1 The Practice of Neuropsychological Assessment

Imaging is not enough.

Mortimer Mishkin, 1988

Clinical neuropsychology is an applied science concerned with the behavioral expression of brain dysfunction. It owes its primordial—and often fanciful—concepts to those who, since earliest historic times, puzzled about what made people do what they did and how. These were the philosophers, physicians, scientists, artists, tinkerers, and dreamers who first called attention to what seemed to be linkages between body (not necessarily brain) structures and people's common responses to common situations as well as their behavioral anomalies (Castro-Caldas and Grafman, 2000; Finger, 1994, 2000; C.G. Gross, 1998; L.H. Marshall and Magoun, 1998). In the 19th century the idea of controlled observations became generally accepted, thus providing the conceptual tool with which the first generation of neuroscientists laid out the basic schema of brain–behavior relationships that hold today (Benton, 2000; Benton [collected papers in L. Costa and Spreen, 1985, *passim*]; Boring, 1950; M. Critchley and Critchley, 1998; Hécaen et Lanteri-Laura, 1977; Stringer, Cooley, and Christensen, 2002; N.J. Wade and Brozek, 2001).

In the first half of the 20th century, war-damaged brains gave the chief impetus to the development of clinical neuropsychology. The need for screening and diagnosis of brain injured and behaviorally disturbed servicemen during the first World War and for their rehabilitation afterward created large-scale demands for neuropsychology programs (e.g., K. Goldstein, 1995 [1939]; Homskaya, 2001; see references in Luria, 1973b; Poppelreuter, 1990 [1917]; W.R. Russell [see references in Newcombe, 1969]). The second World War and then the wars in east Asia and the Mideast promoted the development of many talented neuropsychologists and of increasingly sophisticated examination and treatment techniques.

While clinical neuropsychology can trace its lineage directly to the clinical neurosciences, psychology contributed the two other domains of knowledge and skill that are integral to the scientific discipline and clinical practices of neuropsychology today. Educational psychologists, beginning with Binet (with Simon, 1908) and Spearman (1904), initially developed tests to capture that elusive concept "intelligence." Following these pioneers, mental measurement specialists produced a multitude of examination techniques to screen recruits for the military and to assist educational evaluations; some of these techniques—such as Raven's Progressive Matrices, the Wechsler Intelligence Scales, and the Wide Range Achievement Tests—have been incorporated into the neuropsychological test canon (Boake, 2002). Society's acceptance of educational testing led to a proliferation of large-scale, statistics-dependent testing programs that provided neuropsychology with an understanding of the nature and varieties of mental abilities from a normative perspective. Educational testing has also been the source of ever more reliable measurement techniques and statistical tools for test standardization and the development of normative data, analysis of research findings, and validation studies (Anastasi and Urbina, 1997; Mayrhauser, 1992; McFall and Townsend, 1998). Clinical psychologists and psychologists specializing in personality and social behavior research borrowed from and further elaborated principles and techniques found in educational testing, giving neuropsychology this important assessment dimension (Cripe, 1997; G.J. Meyer et al., 2001).

Psychology's other critical contribution to neuropsychological assessment comes primarily from experimental studies of cognitive functions in both humans and other animals. In its early development, human studies of cognition mainly dealt with normal subjects—predominantly college students who sometimes earned course credits for their cooperation. Animal studies and clinical reports of brain injured persons, especially soldiers with localized wounds and stroke patients, generated much of what was known about the alterations and limitations of specific cognitive functions when one part of the brain is missing or compromised. In the latter half of the 20th century, many experimental psychologists became aware of the wealth of information about cognitive functions to be gained from studying brain injured persons, especially

those with localized lesions (e.g., G. Cohen et al., 2000; Gazzaniga, 2000a, *passim;* Rapp, 2001; Tulving and Craik, 2000, *passim*). Similarly, neuroscientists have become aware of the usefulness of cognitive constructs and psychological techniques when studying brain–behavior relationships (Feinberg and Farah, 2003, *passim;* Fuster, 1995; Luria, 1966; 1973b; Margolin, 1992; Mesulam, 2000, *passim*). Now in the 21st century, neuropsychologists and other neuroscientists have the further advantage of dynamic imaging techniques which, by opening windows into brain processing, further refine our understanding of the neural foundations of behavior (Frackowiak, Friston, et al., 1997; Gazzaniga, 2000a, *passim;* Rugg, 1997). Knowledge from these studies provides neuropsychologists with the neurologically meaningful psychological constructs necessary for the analysis and comprehension of the uniquely and often anomalously multifaceted behavioral presentations of their patients.

When doing assessments, clinical neuropsychologists typically address a variety of questions with awareness of both the neurological and psychological import of their patients' behaviors and with respect for and interest in their patients' very disparate capacities. The diversity of problems and persons presents an unending challenge to examiners who want to satisfy the purposes for which the examination was undertaken and still evaluate patients at levels suited to their capacities and limitations. In this complex and expanding field, few facts or principles can be taken for granted, few techniques would not benefit from modifications, and few procedures will not be bent or broken as knowledge and experience accumulate. The practice of neuropsychology calls for flexibility, curiosity, inventiveness, and empathy even in the seemingly most routine situations (B. Caplan and Shechter, 1995). Moreover, even seemingly routine neuropsychological assessments hold the promise of new insights into the workings of the brain and the excitement of discovery.

The rapid evolution of neuropsychological assessment in recent years reflects a growing sensitivity among clinicians generally to the practical problems of identification, assessment, care, and treatment of brain impaired patients. Psychologists, psychiatrists, and counselors ask for neuropsychological assistance in identifying those candidates for their services who may have underlying neurological disorders. Neurologists and neurosurgeons request behavioral evaluations to aid in diagnosis and to document the course of brain disorders or the effects of treatment (e.g., Grabowski et al., 2002). A fruitful interaction is taking place between neuropsychology and gerontology that enhances the knowledge and clinical applications of each discipline (see Chapter 8, pp. 294–301).

Child neuropsychology has developed hand in hand with advances in the study of mental retardation, learning disabilities, and children's behavior problems. As this text concerns neuropsychological issues relevant to adults, we refer the interested reader to the current child neuropsychology literature (V. Anderson et al., 2001; Baron, Fennell, and Voeller, 1995; Pennington, 2002; C. Reynolds and Fletcher-Janzen, 1997; Sattler, 2001a,b; L.T. Singer and Zeskind, 2001; Teeter and Semrud-Clikeman, 1997; Yeates, Ris, and Taylor, 2000). Adults whose cognitive and behavioral problems stem from developmental disorders or childhood onset conditions may also be in need of a neuropsychological evaluation. Although they are more likely to be seen in clinics or by neuropsychologists specializing in the care of adults, the preponderance of the literature on their problems can be found in books and articles dealing with child neuropsychology. Thus, readers interested in developmental conditions such as attentional deficit hyperactivity disorder, spina bifida, or hydrocephalus arising from a perinatal incident, or in residuals of childhood meningitis or effects of cancer treatment of children, for example, are referred to the developmental literature.

When this book first appeared, much of the emphasis in clinical neuropsychology was on assessing behavioral change. In part this occurred because so much of the demand on neuropsychology had been for assistance with diagnostic problems. Moreover, since many patients seen by neuropsychologists were considered too limited in their capacity to benefit from behavioral training programs and counseling, these kinds of treatment did not seem to offer practical options for their care. Yet, as one of the clinical sciences, neuropsychology has been evolving naturally: assessment tends to play a predominant role while these sciences are relatively young; treatment techniques develop as diagnostic categories and etiological relationships are defined and clarified and the nature of the patients' disorders become better understood. Today, treatment planning and evaluation have become not merely commonplace but often necessary considerations for neuropsychologists performing assessments.

Any of six different purposes may prompt a neuropsychological examination: *diagnosis; patient care*—including questions about management and planning; *treatment-1: identifying treatment needs,* individualizing treatment programs, and keeping abreast of patients' changing treatment requirements; *treatment-2: evaluating treatment efficacy; research,* both theoretical and applied; and now in the United States and to a lesser extent elsewhere, *forensic questions* are frequently referred to neuropsychologists (Prigatano and

Pliskin, 2003, *passim*). Each purpose calls for some differences in assessment strategies. Yet many assessments serve two or more purposes, requiring the examiner to integrate the strategies in order to gain the needed information about the patient in the most focused and succinct manner possible.

1. *Diagnosis.* Neuropsychological assessment can be useful in discriminating between psychiatric and neurological symptoms, in identifying a possible neurological disorder in a nonpsychiatric patient, in helping to distinguish between different neurological conditions, and in providing behavioral data for localizing the site—or at least the hemisphere side—of a lesion. However, the use of neuropsychological assessment as a diagnostic tool has diminished while its contributions to patient care and treatment and to understanding behavioral phenomena and brain function have grown. This shift is due at least in part to the development of noninvasive neurodiagnostic techniques which are both highly sensitive and reliable for many diagnostic purposes (e.g., neuroimaging [see Bigler, 1996; Frith and Friston, 1997; Papanicolaou, 1998] and electrophysiological techniques [Andreassi, 1995; Daube, 1996; Frackowiak, Friston, et al., 1997; Kutas and Dale, 1997]; see also pp. 15–17). Thus, accurate diagnosis, including localization of a lesion, is often achieved by means of the neurologist's examination and laboratory devices.

Still, conditions remain in which even the most sensitive laboratory analyses may not be diagnostically enlightening, such as toxic encephalopathies (e.g., Anger, 1990; Morrow, 1998), Alzheimer's disease and related dementing processes (e.g., Derrer et al., 2002; Filley and Cullum, 1993; Kaye, Swihart, Howieson, et al., 1997; O'Rourke, Tuokko, Hayden, and Beattie, 1997; Visser, Scheltens, Verhey, et al., 1999; Welsh-Bohmer et al., 2003), and mild traumatic brain injury (TBI) (e.g., T.L. Bennett and Raymond, 1997b; Bigler, 1999; Cullum and Thompson, 1997; Ricker and Zafonte, 2000; Reitan and Wolfson, 1999; N.R. Varney and Varney, 1995). In these conditions the neuropsychological findings can be diagnostically crucial.

Even when the site and extent of a brain lesion have been shown on imaging, the image will not identify the nature of residual behavioral strengths and the accompanying deficits: for this neuropsychological assessment is needed. It has been known for decades that despite general similarities in the pattern of brain function sites, these patterns will differ more or less between people (see pp. 32, 85). These kinds of difference are demonstrated nicely by Bigler (2001a) who describes three cases with localized lesions that appeared quite similar on neuroimaging though each had a distinctively different psychosocial outcome. Moreover, cognitive assessment can document mental abilities that are inconsistent with anatomic findings, as for example the 101-year-old nun whose test scores were high but whose autopsy showed "abundant neurofibrillary tangles and senile plaques, the classic lesions of Alzheimer's disease" (Snowdon, 1997). Markowitsch and Calabrese (1996), too, discuss instances in which patients' level of functioning exceeded expectations based on neuroimaging. Thus, neuropsychological techniques will most likely continue to be an essential part of the neurodiagnostic apparatus.

Although limited in its applications as a primary diagnostic tool, neuropsychological assessment can aid in prediction—whether it be the outcome of a diagnosed condition (Bendixen and Benton, 1996; E.D. Richardson, Varney, Roberts et al., 1997; S.B. Rourke and Grant, 1999; Trenerry, 1996), the likelihood that a neuropathological condition will be manifested (Boll, 1985; Ingraham and Aiken, 1996), or the practical consequences of a particular kind of brain impairment (Burgess, Alderman, Evans, et al., 1998; Cahn, Sullivan, Shear, et al., 1998; van Gorp, Baerwald, Ferrando, et al., 1999). As one example of its many purposes, the neuropsychological examination of postcoma traumatic brain injury (TBI) patients in the early stages following their return to consciousness or cessation of posttraumatic amnesia is prognostic of their eventual outcome (Lucas, 1998; Newcombe, 1985; S.R. Ross, Millis, and Rosenthal, 1997). In persons at risk for Huntington's disease, the earliest evidence of illness may show up as subtle alterations in neuropsychological status best observed by refined assessment techniques (Campodonico, Aylward, Codori, et al., 1998; T. Diamond et al., 1992).

Screening is another aspect of diagnosis. Until quite recently, screening was a rather crudely conceived affair, typically dedicated to identifying "brain damaged" patients from among a diagnostically mixed population such as might be found in long-term psychiatric care facilities. Little attention was paid to either base rate issues or the prevalence of conditions in which psychiatric and neurologic contributions were mixed and interactive (e.g., C.G. Watson and Plemel, 1978; Mapou, 1988, and A. Smith, 1983, p. 467, discuss this issue). Yet screening has a place in neuropsychological assessment when used in a more refined manner to identify persons most likely at risk for some specified condition or in need of further diagnostic study, and where brevity is required—whether because of the press of patients who may benefit from neuropsychological assessment (D.N. Allen, Sprenkel, Heyman, et al., 1998 or because the patient's condition may preclude a lengthy assessment (S. Walker, 1992) (also see Chapter 6, p. 150).

2. *Patient care and planning.* Whether or not diagnosis is an issue, many patients are referred for detailed information about their cognitive status, behavioral alterations, and personality characteristics—often with questions about their adjustment to their disabilities—so that they and the people responsible for their well-being may know how the neurological condition has affected their behavior. At the very least the neuropsychologist has a responsibility to describe the patient as fully as necessary for intelligent understanding and care.

Descriptive evaluations may be employed in many ways in the care and treatment of brain injured patients. Precise descriptive information about cognitive and emotional status is essential for careful management of many neurological disorders. Rational planning usually depends on an understanding of patients' capabilities and limitations, the kinds of psychological change they are undergoing, and the impact of these changes on their experiences of themselves and on their behavior.

A 55-year-old right-handed management expert with a bachelor's degree in economics was hospitalized with a stroke involving the left frontoparietal cortex three months after taking over as chief executive of a foundering firm. He had been an effective troubleshooter, who devoted most of his waking hours to work. In this new post, his first as chief, his responsibilities called for abilities to analyze and integrate large amounts of information, including complex financial records and sales and manufacturing reports; creative thinking; good judgment; and rebuilding the employees' faltering morale. Although acutely he had displayed right-sided weakness and diminished sensation involving both his arm and leg, motor and sensory functions rapidly returned to near normal levels and he was discharged from the hospital after 10 days. Within 5 months he was walking 3 1/2 miles daily, he was using his right hand for an estimated 75% of activities, and he felt fit and ready to return to work. In questioning the wisdom of this decision, his neurologist referred him for a neuropsychological examination.

This bright man achieved test scores in the *high average* to *superior* ability ranges yet his performance was punctuated by lapses of judgment (e.g., when asked what he would do if he was the first to see smoke and fire at the movies he said, "If you're the first—if it's not a dangerous fire try to put it out by yourself. However, if it's a large fire beyond your control you should immediately alert the audience by yelling and screaming and capturing their attention"; when directed to write what was wrong with a picture portraying two persons sitting comfortably out in the rain, he listed seven different answers, such as, "Right-hand side of rain drops moves [sic] to right on right side of pict. [sic]," but completely overlooked the central problem). Impaired self-monitoring appeared in his rapid performance of a task requiring the subject to work quickly while keeping track of what has already been done (*Figural Fluency Test*)—he worked faster than most but left a trail of errors; in assigning numbers to symbols from memory (*Symbol Digit Modalities Test*) without noting that he gave the same number to two different symbols only inches apart; and in allowing two small errors to remain on a page of arithmetic calculations done without a time limit. Not surprisingly, he had word finding difficulties which showed up in his need for phonetic cueing to retrieve six words on the *Boston Naming Test* while not recalling two even with cueing; this problem also appeared in discourse; for example, he stated that a dog and a lion were alike in being "both members of the animal factory, I mean animal life." On self-report of his emotional status (*Beck Depression Inventory, Symptom Check List-90-R*) he portrayed himself as having no qualms, suffering no emotional or psychiatric symptoms.

In interview the patient assured me [mdl] that he was ready to return to a job that he relished. As his work has been his life, he had no "extracurricular" interests or activities. He denied fatigue or that his temperament had changed, insisting he was fully capable of resuming all of his managerial duties.

It was concluded that the performance defects, though subtle, could be serious impediments at this occupational level. Moreover, lack of appreciation of these deficits plus the great extent to which this man's life—and sense of dignity and self-worth—were bound up in his work suggested that he would have difficulty in understanding and accepting his condition and adapting to it in a constructive manner. His potential for serious depression seemed high.

The patient was seen with his wife for a report of the examination findings with recommendations and to evaluate his emotional situation in the light of both his wife's reports and her capacity to understand and support him. With her present, he could no longer deny fatigue since it undermined both his efficiency and his good nature, as evident in her examples of how his efficiency and disposition were better in the morning than later in the day. She welcomed learning about fatigue as his untypical irritability and cognitive lapses had puzzled her. With his neurologist's permission, he made practical plans to return to work—for half-days only, and with an "assistant" who would review his actions and decisions. His need for this help became apparent to him after he was shown some of his failures in self-monitoring. At the same time he was given encouraging information regarding his many well-preserved abilities. (Judgmental errors were not pointed out: While he could comprehend the concrete evidence of self-monitoring errors, it would require more extensive counseling for a man with an impaired capacity for complex abstractions to grasp the complex and abstract issues involved in evaluating judgments. Moreover, learning that his stroke had rendered him careless and susceptible to fatigue was enough bad news for the patient to hear in one hour; to have given more discouraging information than was practically needed at this time would have been cruel and probably counterproductive.)

An interesting solution was worked out for the problem of how to get this self-acknowledged workaholic to accept a four-hour work day: If he went to work in the morning, his wife was sure he would soon begin stretching his time limit to five and six or more hours. He therefore agreed to go to

work after his morning walk or a golf game and a midday rest period so that, arriving at the office after 1 PM, he was much less likely to exceed his half-day work limit.

Ten months after the stroke the patient reported that he was on the job about 60 hours per week and had been told he "was doing excellent work." He described a mild naming problem and other minor confusions. He also acknowledged some feelings of depression in the evening and a sleep disturbance for which his neurologist began medication.

In many cases the neuropsychological examination can answer questions concerning patients' capacity for self-care, reliability in following a therapeutic regimen, ability not merely to drive a car but to handle traffic emergencies (Brouwer and Withaar, 1997; Haikonen et al., 1998; Lundqvist, Alinder, Alm, et al., 1997) or appreciation of money and of their financial situation (Cahn, Sullivan, Shear, et al., 1998). When all the data of a comprehensive neuropsychological examination—the patient's history, background, and present situation; the qualitative observations; and the quantitative scores—are taken together, the examiner should have a realistic appreciation of how the patient reacts to deficits and can best compensate for them, and whether and how retraining could be profitably undertaken (A.-L. Christensen and Caetano, 1996; Diller, 2000; Sohlberg and Mateer, 2001).

The relative sensitivity and precision of neuropsychological measurements make them well suited for following the course of many neurological diseases (Heaton, Grant, Butters, et al., 1995; Wild and Kaye, 1998). Data from successive neuropsychological examinations repeated at regular intervals can provide reliable indications of whether the underlying neurological condition is changing, and if so, how rapidly and in what ways (e.g., Salmon, Heindel, and Lange, 1999). Parenté and Anderson (1984) used repeated testing to ascertain whether brain injured candidates for rehabilitation could learn well enough to warrant cognitive retraining. Freides (1985) recommended repeated testing to evaluate performance inconsistencies in patients with attentional deficits. Deterioration on repeated testing can identify a dementing process early in its course (J.C. Morris, McKeel, Storandt, et al., 1991; Paque and Warrington, 1995). Repeated testing may also be used to measure the effects of surgical procedures, medical treatment, or retraining.

A single, 27-year-old, highly skilled logger with no history of psychiatric disturbance underwent surgical removal of a right frontotemporal subdural hematoma resulting from a car accident. Twenty months later his mother brought him, protesting but docile, to the hospital. This alert, oriented, but poorly groomed man complained of voices that came from his teeth, explaining that he received radio waves and could "communicate to their source." He was emotionally flat with sparse speech and frequent 20- to 30-second response latencies that occasionally disrupted his train of thought. He denied depression and sleeping or eating disturbances. He also denied delusions or hallucinations, but during an interview pointed out Ichabod Crane's headless horseman while looking across the hospital lawn. As he became comfortable, he talked more freely and revealed that he was continually troubled by delusional ideation. His mother complained that he was almost completely reclusive, without initiative, and indifferent to his surroundings. He had some concern about being watched, and once she had heard him muttering, "I would like my mind back."

Most of his neuropsychological test scores were below those he had obtained when examined 6 1/2 months after the injury. His only scores above *average* were on two tests of well-learned verbal material: background information and reading vocabulary. He received scores in the *low average* to *borderline defective* ranges on oral arithmetic, visuomotor tracking, and all visual reasoning and visuoconstructive—including drawing—tests. Although his verbal learning curve was considerably below *average,* immediate verbal span and verbal retention were within the *average* range. Immediate recall of designs was *defective.*

Shortly after he was hospitalized and had completed the 20 month examination, he was put on trifluoperazine (Stelazine), 15 mg h.s., continuing this treatment for a month while remaining under observation. He was then reexamined. The patient was still poorly groomed, alert, and oriented. His reaction times were well *within normal limits.* Speech and thinking were unremarkable. While not expressing strong emotions, he smiled, complained, and displayed irritation appropriately. He reported what hallucinating had been like and related the content of some of his hallucinations. He talked about doing physical activities when he returned home but felt he was not yet ready to work.

His test scores 21 months after the injury were mostly in the *high average* to *superior* ranges. Much of his gain came from faster response times which enabled him to get full credit rather than partial or no credit on timed items he had completed perfectly but slowly the previous month. Although puzzle constructions (both geometric designs and objects) were performed at a *high average* level, his drawing continued to be of *low average* quality (but better than at 20 months). All verbal memory tests were performed at *average* to *high average* levels; his visual memory test response was without error, gaining him a *superior* rating. He did simple visuomotor tracking tasks without error and at an *average* rate of speed; his score on a complex visuomotor tracking task was at the 90th percentile.

In this case, repeated testing provided documentation of both the cognitive repercussions of his psychiatric disturbance and the effects of psychotropic medication on his cognitive functioning. This case demonstrates the value of repeated testing, particularly when one or another aspect of the patient's behavior appears to be in flux. Had testing been done only at the time of the second examination, a very distorted

impression of the patient's cognitive status would have been gained. Fortunately, since the patient was in a research project, the first examination data were available to cast doubt on the validity of the second set of tests, performed when he was acutely psychotic, and therefore the third examination was given as well.

Brain impaired patients must have factual information about their functioning to understand themselves and to set realistic goals, yet their need for this information is often overlooked. Most people who sustain brain injury or disease experience changes in their self-awareness and emotional functioning; but because they are on the inside, so to speak, they may have difficulty appreciating how their behavior has changed and what about them is still the same (Prigatano and Schacter, 1991, *passim*). These misperceptions tend to heighten what mental confusion may already be present as a result of altered patterns of neural activity.

Distrust of their experiences, particularly their memory and perceptions, is a problem shared by many brain damaged persons, probably as a result of even very slight disruptions and alterations of the exceedingly complex neural pathways that mediate cognitive and other behavioral functions. This distrust seems to arise from the feelings of strangeness and confusion accompanying previously familiar habits, thoughts, and sensations that are now experienced differently and from newly acquired tendencies to make errors (T.L. Bennett and Raymond, 1997a; Lezak, 1978b. See also Skloot, 2003, for a poet's account of this experience). The self-doubt of the brain injured person, often referred to as "perplexity," is usually distinguishable from neurotic self-doubts about life goals, values, principles, and so on, but can be just as painful and emotionally crippling. Three years after undergoing a left frontal craniotomy for a parasagittal meningioma, a 45-year-old primary school teacher described this problem most tellingly:

> Perplexity, the not knowing for sure if you're right, is difficult to cope with. Before my surgery I could repeat conversations verbatim. I knew what was said and who said it. . . . Since my surgery I don't have that capability anymore. Not being able to remember for sure what was said makes me feel very insecure.

Careful reporting and explanation of psychological findings can do much to allay the patient's anxieties and dispel confusion. The following case exemplifies both patients' needs for information about their psychological status and how disruptive even mild experiences of perplexity can be.

> An attractive, unmarried 24-year-old bank teller sustained a brain concussion in a car accident while on a skiing trip in Europe. She appeared to have improved almost completely, with only a little residual facial numbness. When she came home, she returned to her old job but was unable to perform acceptably although she seemed capable of doing each part of it well. She lost interest in outdoor sports although her coordination and strength were essentially unimpaired. She became socially withdrawn, moody, morose, and dependent. A psychiatrist diagnosed depression, and when her unhappiness was not diminished by counseling or antidepressant drugs, he administered electroshock treatment, which gave only temporary relief.
>
> While waiting to begin a second course of shock treatment, she was given a neuropsychological examination at the request of the insurer responsible for awarding monetary compensation for her injuries. This examination demonstrated a small but definite impairment of auditory span, concentration, and mental tracking. The patient reported a pervasive sense of unsureness which she expressed in hesitancy and doubt about almost everything she did. These feelings of doubt had undermined her trust in many previously automatic responses, destroying a lively spontaneity that was once a very appealing feature of her personality. Further, like many postconcussion patients, she had compounded the problem by interpreting her inner uneasiness as symptomatic of "mental illness," and psychiatric opinion confirmed her fears. Thus, while her cognitive impairment was not an obstacle to rehabilitation, her bewildered experience of it led to disastrous changes in her personal life. A clear explanation of her actual limitations and their implications brought immediate relief of anxiety and set the stage for sound counseling.

The concerned family, too, needs to know about their patient's condition in order to respond appropriately (D.N. Brooks, 1991; Camplair et al., 2003; Lezak, 1988a, 1996; Proulx, 1999). Family members need to understand the patient's new, often puzzling, mental changes and what may be their psychosocial repercussions. Even quite subtle defects in motivation, in abilities to plan, organize, and carry out activities, and in self-monitoring can compromise patients' capacities to earn a living and thus render them socially dependent. Moreover, many brain impaired patients no longer fit easily into family life as irritability, self-centeredness, impulsivity, or apathy create awesome emotional burdens on family members, generate conflicts between family members and with the patient, and strain family ties, often beyond endurance (Lezak, 1978a, 1986b; L.M. Smith and Godfrey, 1995).

3. *Treatment-1: Treatment planning and remediation.* Today, much more of the work of neuropsychologists is involved in treatment or research on treatment (Vanderploeg, 1998). Rehabilitation programs for cognitive impairments and behavioral disorders arising from neuropathological conditions now have access to effective behavioral treatments based on neuropsychological knowledge and tested by neuropsychological techniques (for examples from many parts of the world see:

A.-L. Christensen and Uzzell, 2000; Pélissier, Barat, and Mazaux, 1991; Ponsford, 1995; Prigatano, 1999; Stuss, Winocur, and Robertson, 1999; B.A. Wilson and McLellan, 1997).

In the rehabilitation setting, the application of neuropsychological knowledge and neuropsychologically based treatment techniques to individual patients creates additional assessment demands: Sensitive, broad-gauged, and accurate neuropsychological assessment is necessary for determining the most appropriate treatment for each rehabilitation candidate with brain dysfunction (Allain et al., 1995; T.L. Bennett, 2001; Raskin and Mateer, 2000; Sloan and Ponsford, 1995; Sohlberg and Mateer, 2001). In addressing the behavioral and cognitive aspects of patient behavior, these assessments will include both delineation of problem areas and evaluation of the patient's strengths and potential for rehabilitation. In programs of any but the shortest duration, repeated assessments will be required to appreciate the patient's changing needs and competencies and adapt programs and goals correspondingly. Since rehabilitation treatment and care is often shared by professionals from many disciplines and their subspecialties, such as psychiatrists, speech pathologists, rehabilitation counselors, occupational and physical therapists, and visiting nurses, a current and centralized appraisal of patients' neuropsychological status enables these treatment specialists to maintain common goals and understanding of the patient. In addition, it can give an often more important analysis of how patients fail that will tell the therapist how patients might improve their performances in problem areas (e.g., Greenwald and Rothi, 1998; B.A. Wilson, 1986).

A 30-year-old lawyer, recently graduated in the top ten percent of his law school class, sustained a ruptured right anterior communicating artery aneurysm. Surgical intervention stopped the bleeding but left him with memory impairments that included difficulty in retrieving stored information when searching for it and very poor prospective memory (i.e., remembering to remember some activity originally planned or agreed upon for the future, or remembering to keep track of and use needed tools such as memory aids). Other deficits associable to frontal lobe damage included diminished emotional capacity, empathic ability, self-awareness, spontaneity, drive, and initiative-taking; impaired social judgment and planning ability; and poor self-monitoring. Yet he retained verbal and academic skills and knowledge, good visuospatial and abstract reasoning abilities, appropriate social behaviors, and motor function.

Following repeated failed efforts to enter the practice of law, his wife placed him in a recently organized rehabilitation program directed by a therapist whose experience had been almost exclusively with aphasic patients. The program emphasized training to enhance attentional functions and to compensate for memory deficits. This trainee learned how to keep a memory diary and notebook, which could support him through most of his usual activities and responsibilities; and he was appropriately drilled in the necessary memory and note-taking habits. What was overlooked was the overriding problem that it did not occur to him to remember what he needed to remember when he needed to remember it. (When his car keys were put aside where he could see them with instructions to get them when the examination was completed, at the end of the session he simply left the examining room and did not think of his keys until he was outside the building and I [mdl] asked if he had forgotten something. He then demonstrated a good recall of what he had left behind and where.)

One week after the conclusion of this costly eight-week program, while learning the route on a new job delivering in-house mail, he laid his memory book down somewhere and never found it again—nor did he ever prepare another one for himself despite an evident need for it. An inquiry into the rehabilitation program disclosed a lack of appreciation of the nature of frontal lobe damage and the needs and limitations of persons with brain injuries of this kind.

The same rehabilitation service provided a virtually identical training program to a 42-year-old civil engineer who had incurred severe attentional and memory deficits as a result of a rear-end collision in which the impact to his car threw his head forcibly back onto the head rest. This man was keenly and painfully aware of his deficits, and he retained strong emotional and motivational capacities, good social and practical judgment, and abilities for planning, initiation, and self-monitoring. He too had excellent verbal and visuospatial knowledge and skills, good reasoning ability, and no motor deficits. For him this program was very beneficial as it gave him the attentional training he needed and enhanced his spontaneously initiated efforts to compensate for his memory deficits. With this training he was able to continue doing work that was similar to what he had done before the accident, only on a relatively simplified level and a slower performance schedule.

4. *Treatment-2: Treatment evaluation.* With the ever-increasing use of rehabilitation and retraining services must come questions regarding their worth (Kashner et al., 2003). These services tend to be costly, both monetarily and in expenditure of professional time. Consumers and referring clinicians need to ask whether a given service promises more than can be delivered, or whether what is produced in terms of the patient's behavioral changes has psychological or social value and is maintained long enough to warrant the costs. Here again, neuropsychological assessment can help answer these questions (Sohlberg and Mateer, 1989; Trexler, 2000; Vanderploeg, 1998; see also Diller and Ben-Yishay, 2003; Kaszniak and Bortz, 1993; Ricker, 1998; and B.A. Wilson and Evans, 2003, for a discussion of the cost-effectiveness of neuropsychological evaluations of rehabilitation patients).

Neuropsychological evaluation can often best demonstrate the effects—both positive and negative—

of surgical (e.g., B.D. Bell and Davies, 1998, temporal lobectomy for seizure control; M.F. Newman et al., 2001, coronary artery bypass surgery; Vingerhoets, Van Nooten, and Jannes, 1996, open-heart surgery) or brain stimulation (e.g., Moretti et al., 2002a, to treat Parkinson's disease; Vallar, Rusconi, and Bernardini, 1996, to improve left visuospatial awareness) treatments of brain disorders and associated conditions. Testing for drug efficacy and side effects also requires neuropsychological assessment data (Meador, Loring, Hulihan, et al., 2003; C.M. Ryan and Hendrickson, 1998). Examples of these kinds of testing programs can be found for medications for many different conditions such as cancer (C.A. Meyers, Scheibel, and Forman, 1991), HIV (human immunodeficiency virus) (Llorente, van Gorp, et al., 2001), seizure control (Kelland and Lewis, 1996), attentional deficit disorders (Riordan, Flashman, Saykin, et al., 1999), multiple sclerosis (Fischer, Priore, et al., 2000), hypertension (Jonas et al., 2001), and psychiatric disorders: "difficulties with concentration, memory, and more complicated *executive* cognitive functions occur . . . secondary to many medications used to treat neurologic and other medical illnesses . . . modern neuropsychologic testing has allowed extensive batteries . . . to better define the [cognitive] deficits of individual patients" (Roy-Byrne and Fann, 1997, p. 967).

5. *Research.* Neuropsychological assessment has been used to study the organization of brain activity and its translation into behavior, and to investigate specific brain disorders and behavioral disabilities (this book, *passim;* see especially Chapters 2, 3, 7, and 8). Research with neuropsychological assessment techniques also involves their development, standardization, and evaluation. The precision and sensitivity of neuropsychological measurement techniques make them valuable tools for studying both the large and small—and sometimes quite subtle—behavioral alterations that are the externally and objectively observable manifestations of underlying brain pathology.

The practical foundations of clinical neuropsychology are also based to a large measure on neuropsychological research (see Hannay, Bieliauskas, et al., 1998: Houston Conference on Specialty Education and Training in Clinical Neuropsychology, 1998). Many of the tests used in neuropsychological evaluations—such as those for arithmetic or for visual memory and learning—were originally developed for the examination of normal cognitive functioning and recalibrated for neuropsychological use in the course of research on brain dysfunction. Other assessment techniques—such as certain tests of tactile identification or concept formation—were designed specifically for research on normal brain dysfunction. Their subsequent incorporation into clinical use attests to the very lively exchange between research and practice. This exchange works especially well in neuropsychology because clinician and researcher are so often one and the same.

Neuropsychological research has also made crucial contributions to the study of normal behavior and brain functions. The following areas of inquiry afford only a partial glimpse into these rapidly expanding knowledge domains. Neuropsychological assessment techniques provide the data for interpreting brain mapping studies (e.g., Frackowiak, Friston, Frith et al., 1997, *passim;* Gold, Berman, Randolph, et al., 1996; S.C. Johnson et al., 2001; A.C. Roberts, Robbins, and Weiskrantz, 1998, *passim*). Cognitive status in normal aging has been tracked by neuropsychological assessments repeated over the course of years and even decades (e.g., Malec, Smith, Ivnik, et al., 1997; Snowdon, 1997; Tranel, Benton, and Olson, 1997). The roles that demographic characteristics play in the expression of mental abilities are often best delineated by neuropsychological findings (e.g., Ardila, Ostrosky-Solis, et al., 2000; Kempler, Teng, Dick, et al., 1998; Kimura, 1999; Vanderploeg, Axelrod, et al., 1997; Ylikoski, Ylikoski, Erkinjuntti, et al., 1998). Increasingly precise analyses of specific cognitive functions have been made possible by neuropsychological assessment techniques (e.g., Dollinger, 1995; Schretlen, Pearlson, Anthony, et al., 2000; Troyer, Moscovitch, and Winocur, 1997).

6. *Forensic Neuropsychology.* Neuropsychological assessment undertaken for legal proceedings has become quite commonplace in personal injury actions in which monetary compensation is sought for claims of bodily injury and loss of function (Heilbronner and Pliskin, 2003; McCaffrey, Williams, Fisher, and Laing, 1997; Nemeth, 1993; Sweet, 1999a). Although the forensic arena may be regarded as requiring some differences in assessment approaches, most questions referred to a neuropsychologist will either ask for a diagnostic opinion (e.g., "Has this person sustained brain damage as a result of . . . ?") or a description of the subject's neuropsychological status (e.g., "Will the behavioral impairment due to the subject's neuropathological condition keep him from gainful employment? Will treatment help to return her to the workplace?"). Usually the referral for a neuropsychological evaluation will include (or at least imply) both questions (e.g., "Are the subject's memory complaints due to . . . , and if so, how debilitating are they?"). In such cases, the neuropsychologist attempts to determine whether the claimant has sustained brain impairment which is associable to the injury in question. When the claimant is brain impaired, an evaluation of the type and amount

of behavioral impairment sustained is intrinsically bound up with the diagnostic process. In such cases the examiner typically estimates the claimant's rehabilitation potential along with the extent of any need for future care. Not infrequently the request for compensation may hinge on the neuropsychologist's report.

In criminal cases, a neuropsychologist may assess a defendant when there is reason to suspect that brain dysfunction contributed to the misbehavior or when there is a question about mental capacity to stand trial. The case of the murderer of President Kennedy's alleged assailant remains as probably the most famous instance in which a psychologist determined that the defendant's capacity for judgment and self-control was impaired by brain dysfunction (J. Kaplan and Waltz, 1965). Interestingly, the possibility that the defendant, Jack Ruby, had psychomotor epilepsy was first raised by Dr. Roy Schafer's interpretation of the psychological test findings and subsequently confirmed by electroencephalographic (EEG; i.e., brain wave) studies. At the sentencing stage of a criminal proceeding, the neuropsychologist may also be asked to give an opinion about treatment or potential for rehabilitation of a convicted defendant.

Use of neuropsychologists' examination findings, opinions, and testimony in the legal arena has engendered what, from some perspectives, seems to be a whole new industry dedicated to unearthing malingerers and exaggerators whose poor performances on neuropsychological tests make them appear to be cognitively impaired—or more impaired, in cases where impairment may be mild. To this end, a multitude of examination techniques and new tests have been devised (Chapter 20; also see J.S. Hayes, Hilsabeck, and Gouvier, 1999; Pankratz, 1998; Vickery et al., 2001). Whether the problem of malingering and symptom exaggeration in neuropsychological examinations is as great as the proliferation of techniques for identifying faked responding would suggest remains unanswered. Certainly, when dealing with forensic issues the examining neuropsychologist must be alert to the possibility that claimants in tort actions or defendents in criminal cases may—deliberately or unwittingly—perform below their optimal level; but the examiner must also remain mindful that for most examinees their dignity is a most prized attribute that is not readily sold. Moreover, base rates of malingering or symptom exaggeration probably vary with the population under study: TBI patients in a general clinical population would probably have a lower rate than those referred by defense lawyers who have an opportunity to screen claimants—and settle with those who are unequivocally injured—before referring the questionable cases for further study (e.g., Fox, et al., 1995; see Stanczak et al., 2000, for a discussion of subject-selection biases in neuropsychological research; Ruffalo, 2003, for a discussion of examiner bias).

Usually a neuropsychological examination serves more than one purpose. Even though the examination may be initially undertaken to answer a single question such as a diagnostic issue, the neuropsychologist may uncover vocational or family problems, or patient care needs that have been overlooked, or the patient may prove to be a suitable candidate for research. Integral to all neuropsychological assessment procedures is an evaluation of the patient's needs and circumstances from a *psychological* perspective that considers quality of life, emotional status, and potential for social integration. When new information that has emerged in the course of an examination raises additional questions, the neuropsychologist will enlarge the scope of inquiry to include newly identified issues, as well as those stated in the referral.

Should a single examination be undertaken to serve several purposes—diagnosis, patient care, and research—a great deal of data may be collected about the patient and then applied selectively. For example, the examination of patients complaining of immediate memory problems can be conducted to answer various questions. A diagnostic determination of whether immediate memory is impaired may only require finding out if they can recall significantly fewer words of a list and numbers of a series than the slowest intact adult. To understand how they are affected by memory dysfunction, it is important to know the number of words they can recall freely and under what conditions, the nature of their errors, their awareness of and reactions to their deficit and its effect on their day-to-day activities. Research might involve studying immediate memory in conjunction with blood sugar levels or brain wave tests, or comparing the performance of these memory impaired persons to that of patients with other kinds of memory complaints.

THE VALIDITY OF NEUROPSYCHOLOGICAL ASSESSMENT

A question that has been repeatedly raised about the usefulness and validity of neuropsychological assessments concerns its "ecological" validity. *Ecological validity* typically refers to how well the neuropsychological assessment data predict future behavior or behavioral outcomes. These questions have been partially answered—almost always affirmatively—in research that has examined relationships between neuropsychological findings and ultimate diagnoses, e.g., the detection of dementia (Bondi, Salmon, Galasko, et al., 1999;

G.J. Meyer et al., 2001), between neuropsychological findings and imaging data (E.D. Bigler, 2001b), and between neuropsychological findings and employability for example (see also Sbordone and Long, 1996; B.A. Wilson, 1993).

Most recently very specific studies on the predictive accuracy of neuropsychological data have appeared for a variety of behavioral conditions: Prediction of treatment outcome for substance abuse patients rested significantly on Digit Span Backward and the Beck Depression Inventory (Teichner et al., 2001). Hanks and colleagues (1999) found that measures of executive function (Letter-Number Sequencing, Controlled Oral Word Assocation Test, Trail Making Test-B, Wisconsin Card Sorting Test) along with story recall (Logical Memory) "were strongly related to measures of functional outcome 6 months after rehabilitation" of patients with spinal cord injury, orthopedic disorders, or TBI (p. 1030). HIV^+ patients' employability varied with their performances on tests of memory, cognitive flexibility, and psychomotor speed (van Gorp, Baerwald, Ferrando, et al., 1999). Neuropsychological test findings that correlated significantly with the functional deficits of multiple sclerosis were on the California Verbal Learning Test–long delay free recall, the Paced Auditory Serial Addition Test, the Symbol Digit Modalities Test, and two recall items from the Rivermead Behavioral Memory Test (Higginson et al., 2000).

Several aspects of the very practical prediction of ability to perform activities of daily living (ADL) have been explored (A. Baird, Podell, et al., 2001; Cahn, Sullivan, et al., 1998; Cahn-Weiner, Boyle, and Malloy, 2002). Deloche and his coworkers (1996) report a strong relationship between scores on an arithmetic test battery and those on an ADL questionnaire. The Hooper Visual Organization Test above all, but also the Boston Naming Test and immediate recall of Logical Memory and Visual Reproduction were predictive of safety and independence in several activity domains (E.D. Richardson, Nadler, and Malloy, 1995). A comparison of rehabilitation inpatients who fail and those who do not showed that the former made more perseverative errors on the Wisconsin Card Sorting Test and performed more poorly on the Stroop and Visual Form Discrimination tests (Rapport, Hanks, et al., 1998). The problem of predicting driving competency was addressed by J.E. Meyers, Volbrecht, and Kaster-Bundgaard (1999), who reviewed the data from several hundred examination protocols of persons referred for neuropsychological assessment. They report that discriminant function analysis was 94.4% accurate in identifying competence and noncompetence in driving.

A number of studies have looked at TBI outcome predictions. S.R. Ross and his colleagues (1997) report that two tests, the Rey Auditory Verbal Learning Test and the Trail Making Test together and "in conjunction with age significantly predicted psychosocial outcome after TBI as measured by patient report" (p. 168). A review of studies examining work status after TBI found that a number of neuropsychological tests were predictive, especially "measures of executive functions and flexibility" (p. 23); specifically named tests were the Wisconsin Card Sorting Test, a dual—attention and memory—task, the Trail Making Test-B, and the Tinker Toy Test; findings on the predictive success (for work status) of memory tests varied considerably (Crépeau and Scherzer, 1993). Another study of TBI patients' return to work found that, "Neuropsychological test performance is related to important behavior in outpatient brain-injury survivors" (p. 382), and further noted that, "no measures of trauma severity contributed in a useful way to this prediction (of employment/unemployment)" (p. 391) (M.L. Bowman, 1996). T.W. Teasdale and colleagues (1997) also documented the validity of tests—of visuomotor speed and accuracy and complex visual learning given before entry into rehabilitation—as predictors of return to work after rehabilitation.

WHAT CAN WE EXPECT OF NEUROPSYCHOLOGICAL ASSESSMENT AT THE BEGINNING OF THIS NEW CENTURY?

In the 1995 edition of this book, the question was asked, "What might the future hold for neuropsychological assessment?" From neuropsychology's past history it was easy to predict correctly that there would be a continuing proliferation of tests, batteries, nontest assessment approaches, and technical refinements for many of these assessment tools. Moreover, what was predicted in 1995 appears to be valid today: i.e., if present trends augur the future, we can expect more and more varied applications of neuropsychological assessment in both clinical and theoretical research in medicine, the neurosciences, education, and the social sciences as well (e.g., see Cacioppo, Berntson, et al., 2002).

Some specific trends predicted in 1995 will certainly continue into the future. Concerns about the validity of test and battery based interpretations and predictions have been addressed by many researchers using a variety of techniques applied to an even wider variety of tests. For example, some studies provide new norms or examine the validity of tests of very specific aspects of such functions as visual memory (Barr, Chelune,

Hermann, et al., 1997; Paolo, Tröster, and Ryan, 1998a,b); concept formation and mental flexibility (Holtz, Gearhart, and Watson, 1996; Kozel and Meyers, 1998; Upton and Thompson, 1999), and verbal abilities (Ruff, Light, Parker, and Levin, 1996; Warrington, 1997). Other studies have analyzed the components of tests (e.g., *Line Bisection:* Luh, 1995; *Money Road-Map Test:* Vingerhoets, Lannoo, and Bauwens, 1996; *Wisconsin Card Sorting Test:* Greve, Ingram, and Bianchini, 1998). Still other studies have focussed on the neuropsychological and statistical bases of test batteries (e.g., the *CANTAB Battery:* Robbins, James, Owen, et al., 1998; the *Halstead-Reitan Battery:* Dikmen, Heaton, Grant, and Temkin, 1999; the *Wechsler Adult Intelligence Scale-III:* Kreiner and Ryan, 2001; J.J. Ryan and Paolo, 2001).

Computerized assessment programs have been proliferating and may be on the verge of assuming a dominant place in the neuropsychological assessment repertory. The advantages and disadvantages of computerized assessment have been reviewed, with recommendations and cautions (e.g., K.M. Adams and Heaton, 1987; Bleiberg et al., 2000; Gonzalez et al., 2003; Larrabee and Crook, 1996). Guidelines for the appropriate and ethical computerization of neuropsychological assessments, first published in 1987, are valid today and should be reviewed by anyone contemplating the introduction of computerized programs into their examination procedures (see Matthews, 1991). However, a perusal of recently published articles, books, and test publishers' catalogues suggests that, by and large, most clinicians and research examiners continue to rely primarily on clinical assessment techniques with some use of specialized computer programs (e.g., for the *Category Test,* the *Continuous Performance Test,* the *Wisconsin Card Sorting Test*). Thus, while their development continues, computerized tests have a more adjunctive than central role in the practice of clinical neuropsychology. However, their use for large-scale research and study programs is increasing (Anger, Rohlman, and Storzbach, 1999; Anger, Storzbach, et al., 1998; Bowler, Thaler, et al., 1990).

By 1995, the need to develop appropriate assessment techniques and test norms for older age groups had become urgent. That need has been well-satisfied since then in books (e.g., Nussbaum, 1997; Tuokko and Hadjistavropoulos, 1998; Woodruff-Pak, 1997) and in journals. It is now rare for an issue of any of the most popular neuropsychology journals to appear that does not contain at least one article dealing with some aspect of the aging brain, its competencies, and its vicissitudes.

One measure of the degree to which neuropsychology has become an accepted and valued partner in both clinical and research enterprises is its dispersion to cultures other than Western European, and its applications to language groups other than those for which tests were originally developed. At the beginning of the 21st century, neuropsychology is facing new challenges to its usefulness posed by the need for both greater cross-cultural sensitivity (Nell, 1999; Pontón and León-Carrión, 2001; Shepard and Leathem, 1999) and more language-appropriate tests (see Chapter 6, pp. 313–314). The increase in demands for neuropsychological assessment of persons with limited or no English language background has been the impetus for developing instruments written in the patient's language and standardized on persons in that patient's culture and language group; use of interpreters is only a second-best partial solution (Artioli y Fortuny and Mullaney, 1998; LaCalle, 1987). In the United States and Mexico, test developers and translators have begun to respond to the need for Spanish language tests with appropriate standardization (e.g., Acevedo et al., 2000; Ardila, 2000b; Pontón and León-Carrión, 2001; Stricks, Pittman, Jacobs, et al., 1998; Taussig, Mack, and Henderson, 1996). Studies providing norms and analyses of tests in Chinese reflect the increasing application of neuropsychological assessment in the Far East (Chan and Poon, 1999; Hua, Chang, and Chen, 1997; Lu and Bigler, 2000). These are good beginnings, as a next important goal for neuropsychological assessment should be the dissemination of research-based language- and culture-appropriate neuropsychological examination techniques and skills.

While real progress has been made over the last few decades in understanding cognitive and other neuropsychological processes and how to assess them, further knowledge is needed for tests and testing procedures to be sufficiently organized and standardized that assessments may be reliably reproducible, practically valid, and readily comprehensible. The range of disorders and disease processes, the variation in the presentation of each across individuals, the overlapping presentations of disorders and diseases, their pharmacologic and other treatments, and the interaction between the effects of these disorders make it unlikely that any "one size fits all" battery can be developed or should even be contemplated. Reitan noted as early as 1964 that, "We may be able to accumulate large enough groups [for normative purposes] within the next 20 years, but we would hope by that time the results might have lost their significance at least partially through obsoletion of the test battery." However, today's knowledge about the neuropathological and psychological entities that are the subject of neuropsychology together with the increasingly sensitive statistical techniques for

test evaluation should lead to some simplification and generalization in examination procedures.

One means of achieving such a goal while retaining the flexibility appropriate for the great variety of persons and problems dealt with in neuropsychological assessment could be a series of relatively short fixed batteries designed for use with particular disorders and diseases and specific deficit clusters (e.g., visuomotor dysfunction, short-term memory disorders). Neuropsychologists in the future would then have at their disposal a set of test modules and perhaps structured interviews (each containing several tests) that can be upgraded as knowledge increases and that can be applied in various combinations to answer particular questions and meet specific patients' needs.