning. Although neuropsychology combines neurologic and psychological foci, the neurologic goal of detecting and classifying lesions dominated clinical neuropsychology through the 1970s. Since then, emphasis has shifted to a more behavioral focus, assessment of the human person, ranging from assessing cognitive abilities to evaluating quality-of-life indicators. In this approach, the goal as a clinical neuropsychologist is to describe brain–behavior functioning in such a manner as to accurately depict the current and future adaptive capabilities of the individual. Such information is important in evaluating the rehabilitation needs of a patient to facilitate adaptive functioning and prognosis, or in assessing the degree and type of assistance needed in the home and work environments. This chapter addresses these important issues in neuropsychological description, its similarities to and differences from generic psychological description, how it seeks to describe current adaptation in the real world, and how neuropsychologists use it to predict the course of recovery or decline of an individual.

Interpreting Neuropsychological Assessment Data

By now it should be obvious that the neuropsychological examination is a complex undertaking. Not only are no two patients alike, but how neuropsychologists administer the tests and which tests they select often differ. In addition, many procedures we have reviewed measure more than one functional domain, making it difficult to interpret the neuropsychological construct and cause underlying an impaired performance. This section presents an overview of interpretative guidelines for the neuropsychologist.

We provide quantitative and qualitative dimensions of neuropsychological performance, as well as case studies; elucidate neuropsychological diagnosis; and detail evaluation. Although this depends on the specific referral question, the clinical neuropsychologist is primarily interested in generating **interpretive hypotheses** about the patient and in answering specific questions about the test data, including the following:

Is there any cerebral impairment?
Evidence of behavioral deficits?
Behavioral changes caused by lesion?
How severe is the injury?
Is the injury medically significant?
Does the injury impair the person's ability to function in his or her daily activities?
Is the lesion progressive or static?
Is the lesion diffuse or lateralized, or are there multiple lesions?
Is the impairment anterior or posterior? Can it be localized?
What is the most likely pathologic process? What is the prognosis?
What are the individual's cognitive/behavioral strengths and weaknesses, and how do they relate to daily living skills, treatment, and rehabilitation?
Do the neuropsychological deficits influence the patient's quality of life?
What is the patient's reaction to the injury and/or impairment?

APPROACHES TO NEUROPSYCHOLOGICAL INTERPRETATION

Clinicians disagree somewhat in their approach to neuropsychological interpretation. These differences center on both practical and theoretical test issues and have become a source of debate. In making determinations regarding the evolution of a specific assessment and interpretation approach, practical and theoretical issues are often intertwined. A typical example is test selection and time needed for completing the neuropsychological examination. Neuropsychologists usually broaden information regarding a patient by administering a wider range of tests (such as memory, motor, learning, and language); they deepen information by administering a number of tests examining varying aspects of the same cognitive domain (such as selective attention or sustained attention). They must balance these theoretical considerations against the practical reality of examination length. Many patients cannot tolerate long testing sessions because of fatigue effects. Given the current climate in which managed health care reduces specialized services to patients, most clinicians are also concerned about cost-effectiveness in time spent on evaluating the patient.

The approaches presented here include the major strategies of neuropsychological assessment and interpretation from which numerous variations have developed. We discuss the pros and cons of each approach in regard to both theoretical and practical issues.

Standard Battery Approach

Halstead (1947) and Reitan (1966) pioneered the use of a **standard battery approach** of tests for identifying brain damage. First, Halstead and Reitan identified tests that were sensitive to the integrity of cortical functioning. Then they sought to incorporate the evaluation of all the major cognitive, sensory, motor, and perceptual skills that a neuropsychological examination should reflect. The purpose of the Halstead–Reitan Neuropsychological Battery was to allow the development of various principles for inferring psychological deficit as applied to results obtained on individual subjects (Reitan & Wolfson, 1993). In this approach, the clinician gives the same tests to all patients, regardless of his or her impression of an individual patient or the referral question. Typically, a technician administers the neuropsychological procedures, rather than a doctoral-level psychologist, because the tests are administered according to standardized rules of procedure, without variations. Using technicians allows more testing for the same cost, because the more expensive time of a doctoral-level neuropsychologist is not needed.

This standard battery approach has several advantages. First, it can ensure that all subjects are evaluated for all basic neuropsychological abilities. This makes it unlikely that the diagnosis could overlook a condition of importance. Second, the neuropsychologist can use the data to identify objective patterns of scores that he or she can consider in diagnosing various neuropathologic conditions. Patterns within the data can help in diagnosing the probability of certain causes of brain dysfunction. Knowledge of causes can be useful in providing the patient, physician, or treatment team with tentative diagnoses, as well as in predicting the course of a disorder. Finally, the standard battery approach lends itself to the teaching of neuropsychological assessment and interpretation, because the beginning neuropsychology student need not make decisions about test selection, and the interpretation is objective and data driven. Finally, because the test instructions, test selection, and test interpretation are all standardized, this approach is particularly useful for empirical studies and facilitates comparison across different research projects.

There are also drawbacks to the test battery approach. The time involved in testing any patient can be considerable. Problems such as fatigue or loss of motivation may develop. The time involved forces the use of a testing technician to ensure a reasonable cost and reasonable use of the neuropsychologist's time. As a result, the neuropsychologist may have little contact with the patient outside of the interview and, thus, loses the opportunity to make a qualitative analysis of the patient's behavior. Obtaining qualitative impressions of the patient's appearance and behavior often is important, however. For example, we once observed a neuropsychologist who used the standard battery approach make an interesting misdiagnosis. This particular neuropsychologist strictly favored the neuropsychological battery approach and therefore typically did not interview his patients. He claimed that the subjective presentation of the case would "contaminate" his ability to make an objective interpretation. During a neuropsychological examination of a patient, the neuropsychologist's psychometrician indicated on her data summary sheet that the patient's performance on the Finger Tapping test was zero. The neuropsychologist proceeded to interpret this score as "severe, right-sided, upper extremity motor slowing with possible corresponding left hemisphere cortical dysfunction." But visual inspection of the patient would have made it obvious that the patient was not suffering from motor slowing and "brain damage"—instead, his right arm was amputated! The issue of using psychometricians to administer the neuropsychological tests remains controversial in contemporary neuropsychology.

The original choice of tests to include in the battery heavily influences standard batteries. The theoretical beliefs of the person doing the choosing often bias the choice. A poorly chosen test battery, no matter how many times it is given, will continue to yield unsatisfactory results. In different situations, alternate areas of assessment may be more effective in providing information. However, because the user of a standard battery gives no additional tests, he or she would never discover this. For example, the Halstead–Reitan Neuropsychological Battery does not include a memory test.

You can see a common problem of interpreting the empirical approach in composite tests that require the examinee to have a number of cognitive skills. For example, the Hooper Visual Organization Test (Hooper, 1983) requires the subject to name or write more or less readily recognizable cut-up objects. The Hooper consists of 30 stimuli. The maximum score is 30, and a score below 20 typically indicates "organic brain pathology." Because examiners think the measure primarily measures perceptual integration, a function often associated with right hemisphere function, they often interpret low scores as perceptual fragmentation most likely related to dysfunction of the right hemisphere. However, left hemisphere stroke patients often make low scores on this test, not related to impaired perceptual functioning, but related to the patient's impairment in naming objects. Thus, critiques of the battery approach often suggest that understanding why a patient failed a task is as valuable as that the person failed (Luria, 1966). Such information, they argue, often can be more useful than test scores in making intervention and diagnostic decisions. Furthermore, opponents of the empirical approach argue that complex behavior cannot and should not be reduced to a single number or test score. For example, the Hooper demands include comprehending the instruction; visually scanning the stimulus figure; mentally rotating the cut-up parts of the object to form a whole; and recognizing, naming, and articulating the object, either in writing or orally. Thus, this seemingly simple task actually requires the person to integrate a number of neuropsychological processes to generate a correct response.

The standard battery method also fails to recognize that altering a test procedure is sometimes valuable in determining a specific deficit. A standard battery may not be appropriate for all patients, especially when there are peripheral deficits, such as injury to the limbs, a serious visual loss, or spinal cord injury. Such patients' inability to complete a given test may reflect a peripheral motor or visual problem, rather than a dysfunction of the central nervous system. Consequently, data from such a patient on a standard battery may be useless for diagnosis, evaluation, and intervention. Finally, interpreting even a standard battery requires considerable skill, knowledge, and experience. Nevertheless, as standard rules and norms develop, standard batteries are somewhat easier to interpret and to teach.

Although the criticisms of the battery approach are valid, many psychologists remain faithful to administering a "core battery." Approximately 55% of neuropsychologists favor a flexible, modified battery approach, suggesting that the type of patient treated and the nature of the referral question play important roles in test selection.

Process Approach

The **process approach** to neuropsychological testing, often called the *hypothesis approach,* rests on the idea that the neuropsychologist should adapt each examination to the individual patient. Rather than using a standard battery of tests, the neuropsychologist selects the tests and procedures for each examination, using hypotheses he or she has made from impressions of the patient and from information available about the patient. As a result, each examination may vary considerably from patient to patient for length and test selection. The clinician may use standard tests, or may alter and adapt tests as he or she tries to form an opinion on the nature of the deficits (Christensen, 1979; Lezak et al., 2004). Altering tests to discover the patient's strategies is a popular method within the process approach to neuropsychological assessment (e.g., see Milberg, Hebben, & Kaplan, 1986). Many conclusions reached in the examination follow the clinician's qualitative interpretations of the test results and the patient's behavior. The clinician also grounds the conclusions on his or her experience and knowledge of the clinical literature. The principal developers of the process approach are Alexander Luria and Edith Kaplan.

The process approach has several advantages. First, it acknowledges the individual nature of the patient's deficits and seeks to adapt the examination to this individuality. Under the proper condition, such a technique can yield more precise measurements of a subject's skill on a given ability than just the patient's score on a given test. Second, the examination can concentrate on those areas the neuropsychologist sees as most important for the patient. It can ignore areas not important for the patient's prognosis. Because the time for any examination is limited, this enables the clinician to more thoroughly investigate significant areas.

Perhaps most important, the flexible/process approach emphasizes in what manner a patient fails or succeeds in a specific cognitive task. For example, a patient is unable to answer the question, "What is the capital of the United States?" Does this relate to the patient not understanding the question (speech comprehension), does it indicate an inability to answer verbally (expressive aphasia), or does the patient not know the answer (poor factual knowledge)? The standard battery approach does not allow a deviation from the standard instructions of the test, because deviating would invalidate the results. If the patient is unable to answer the question, the process approach allows for further investigation. For example, the examiner can show the patient a multiple-choice card with the answer and several wrong alternatives. If the patient points to the correct answer, "Washington, D.C.," the neuropsychologist would interpret this response as meaning that the patient knows this factual knowledge but cannot express this information either verbally or in writing. Thus, the process approach lets the clinician concentrate on tasks related to the most important deficits that the patient exhibits.

The process approach also has several disadvantages. Because the content of the examination emphasizes areas that the clinician believes are important, the examination may selectively confirm the clinician's opinion. Because the clinician may never test areas that he or she sees as irrelevant, no one may realize that a deficit has been missed. Because the test's focus is just on the patient and his or her expected problems, the data may be biased toward confirming the original hypothesis. Thus, many neuropsychologists believe this more subjective approach relies willy-nilly on clinical experience, hunches, colleagues' anecdotes, intuition, common sense, folklore, and introspection (Meehl, 1973).

Using tests not standardized for a clinical population, or tests that have been adapted, also presents potentially serious problems. The interpretation of a test that has not been adequately standardized is always questionable. The clinician's subjective impression of what a score should mean for a given patient may be quite wrong. A test that appears to measure one thing in a normal population may measure something entirely different in a brain-injured population. In each of these situations, the accuracy of the individual clinician's judgment becomes the accuracy of the test. Thus, in the process approach, the opinion of the clinician is as good as his or her reputation. Currently, no measures of such accuracy exist, but probably this varies considerably among clinicians.

The use of different examinations and procedures for each patient precludes the experimental validation of individual tests in applied clinical settings. It also precludes evaluation of the process as a whole, because conclusions do not come from test scores, but from the clinician's judgments. Clinicians may, in such a situation, continue using an ineffective test because it appears to work. The process approach, therefore, does not lend itself to large-scale research, but often relies on case studies.

Structuring an examination on an individual basis may mean that it assesses only some of the basic functions mediated by the brain. Rehabilitation and prognosis depend on the state of the brain as a whole; the lack of information on the entire brain can impede an intervention program or invalidate a prognosis. In practice, it is not unusual to see patients with secondary deficits that appear unrelated to their primary referral problem and to the impression that the patient gives. For example, it is not unusual for a patient with a major stroke to have had smaller, secondary disorders of cerebral circulation. The deficits might have existed before the patient's current

Table 3.4 ***Summary and Comparison of Approaches to Neuropsychological Interpretation***

Standard Battery Approach	Process Approach
Same tests or "core battery" given to all	Examination administered by a neuropsychologist
Tests administered according to standardized rules	Tests not administered in a standard way
Interpretation based on standardized norms	Conclusions based on clinical experience
Advantages	
Comprehensive evaluation of abilities	Acknowledges the individuality of patient
Objective interpretation based on normative data	Examination focuses on most important deficits
Facilitates teaching because of standard rules/norms	Emphasizes how a task is failed or solved
Useful for empirical studies	Useful for clinical case studies
Disadvantages	
Time demanding and labor intensive	Test procedure may be biased by clinician
Tests only as good as standardization	Opinion of the clinician is subjective
Relatively inflexible approach to testing	Difficult to teach, because it requires experience
Scores may not reflect a single cognitive process	Does not lend itself to large-scale research

problem arose. Whatever the source of the deficits, the clinician must identify and consider them in making any recommendations for a client. Finally, the flexible/process approach is more difficult to teach to students, because few "rules" and "procedures" exist. Test selection, adaptation, and interpretation depend largely on extensive clinical experience. This approach is also time-consuming, because the neuropsychologist, rather than a technician, must perform the evaluation. Table 3.4 reviews the advantages and disadvantages of the standard battery and process approaches.

Paul Meehl, a preeminent psychodiagnostician and former president of the American Psychological Association, addressed the complex decision-making process involved in psychological assessment. In 1957, he wrote the now-classic essay entitled "When Shall We Use Our Heads Instead of the Formula?" (1973). With this question he examined the rationale for when to use more empirical (psychometric) compared with more clinical approaches (qualitative) to psychological assessment, interpretation, and diagnosis. By the term *formula*, Meehl implied the scientific, empirical, and data-driven approach to psychology, consistent with those neuropsychologists who favor the fixed battery approach. By "using our heads," in contrast, Meehl was referring to the more clinical, commonsense, approaches typically used by the process approach in neuropsychology. Meehl suggested that the two answers to his question—"Always" and "Never"—were equally unacceptable. He also proposed that it would be silly to answer, "We use both methods; they go hand in hand." If the formula and your head invariably yield the same predictions about an individual, you should use the less costly method, because the more costly one is not adding anything. If the methods *do not* always yield the same prediction—and most empirical studies show that they do not—then the psychologists cannot use both, because they cannot predict in opposite ways for the same patient.

This discussion remains a central theme in any type of psychological assessment, although the empirical approach has been increasingly refined since Meehl wrote his famous paper. Empirical and theoretic considerations suggest that the field of neuropsychology would be well advised to continue to concentrate efforts on improving actuarial techniques, rather than to focus on calibrating each clinician for each of many different diagnostic problems. In the meantime, neuropsychologists continue to make descriptions, interpretations, and predictions about human behavior. How should neuropsychologists be making interpretive decisions? Should they use the process approach, or should they follow the empirical, psychometric approach? Mostly, neuropsychologists will use their heads, because researchers have not developed adequate empirical batteries for every type of neuropsychological problem. In those cases in which there are good empirical approaches to neuropsychological problems (as in estimating intelligence), they should use an empirical approach. What if there is a case in which the formula disagrees with the clinical opinion of the process approach? Which approach should neuropsychologists use then? Meehl, a staunch scientist, suggested that in such a situation, they should use their heads very, very seldom—

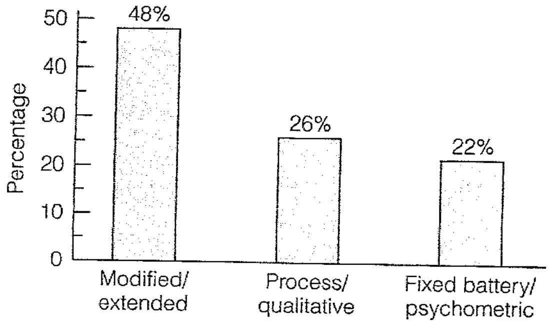


Figure 3.15 Approaches to neuropsychological test interpretation. (Reproduced from Gordon, A., & Zillmer, E. A. [1997]. Integrating the MMPI and neuropsychology: A survey of NAN membership. *Archives of Clinical Neuropsychology, 4,* 325–326, by permission of Elsevier.)

except, of course, if the issue is as clear as a broken leg or amputated arm.

Considerable controversy has raged about the preceding approaches to performing and interpreting a neuropsychological evaluation. Although there are certainly schools of thought about this, almost 50% of neuropsychologists report using parts of both approaches (Figure 3.15). That is, a majority of neuropsychologists use a modified battery approach, in which they choose specific tests to answer a referral question. They may interpret some tests in an empirical fashion and other test behavior in a more qualitative way. Approximately 25% report that they strictly adhere to a standard/fixed battery approach or a process/qualitative approach.

We caution the neuropsychology student that diagnostic and treatment decisions warrant integrating data drawn from a number of sources, including neuropsychological measures, pertinent neuromedical findings, and the patient's developmental and medical histories. Neuropsychologists typically do not render diagnostic decisions based on a single neuropsychological measure. Obviously, site, nature, and severity of the injury/disease process, premorbid personality, and a host of other moderating variables affect neuropsychological test performance. Interpreting the neuropsychological data requires a thorough understanding of neuropsychological principles, developmental findings, and psychopathology.

Interpretation of the neuropsychological protocol can then proceed through several levels of analysis, including the following:

- Overall level of impairment
- Pattern of impairment
- Lateralizing and localizing signs
- Qualitative observations

Once interpretation proceeds through these levels, the neuropsychologist can then evaluate test data to determine consistency with a patient's known medical conditions and presenting diagnoses, as well as to predict functional abilities and limitations.

ASSESSING LEVEL OF PERFORMANCE

Use of Norms in Neuropsychology

The use of norms in neuropsychology entails comparing an individual's test scores and available **normative data.** This approach provides the neuropsychologist with information regarding an individual's ability in comparison with others. This method compares the patient's score on a test to an expected score, or norm. The method determines the expected test score from the performance of a normative sample of patients and control subjects. Such norms may take into account such factors as age, sex, education, and intelligence. Many neuropsychological tests have a **cutoff score.** A patient scoring worse than the cutoff score is labeled as impaired; a patient scoring better is labeled as within normal limits.

The selection of any specific cutoff point relates to factors of test **specificity** and test **sensitivity.** When seeking to identify people whose cognitive abilities are abnormal (e.g., brain damage), neuropsychologists prefer a sensitive test. In such cases, they set the cutoff score so that as few errors as possible arise in classifying a disease entity. However, sensitive tests that rely on measuring impaired cognitive functioning may also include false-positive errors, for example, erroneously identifying psychiatric patients as brain damaged. Such a test is of little value to the neuropsychologist, who wants to delineate the precise nature of a patient's deficits. Rather, the clinician needs tests that examine specific aspects of neuropsychological functions; that is, tests that have high specificity. Such tests may assess more general areas of cognitive functioning, including sustained attention or immediate memory. But they may miss patients who have impairments outside of those specific areas of cognitive functions, which results in false-negative errors. Of course, tests that have high sensitivity and high specificity are most useful in neuropsychology. In reality, there is always a tradeoff between aspects of how specific a procedure is versus its usefulness as a sensitive test. Thus, neuropsychologists often set cutoff scores at an intermediate point at which the chances of misclassifying either impaired performance or normal performance are about equal.

Statistical Approaches

When administering a battery of tests, it is important to be able to compare performance on tests that measure widely different skills. As you gain enough experience with a set of tests, this skill often becomes automatic. However, the easiest way to accomplish this task is to use standardized scores rather than raw scores. A raw score is a score that is presented in terms of the original test units. It is simply the number of items passed or points earned. A standard score, in contrast, is a derived score that uses as its unit the standard deviation of the population on which the developers standardized the test. Thus, a standard score is a deviation score. A standard deviation relates to the variability or scatter of test scores. This pattern is known as a *distribution* of test scores. The normal probability distribution (also known as the *bell-shaped curve*) represents the frequency with which many human characteristics are dispersed over the population. For example, intelligence and spatial reasoning ability are distributed in a manner that closely resembles the bell-shaped curve.

In the **normal distribution,** 68.2% of all cases fall between ±1 standard deviation (SD) from the mean, 95.4% of the cases fall between ±2 SD from the mean, and 99.7% of the cases fall within ±3 SD from the mean. The normal distribution is the basis for the scoring system on many standardized tests. For example, on the Scholastic Aptitude Test (SAT), the developers set the mean at 500 and the standard deviation at 100. Hence, SAT scores reflect how many SDs above or below the mean a student scored. For example, a score of 700 means that you scored 2 SDs above the mean, exceeding approximately 97% of the population on which the test is normed. Thus, test scores that place examinees in the normal distribution can always be converted to percentile scores, which are often easier to interpret. A percentile score indicates the percentage of people who score below the score you obtained. For example, if you score at the 60th percentile, 60% of the people who take the test scored below you, and the remaining 40% scored above you. Tables are available that permit transformation from any SD placement in a normal distribution to a percentile score.

Neuropsychologists use a variety of standard scores. They determine standard scores by a mathematical formula that can convert raw scores from tests to a standard scale. For example, Table 3.5 lists commonly used standardized scores in clinical neuropsychology.

Table 3.5 ***Examples of Different Standardized Scores***

Name of Standardized Score	Mean	Standard Deviation	Tests Used
Z-score	0	1	None
Sten score	5	1	16 personality factors
Scaled score	10	3	Wechsler subtests
T-score	50	10	Minnesota Multiphasic Personality Inventory, many norms
Standard score (SS)	100	15	Wechsler Intelligent Quotient scores

Once you know the test score frequency of a neuropsychological measure, you can easily compute a standard score. For example, determine the standard score (SS) by first subtracting the mean score from a normative group for a test from the person's actual score. Divide the result by the SD of the scores in the normative sample. Multiply this result by 15 (the SD), and add 100 (the mean) to this answer. The formula for standard score is as follows:

$$\text{SS} = 100 + \frac{\text{(Score obtained minus average normative score)}}{\text{Standard deviation (normative sample)}} \times 15.0$$

The standardized score approach to neuropsychological assessment has several advantages. First, all scores are roughly comparable. Second, you can make adjustments for such factors as age and education. You do this by determining normative means and SDs for different age or educational levels. You can then include the normative scores corresponding to a given person's age or education. Of course, not all neuropsychological measures result in normal test distributions. Some distributions skew in one direction or another. Some neuropsychological tests, particularly those that the process approach favors, are relatively "easy." That is, most "intact" individuals would have few problems passing the test. For example, "On a plain piece of paper, draw a clock with all the numbers and the hands of the clock positioned at 10 minutes after 11." Most individuals would pass this task, but patients with disturbances in visuospatial perception or planning ability may "fail." Thus, the resulting test score distribution is dichotomous (pass/fail) and does not present a normal distribution. It is inappropriate to calculate standard scores from such a test distribution. A great pitfall of the statistical approach to neuropsychological interpretation is that developers have transformed to standard scores many tests that are not normally distributed, thus providing inexact estimations of performance.

Neuropsychology in Action 3.1

Case Example: The Neuropsychology of Lyme Disease

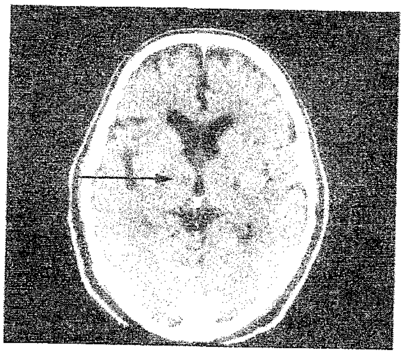
by Eric A. Zillmer

David was an active, 66-year-old, right hand-dominant, married man who had completed 11th grade before joining the U.S. Armed Forces. Before retiring, David was employed as a medical technician in a psychiatric hospital. His wife, a nurse, was his supervisor. In August 1992, David began experiencing periods of blurred vision, headaches, nausea and "feeling ill all over, as if I was coming down with the flu." The family doctor suspected a heart problem because David had a history of mild hypertension and angina beginning in 1987, but a 24-hour electrocardiogram (EKG) monitor showed no heart malfunction. Over the next month, David experienced five similar episodes. Then, in September 1992, he awoke with numbness and weakness on the right side, as well as slurred speech, and was subsequently hospitalized. Initial neurologic findings indicated that David was awake and alert with dysarthria and right hemiparesis. The examiner noted periods of paralysis, with the comment that the patient felt "locked in" when these occurred. Physicians at the hospital diagnosed him as having had a transient ischemic attack (TIA; see Chapter 12). After a 10-day course of treatment, the patient was sent home. Hospital records noted that he was "fully recovered" at this point.

MRI of the brain suggested prominence of the ventricular system and subarachnoid spaces consistent with moderate atrophy. The report also noted mild white matter changes on the periventricular region. CT and MRI films of the coronal (Figure 3.16) planes showed a subacute cerebellar infarct (stroke). CT scans of the head, without intravenous contrast infusion, confirmed the atrophy and previously visualized infarct in the left cerebellum. Repeat CT scan of the head without contrast 3 weeks later showed an additional new small infarction in the left thalamus (see Figure 3.16). Intracranial and neck angiogram sequences revealed no stenosis of the right or left carotid artery bifurcations. Taken together, radiologic data suggested moderate atrophy, postacute left cerebellar infarct, a small left thalamic infarct, and minimal thickening of the common, internal, and external carotid arteries. The radiologic studies did not indicate the presence of intracranial hemorrhage or any significant stenosis or plaque in the right or left carotid system. Electroencephalogram showed no definite focal or epileptogenic features.

David continued to have episodes of nausea and blurred vision, and in October 1992, he was again hospitalized with right hemiparesis, dizziness, and slurred speech. Initial diagnosis was that he had suffered another TIA. He was experiencing projectile vomiting and had episodes of high fever and brief periods when he could move only one eye. He also had behavioral digressions during which he would not recognize anyone and would pull out his IV tubes and exhibit other strange behaviors until he had to be restrained to the bed. The medical staff was mystified as to the causes of David's symptoms.

A few weeks into David's treatment, the Centers for Disease Control and Prevention (CDC) notified the hospital that David had tested positive for Lyme disease. Puzzled by the cause of David's symptoms, his family doctor previously had taken a blood serology before the second hospitalization and forwarded samples to the CDC. David was given a course of treatment appropriate for



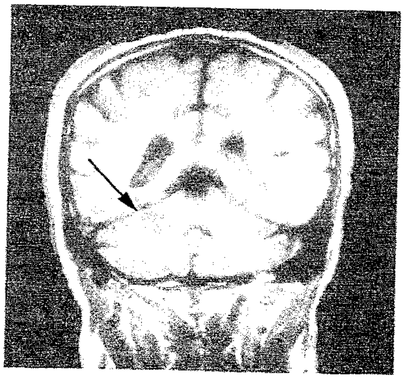


Figure 3.16 Horizontal computed axial tomography scan (top) showing infarction in left thalamus. Coronal magnetic resonance image (bottom) demonstrating subacute cerebellar infarct, as well as moderate atrophy. (Courtesy Eric Zillmer.)

DEFICIT MEASUREMENT

Deficit measurement, as an approach, is standardized and group oriented. It is useful for understanding general conditions and disease states. By comparing a person with "the norm," you can determine statistically probable deficits. By examining a battery of tests, you can examine an individual's pattern of strengths and weaknesses. You can compare these with known, general profiles. But clinicians are also concerned with the uniqueness and dynamic qualities of each individual. The adaptive approach to neuropsychology mirrors developments in other areas of psychology. To paraphrase Howard Gardner, the Harvard psychologist, neuropsychologists should not be asking, "How smart is this person?" but "How is this person smart?" In clinical neuropsychology, the focus is not only both stroke and Lyme disease. As a result, David's strange symptoms abated and have not returned, though the hemiparesis and dysarthria remain. The hospital physician did not agree that Lyme disease was responsible for David's symptoms. David was discharged to a rehabilitation hospital for continued care, where he was referred for neuropsychological testing to evaluate his cognitive status and his ability to participate in speech and physical therapies. Table 3.6 reviews the results of the neuropsychological battery.

David exhibited generalized deficits, with impaired performance across cognitive areas. His performance on the neuropsychological tests indicated impaired attentional capacity, motor slowness, weakness in the nondominant upper extremity (the patient was unable to use his dominant hand), impaired fine-motor ability, left auditory suppressions, impaired visuoconstructional ability, deficient spatial memory, and poor executive functioning. David's memory performance demonstrated slightly impaired verbal recall, moderately impaired visual recall, and moderately to severely impaired delayed recall for both verbal and visual material. His intellectual performance, as measured by the Wechsler Adult Intelligence Scale, Third Edition (WAIS-III), was in the Low Average range. David's IQ scores indicated slightly higher verbal than performance ability, again partially because of his right hemiplegia, but also because of impaired perception of visual material, especially visual details. The visual impairment was further documented by his borderline performance on the Hooper Visual Organization Test. On the Wisconsin Card Sorting Task, David failed to complete any categories and used the maximum possible number of trials to complete the test. Results of clinical personality testing (Minnesota Multiphasic Personality Inventory [MMPI]) did not indicate significant psychopathology or psychological dysfunction. However, factors reflected in the protocol did suggest susceptibility to developing psychological problems including denial, somatic concern, and tension. Individuals with similar profiles are often mildly dysphoric, pessimistic about the future, and difficult to engage in psychological therapies because of their defensiveness and lack of insight.

The neuropsychological evaluation did not shed any light on whether Lyme disease was the "culprit" for David's medical problems (for a more detailed description of the clinical, radiologic, and neuropsychological manifestations of Lyme disease, see Bundick, Zillmer, Ives, & Beadle-Lindsay, 1995). David's case analysis demonstrates that psychological and neuropsychological assessment may serve to aid in the more definitive diagnosis and improved intervention/rehabilitation of patients exhibiting complex symptoms.

Table 3.6 ***Neuropsychological Profile of Patient with Lyme Disease***

Age, years	66
Sex	Male
Education, years	11
Occupation	Retired medical technician
Intellectual functioning (WAIS-III)	
Verbal IQ	91 (31)
Performance IQ	84 (28)
Full Scale IQ	87 (27)
Abstract reasoning, cognitive efficiency, mental flexibility	
TMT A (seconds)	109 (26)
TMT B (seconds)	255 (35)
Wisconsin Card Sort (in perseveration errors)	65 (34)
Memory: WMS-R	
Logical Memory I	19 (36)
Logical Memory II	5 (11)
Motor speed and coordination	
Finger Oscillation DH	Not attempted
Finger Oscillation NDH	31 (29)
Grooved Pegboard (seconds) DH	Not attempted
Grooved Pegboard (seconds) NDH	154 (34)

Note: WAIS-III = Wechsler Adult Intelligence Scale, Third Edition; IQ = intelligence quotient; TMT = Trail Making Test; WMS-R = Wechsler Memory Scale–Revised; DH = dominant hand; NDH = nondominant hand.
T-scores in parentheses from Heaton, Grant, and Matthews (1991).

on the level of deficits and strengths to describe functioning; for example, "How adapted (normal) is this person?" but also, "How does this person adapt to his or her condition?" Neuropsychologists should question what is lost in terms of understanding the brain if they do not consider the range and extent of individual adaptations to injury, tumor, and disease.

Differential Score Approach

The deficit measurement approach compares a patient's score on two tests. One test is theoretically highly sensitive to brain damage (e.g., a new problem-solving task); the second is theoretically insensitive to brain dysfunction (e.g., a measure of factual language). The insensitive test is supposed to reflect the individual's ability before any brain injury occurred, whereas the sensitive test reflects the effects of brain damage. If the sensitive test score is significantly worse, the neuropsychologist assumes the difference is caused by a brain injury. In general, you combine two test scores to get a single score measuring their difference. You may accomplish this by simply subtracting or dividing one score by the other. Then analyze this single score by treating it as described in earlier in the Assessing Level of Performance section.

Pattern Analysis

A modification of the differential score approach is **pattern analysis,** which examines the relationships among the scores in a test battery. It seeks to recognize patterns consistent with specific injuries and particular neurologic processes and has value in identifying mild disorders that cause relatively little disturbance in level of performance. For example, in early stages of Alzheimer's dementia, neuropsychologists would expect a deficit in memory functioning compared with performance on verbal tests, which may be relatively normal. If you plot all the neuropsychological data on a standardized norm worksheet, a profile of cognitive skills may emerge. You can then observe the interrelationships among these differing cognitive skills areas. A basic method of pattern analysis involves observing strengths and weaknesses in the highest and lowest scores. You can evaluate cognitive strengths and weaknesses relative to the normative group by observing which scores fall above, below, or within the average range. You can also determine strengths and weaknesses relative to the individual's specific profile. Again, high and low scores are highlighted, but without regard for where they fall relative to the normative sample. Finally, you can integrate information about cognitive strengths and weaknesses with therapeutic suggestions to family and the treatment team to improve the patient's recovery.

The differential score method and pattern analysis have the advantage of recognizing that each individual starts at a different level of performance. Thus, it avoids error of misclassifying all people with low ability as "brain injured." However, this approach has several potential sources of error. First, a sensitive test may fail to reflect the impairment present. Currently, no test is sensitive to all forms of brain dysfunction. Second, the brain injury may lower a score on an insensitive test. Because all abilities depend on the brain, brain damage can affect all abilities. No test is fully insensitive to brain injury. Finally, relatively little is known about specific patterns of deficits that correlate with specific neurologic disorders, or how to set any cutoff points to identify those conditions.

LATERALIZING SIGNS

The two cerebral hemispheres control the contralateral sides of the body for most sensory and motor behaviors. If one side of the body performs significantly worse than the other, the opposite hemisphere may have been injured. Lateralizing signs are specific test results or behaviors that suggest right or left cerebral hemisphere dysfunction. This approach resembles the differential score approach in that one side of the body serves as the control for the other. Generally, you subtract the scores from the two sides of the body to obtain a single difference score. You then treat this score as described in the level-of-performance approach. This approach may yield inaccurate conclusions, however, when an injury involves both hemispheres, or when an injury to the spinal cord is involved, because such injuries may also cause lateralized motor or sensory deficits or impair performance bilaterally.

PATHOGNOMONIC SIGNS (QUALITATIVE OBSERVATIONS)

Examining **pathognomonic signs** is a method that clinical neurologists commonly use. In the medical model, the clinical examination often assumes that specific, distinctive characteristics of a disease or pathologic condition can be detected. These signs or symptoms are often labeled *pathognomonic* (derived from Greek meaning "fit to give judgment"), because often a specific diagnosis can be made from them. The medical model is a causal model in which specific signs stem either from a specific medical condition or from the disease itself. Thus, a standard medical examination is often a series of medical tests for pathognomonic signs. Once a disease has been diagnosed, it can be treated. This model has served the field of medicine rather well. For example, the model attempts to fit (pigeonhole) the available information from the medical examination into often rigid and inflexible diagnostic criteria. Also, if the signs from the medical examination do not precisely fit, or are contradictory, and if some symptoms are transient, the model does not work well, because no substantive diagnosis can be established; thus, no treatment can be offered.

Pathognomonic signs occur rarely in normal individuals. In clinical neurology, this includes such signs as an eye that will not move from side to side. In neuropsychology, examples of pathognomonic signs include the rotation of a drawing or the failure to draw the left half of a figure. You can count the number of pathognomonic signs within a given test to get a summary number. You can treat this number as a level-of-performance score. In other cases, the simple presence of a particular pathognomonic sign is taken as an indication of brain damage. See Neuropsychology in Action 3.1 for a case example related to the neuropsychological interpretation and diagnosis.

Summary

The neuropsychological evaluation is a method of examining the brain by studying its behavioral product. As with other psychological assessments, neuropsychological evaluations involve the comprehensive study of behavior by means of standardized tests that are sensitive to brain–behavior relationships. In effect, the neuropsychological examination offers an understanding of the relationship between the structure and the function of the nervous system. Thus, the goal of the clinical neuropsychological examination is to be able to evaluate the full range of basic abilities represented in the brain. In practice, the neuropsychological assessment is multidimensional (concerned with evaluating many different aspects of neurofunctioning from basic to complex), reliable (stable across different situations and time), and valid (meaningful).

The neuropsychologist's role in evaluation has evolved from a diagnostic emphasis to one in which current neuropsychological functioning is described and the individual's adaptation to the unique demands of his or her environment is evaluated. The focus is on performance in the testing setting, as well as on a task analysis of the cognitive requirements of home and work. Neuropsychological testing profiles can aid in identifying general categories of neurologic disease and conditions. The purpose of the neuropsychological evaluation examines the individual's strengths and weaknesses, ability to deal with stress, adaptation, and overall social and occupational functioning. It is in this latter, more descriptive role that neuropsychologists have made their most recent advances.

Critical Thinking Questions

- Why are the concepts of reliability and validity so important in psychological and neuropsychological assessment?
- What kinds of questions and tests do neuropsychologists use in a neuropsychological evaluation?
- How are neuropsychology assessment procedures the same? How are they different?
- What sort of recommendations and treatments can neuropsychologists give to brain-impaired people that will be useful in their daily lives?
- How do the major two approaches (process and battery) to interpreting neuropsychological data differ?

Key Terms

Neuropsychological evaluation
Psychometrics
Standardized test
Reliability
Validity
Construct validity
Content validity
Criterion validity
False positive
Base rate
Achievement tests
Behavioral-adaptive scales
Intelligence tests
Neuropsychological tests
Personality tests
Vocational inventories
Crystallized functions
Fluid functions
Orientation
Sensation
Perception
Motor apraxia
Ideomotor apraxia
Malingering
Interpretive hypotheses
Standard battery approach
Process approach
Normative data
Cutoff score
Specificity
Sensitivity
Normal distribution
Deficit measurement
Pattern analysis
Pathognomonic signs

Web Connections

http://ericae.net
ERIC Clearinghouse on Assessment and Evaluation—Extensive site on psychological and educational testing and assessment; includes test locator, frequently asked questions, search engine for ERIC, and many other links.