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Forensic Neuropsychology: are we there yet?☆

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Abstract

Forensic Neuropsychology is a new and rapidly evolving subspecialty of clinical neuropsychology that applies neuropsychological principles and practices to matters that pertain to legal decision-making. Forensic neuropsychologists provide the trier of fact with specialized information regarding brain-behavior relationships. The primary responsibility of the forensic neuropsychologist is to provide information based on scientifically-validated neuropsychological principles and clinical methodology that is pertinent to the Forensic Question at hand—which is not just whether the patient has dysfunction, but whether the dysfunction results from the event under consideration. To best answer the Forensic Question, the neuropsychologist must use a methodology that has been scientifically-validated on brain-impaired individuals, and can distinguish various brain conditions from each other as well as from normal variation. The methodology must be able to determine whether any dysfunction found is, in fact, the result of a neurological condition as opposed to non-neurological, psychological, or even factitious disorders. This paper discusses neuropsychological methodology in the context of forensic application and the requirements of the legal process and illustrates these issues with case examples.

Keywords: Forensic Neuropsychology; Decision-making; Forensic Question

1. Introduction

Forensic Neuropsychology is a subspecialty of clinical neuropsychology that directly applies neuropsychological principles and practices to matters that pertain to legal

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decision-making. Practitioners of forensic neuropsychology are trained as clinical neuropsychologists and subsequently specialize in the forensic application of their knowledge and skills.

The field of forensic neuropsychology is quite new and is rapidly evolving. There are, at the present time, no formal training programs, licensure requirements, or professional organizations devoted specifically to forensic neuropsychology. There are relatively few textbooks in the field, and only a single journal devoted solely to the field, the *Journal of Forensic Neuropsychology*. There is no formal process for assigning the title of "forensic neuropsychologist" upon a practitioner. Rather, this title can be claimed, in most states, by a practitioner who is first qualified as a licensed psychologist, and who possesses the additional training and experience necessary to meet the guidelines for qualifications as a neuropsychologist. One's training, background, and knowledge must meet, at the minimum, the requirements for licensure in one's state and the ethical guidelines for practice of the APA. The National Academy of Neuropsychology has proposed a specific definition of a clinical neuropsychologist. One would expect a forensic neuropsychologist to have further training and experience in the legal arena, although to date, the nature and type of this education has not been specified.

1.1. Surveys of forensic practice

Although new, the field of forensic neuropsychology has grown significantly in the past 20 years. Several practice surveys have been conducted that illustrate the growth and importance of forensic neuropsychology (Guilmette, Faust, Hart, & Arkes, 1990; Putnam, 1989; Putnam & DeLuca, 1990; Putnam, DeLuca, & Anderson, 1994; Seretny, Dean, Gray, & Hartlage, 1986; Sweet & Moberg, 1990; Sweet, Moberg, & Suchy, 2000a, 2000b; and Sweet, Moberg, & Westergaard, 1996). In general, these surveys indicate:

- referrals from attorneys rank equally in frequency with referrals from neurosurgeons, psychologists, general physicians, and rehabilitation specialists;
- forensic neuropsychology is one of the most common sources of supplemental income;
- legal entities account for almost one-third of private practice referral sources
- psychologists engaged in forensic work have higher incomes than those who did not;
- practicing psychologists are spending more time in forensic neuropsychological activities;
- only neurology and psychiatry are more important referral sources than attorneys;
- among private practitioners, attorneys are the top referral source.

Other evidence for the growth and importance of forensic neuropsychology is the increasing number of presentations on this topic at national meetings, as well as the increasing numbers of peer-reviewed publications. Recently, the American Board of Professional Neuropsychology (ABPN) added a subspecialty in forensic neuropsychology to its certifying process.

Forensic Neuropsychology's growth is a direct result of the growth in the field of clinical neuropsychology. Over the past 40 years, clinical neuropsychology has established principles of brain-behavior relations and valid and reliable methodologies for measuring these relationships. These principles and methodologies allow clinical neuropsychologists to provide the trier of fact with specialized information for use in the legal decision-making process.

1.2. Neuropsychological testimony

Neuropsychological testimony is well-accepted in the courts. In a review of 200 appellate court cases in the 1980s, Richardson and Adams (1992) found that decisions in all jurisdictions upheld the right of a clinical neuropsychologist to testify about the presence of brain dysfunction.

In contrast to the apparent unanimity regarding a neuropsychologist's ability to testify concerning the presence of brain dysfunction, there has been less acceptance of the clinical neuropsychologist's ability to testify about the *cause* of brain dysfunction. Nonetheless, Richardson and Adams found that 9 of 11 jurisdictions allowed neuropsychological testimony regarding causation. Typically, challenges to neuropsychological testimony have been raised on the grounds that psychologists are not medical doctors and that the causal determination of brain damage is a medical issue.

1.3. Case precedent

An early case that addressed the question of a neuropsychologist's ability to provide expert testimony regarding brain impairment was *Indianapolis Union Railway v. Walker* (1974). In this case, a passenger was injured in an auto collision with a train. The neuropsychologist (Ralph M. Reitan) provided testimony as to the presence, location, cause, and permanence of brain impairment. His ability to testify as an expert was challenged on appeal by the defendant because his testimony was not based on reasonable medical certainty. Specifically, the defendant's argument was that Dr. Reitan was not a licensed medical doctor, and therefore, was not competent to testify as an expert concerning the physical neurological condition of the plaintiff. However, the appellate court concluded that the defendant's argument was without merit, and cited Dr. Reitan's education, training, knowledge, and experience as evidence of his expertise. Puente has called this case "the first seminal case in [our] subspecialty" (Puente, 1997, p. 168), and this case likely laid the foundation for the acceptance of clinical neuropsychological testimony in the courtroom.

Clinical neuropsychologists are trained in the study of brain-behavior relationships. The training process that neuropsychologists go through typically involves a thorough grounding in the scientific method. The scientific method requires that ideas or hypotheses be systematically studied, with the results disseminated, so that findings can be replicated and validated, leading to refinement of the working theory or to its dismissal if results do not support it. This process is thus an on-going and collaborative one, with the accumulation of validated and scientifically accepted information over time. In contrast, the legal method involves an attempt to resolve conflict through an adversarial approach in which each side is allowed to present its position and supporting information. Direct examination and cross-examination are the methods by which information is tested. This process results in a specific decision that is essentially absolute and final without the qualifications and probability statements typically used in the scientific approach.

The differences between these two methodologies are well captured by a statement made by Supreme Court Justice Blackmun. He described the scientific process as one of "perpetual revision. Law, on the other hand, must resolve disputes finally and quickly" (cited in Giuliano, Barth, Hawk, & Ryan, 1997, p. 11). As such, the neuropsychologist is typically called into the legal process in order to help in reaching a final decision, but the neuropsychologist's input will result from methods that rely on probability statements and confidence intervals. That is, while the court is attempting to reach a definite decision, the neuropsychologist must provide information and conclusions within the standards of the field. The neuropsychologist does not make the decision, but is often asked for strongly stated opinions, which may not fit within the limits of our science.

Neuropsychologists are typically called into legal proceedings as expert witnesses. Their value to the court is in their "scientific, technical, or other specialized knowledge [that] will assist the trier of fact to understand the evidence or to determine a fact in issue" (Rule 702, Federal Rules of Evidence, West Publishing, 1990). As an expert witness, the clinical neuropsychologist is often asked to render an opinion about a patient's brain-related function as it relates to the claim at hand. As part of this opinion, the clinical neuropsychologist is also often asked about the cause, nature, and extent of any injury or dysfunction, as well as the possible impact of these impairments on the patient's daily function, occupation, etc. The clinical neuropsychologist may also be asked about the prognosis and permanence of these deficits, as well as the potential for improvement through treatments or therapies. The neuropsychologist's opinion is typically based on a clinical assessment of the patient, using methods and procedures currently accepted within the field. These methods are expected to be appropriately grounded in scientific validity and reliability.

1.4. Admissibility of evidence

While neuropsychologists evaluate their methods and results by scientific standards, these standards are not necessarily the ones that determine whether neuropsychological expert testimony will be allowed in court. For over 70 years, the standard for admissibility of scientific testimony has been the *Frye* rule (*Frye v. United States*, 1923), which states that ". . . while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained *general acceptance* in the particular field in which it belongs" [emphasis added]. If a method had such general acceptance, then testimony regarding it would be admissible in court. This rule precluded admission of any novel or innovative technique. For example, it was not sufficient for experts to vouch for the validity of their own technique without evidence for support and acceptance from their field. While the *Frye* rule addresses the issue of a technique's recognition and acceptance in a field, it does not address the scientific validity of the technique. Thus, a technique or procedure could be admissible in court, on the basis of its general acceptance, but could still lack scientific validity. Despite this apparent shortcoming, the *Frye* rule is still used in a number of jurisdictions.

In 1993, the U.S. Supreme Court set a new evidentiary standard for admissibility of scientific testimony in the case of *Daubert v. Merrell Dow Pharmaceuticals*. In this decision, the Court asserted that Federal Rule of Evidence 702 was the standard for admissibility of expert testimony in Federal courts. Rule 702 states: "If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skills, experience, training, or education, may testify thereto in the form of an opinion or otherwise." This rule established a criterion of relevancy for expert testimony, established the terms according to which a witness could qualify as an expert, and regulated the subjects about which an expert could testify. Moreover, in the ruling, several factors were outlined which could be considered by judges in determining whether a technique met this standard:

- Has the technique been tested?
- Has the technique been subjected to peer review and publication?
- What is the error rate in applying the technique?
- To what extent has the technique received general acceptance in the relevant scientific community?

There have been subsequent rulings that have elaborated on the application of the *Daubert* standards, including *General Electric v. Joiner* (1997), *Kumho Tire Co. v. Carmichael* (1999), and *Moore v. Ashland Chemical* (1997).

The acceptance of *Daubert* is not uniform across all U.S. jurisdictions. Reed (1999) found that 33 states were using "at least some version of the *Daubert* standard, while 17 states continue to use the 'older' *Frye* standard" (p. 49).

1.5. Neuropsychological methodology

Clinical neuropsychologists can be called upon to assist in both criminal and civil cases. Regardless of the legal venue, the primary responsibility of the clinical neuropsychologist participating in forensic work is to provide information based on scientifically-validated neuropsychological principles and clinical methodology that is pertinent to the Forensic Question at hand—for example, "Does the plaintiff suffer from significant cognitive deficit as a result of the mild head injury sustained in a motor vehicle accident?" Or, in a criminal case, "Can the defendant's criminal behaviors be explained by brain damage he sustained as a teenager?"

Commonly, in a forensic neuropsychological evaluation, a battery of tests is used to assess neurocognitive functions in order to answer these questions. Different neuropsychologists may construct their batteries from different selections of tests. Some batteries are composed according to the patient's presenting complaints and the referral question ("flexible battery"). Other neuropsychologists begin with a specific set of tests, seldom deviating from this selection, although often supplementing the basic battery ("fixed battery"). Regardless of which approach is used, the results of the battery of tests often form the primary basis for the neuropsychological testimony in answering the Forensic Question.

2. The Forensic Question

In my experience, the critical Forensic Question is not just whether the patient has dysfunction, but whether the dysfunction results from the event under consideration. For example, the neuropsychologist might be faced with the question of whether the patient's complaints of memory and attention and concentration problems are reflective of brain impairment in light of low-average intelligence, high school education and former employment as a sales manager. If so, does this brain-related impairment relate to a head injury or to previously-diagnosed hypertension and diabetes or to a psychological reaction to the accident?

It is crucial for the neuropsychologist to select techniques and procedures that will best answer these questions. The clinical neuropsychologist must use a methodology that can provide brain-relevant information about the patient's current cognitive function and dysfunction and that can address the cause of any dysfunction found. The neuropsychologist must employ a methodology that has been scientifically-validated on brain-impaired individuals, and can distinguish various brain conditions from each other as well as from normal variation. Specifically, this methodology must have demonstrated validity in determining presence of brain impairment, location of the cerebral damage, nature of the brain condition, as well as differentiating various neurological disorders and other conditions that can afflict the brain. The methodology must be able to determine whether any dysfunction found is, in fact, the result of a neurological condition as opposed to non-neurological, psychological, or even factitious disorders.

To accomplish this, the forensic neuropsychologist must use a methodology that allows the conclusion that the findings are specific to the brain-related condition under dispute. Differentiating these complex conditions requires validated test patterns and relationships. Such patterns and relationships can show, for example, whether impaired scores on one or more tests, in comparison with scores on other tests, are indicative of brain impairment or of normal variability. Most importantly, these patterns and relationships must be able to independently differentiate brain impairment resulting from one neurological etiology from another. As noted by Elbert Russell, this pattern analysis method is "primarily concerned with the relationships between tests rather than with the individual scores or level of functioning on particular tests. This method compares tests with each other in order to discover a pattern that reveals information about a cognitive condition" (Russell, 1998, p. 367). Inherently, this assessment approach requires the use of a similar set of tests that has been given to persons with confirmed brain impairment of various types. This cannot be done by a purely normative approach, nor can it be done by a "tally" approach, for example adding up the number of impaired scores compared to the number of normal scores. The use of these patterns and relationships provides information that can be used to answer the Forensic Question.

Frequently, an approach to the Forensic Question is to use a selection of standardized and normed tests that provides information on the patient's standing in comparison with others of the same age, education and gender. However, sole reliance on normed tests of function has significant limitations in answering the Forensic Question. While this approach addresses the patient's function, it is unable to address the *cause* of any dysfunction found. This model of assessment uses the function of normal individuals as the basis for comparison, and thus, any conclusions are limited to statements regarding the patient's standing with respect to normal variation. Moreover, when faced with a low test score, it is problematic to conclude that this poor performance is the result of brain damage if the test norms include only normal individuals. That is, one cannot conclude that identified weaknesses are the result of brain impairment if the test was developed using only those with normal brain function. For example, is the fifth percentile of *normal* subjects the point below which patients can be considered brain-damaged? Is a score that is one or more standard deviations below the mean for normal subjects an indication of brain damage? Clearly, this approach has significant limitations.

The presence of cognitive deficits does not necessarily imply brain injury. A conclusion regarding brain injury can be validly made only through the use of a methodology that has been thoroughly validated in its ability to identify neurocognitive performances related to various brain-behavior conditions. The mere selection of standardized, psychometrically-sound tests to identify cognitive deficits does not assure that the results will be forensically, or even neuropsychologically, relevant. The astute forensic neuropsychologist and the knowledgeable attorney will readily realize that cognitive impairment may be due to a host of factors.

The forensic neuropsychologist must be able to demonstrate a causative link between the cognitive impairments and the event at hand. Typically, in a forensic situation, the neuropsychologist is asked for an opinion that can be stated "with a reasonable degree of neuropsychological certainty." What is required is a methodology that can independently predict the cause of any deficits found. Too often the mere co-occurrence of the motor vehicle accident, for example, and the patient's complaints are used to establish the accident as the cause of the cognitive deficits. However, considering that the patient has experienced the trauma of an MVA and also has a financial incentive to appear impaired, it is the responsibility of the forensic neuropsychologist to determine whether the deficits found are the result of brain impairment from this accident, as opposed to psychological trauma, physical (peripheral) injury, malingering, a pre-existing condition, or some combination of these causes. This is a question of differential diagnosis.

2.1. Differential diagnosis

In differential diagnosis, the neuropsychologist must formulate a scientifically-based opinion regarding the cause of the neuropsychological findings. Questions will be raised about the accuracy of the tests used to reach the conclusion. Unfortunately, much of clinical neuropsychology has focused on identifying deficits in function without determining the accuracy of the diagnostic procedure in differentiating various neurological or non-neurological conditions. Surprisingly, there are few clinical neuropsychological studies on the accuracy of differential diagnosis of our procedures, unlike the medical literature that is filled with such studies. The following case illustrates the importance of differential diagnosis.

2.2. Case CL

CL was a 74-year-old married woman with a history of a stroke 2.5 months prior to neuropsychological evaluation. According to her husband, she was unresponsive for approximately a half-hour at the time of the event. She began to respond after the second day of a 10-day hospitalization. Reportedly, she experienced two seizures. She was amnestic for the entire hospitalization. At the time of discharge, she had slow speech, right-sided weakness, and needed a walker. Apparently, she began to show recovery of function until approximately 2–3 weeks prior to the neuropsychological evaluation, at which time she began demonstrating significant worsening in functioning.

The patient presented with significant cognitive problems. Previous medical history was remarkable for heart problems since 1995. She received a pacemaker 3 years ago. She reported more than a 10-year history of hypertension. Medications included Neurontin, Verapamil, Zocor, Coumadin, and Maxzide.

Her educational background included a high school degree and 1 year of college. She had been retired for a number of years.The assessment included the Halstead-Reitan Neuropsychological Test Battery (HRB), and the results are presented in Figures 1–3. As can be seen from Figure 1, this patient has rather significant and severe neurocognitive impairment, involving abstract reasoning, psychomotor problem-solving, incidental memory and learning, and attention-concentration. There are also impairments of motor and sensory abilities. Figure 2 shows that she has definite and severe language problems. Figure 3 illustrates definite signs of constructional dyspraxia. The patient earned a General Neuropsychological Deficit Scale (GNDS) score of 84 indicating severe brain impairment. In addition, the results indicate significant left hemisphere involvement. There are many test scores within the severe range. These results would be quite consistent with a recent stroke of the left hemisphere.

However, closer analysis of the test data in fact shows that the pattern of results is NOT consistent with those typically seen with a recent left hemisphere stroke. Specifically, the motor findings are somewhat inconsistent with expectation of a recent left hemisphere stroke given the severity of the other left hemisphere findings. The HRB allows this kind of differentiation of the underlying neurological condition. There are known patterns and relationships among the various tests that point to the conclusion that these results are more likely associated with a rapidly growing intrinsic tumor. In fact, shortly after the evaluation, the patient was diagnosed with a gliobastoma multiforme.

This case illustrates the importance of differential diagnosis in a clinical situation. In the forensic situation, the neuropsychologist's ability to make a differential diagnosis will be questioned. Neuropsychologists are expected to provide testimony regarding the causal link of the neuropsychological impairments. Methodologies not validated for differential diagnosis will likely be challenged, and as a result, the findings and conclusions may be of limited usefulness to the court.

2.3. The "credible link"

The HRB is a well-validated procedure that can answer the Forensic Question and meets the methodological requirements described. Several published experts in the field have commented on the use of the HRB as the method of choice in the forensic setting. After reviewing guidelines for psychological testing in the forensic context, Williams (1997) recommended the use of the Halstead-Reitan Battery, stating, "No other battery is as well validated with such a variety of neurological and psychiatric disorders. This is invaluable in making differential diagnoses" (p. 60). Laing and Fisher (1997) state, "A standardized or fixed battery approach, which requires the same tests to be administered regardless of the patient's presenting problem, is recommended for use in the forensic context." In his review of *Chapple v. Ganger*, Reed (1996) stated, "Within clinical neuropsychology, professionals who use the validated or fixed neuropsychological test batteries to obtain reliable and valid objective test results will generally find the *Daubert* standard an easy threshold to pass . . . " (p. 321).

Case: CL **Age:** 74 **Education:** 13 **Gender:** F **Handedness:** R

Wechsler Adult Intelligence Scale

VIQ	**85**
PIQ	**97**
FSIQ	**89**

Verbal Subtests	
Information	**8**
Comprehension	**4**
Arithmetic	**5**
Similarities	**8**
Digit Span	**7**
Vocabulary	**0**

Performance Subtests	
Digit Symbol	**3**
Picture Completion	**8**
Block Design	**6**
Picture Arrangement	**6**
Object Assembly	**4**

Wide Range Achievement Test – 3

	Standard Score	Grade Equivalent
Reading	100	11
Spelling	86	5
Arithmetic	73	2

Halstead-Reitan Neuropsychological Test Battery

Halstead Impairment Index 0.9

Category Test	**111***
Tactual Performance Test	
Total Time	28.1
Memory	5
Localization	4
Seashore Rhythm Test	24
Speech-sounds Perception Test	7

Dominant hand	10.0	Blocks in	3
Non-dominant hand	8.1	Blocks in	10
Both hands	10.0	Blocks in	7

Finger Tapping Test	Dominant hand	17
	Non-dominant	28

Trail Making Test	Part A	148
	Part B	300**

	Right	Left
Strength of Grip (kg)	13.5	20.5
Bilateral Simultaneous Sensory Stimulation		
Tactile	8	0
Auditory	0	4
Visual	0	1

Visual Fields: Full

	Right	Left
Tactile Finger Recognition	7	1
Finger-Tip Number Writing	4	3
Tactile Form Recognition Test		
Time (sec)	12	11
Errors	1	0

* Pro rated
** Discontinued

Fig. 1. Test results for CL.

The *Daubert* Court's reasoning regarding the admissibility of scientific testimony has direct bearing on methodology. The Court stated: "For purposes of determining whether expert testimony is sufficiently grounded on valid scientific principles so as to be admissible, general acceptance . . . is [a] factor to be considered; however, it is not dispositive. The focus is on the

Reitan-Indiana
Aphasia Screening Test
Form for Adults and Older Children

Name CL
Age 74 Educ 13 Date
Examiner

Copy SQUARE 1) Lifted 2) Drew inside square 1st	Repeat TRIANGLE
Name SQUARE	Repeat MASSACHUSETTS
Spell SQUARE	Repeat METHODIST EPISCOPAL
Copy CROSS	Write SQUARE
Name CROSS Triangle (Q) …no (Circle?) no (Rectangle?) no (Cross?) yes	Read SEVEN
Spell CROSS	Repeat SEVEN
Copy TRIANGLE	✓ Repeat/Explain HE SHOUTED THE WARNING. He shouted the warning, He shouted the warning, Don't Know, He shouted the warning…. (Q) He shouted the warning, He shouted the warning!
Name TRIANGLE	Write HE SHOUTED THE WARNING.
Spell TRIANGLE	Compute 85 − 27 = 1) copied horizontally, then looked up as if done. 93 (Q: 74-17=) wrote 7, changed to L. 92 (Q: 34-21=) 55
Name BABY turns head (ok)	Compute 17 × 3 = 1) Much difficulty, writes problem = 31 (Q: 12 x 8=) 48 (Q: 7 x 6=) don't know
Write CLOCK	Name KEY
Name FORK began to write	Demonstrate use of KEY Holds up pencil, but doesn't do anything with it. (Q without pencil) just holds hand up as if holding key. Looks up as if done.
Read 7 SIX 2 1) 7-6-5, no 7-6-2 2) ok	Draw KEY
Read MGW 1) MGM, MGW 2) ok	Read PLACE LEFT HAND TO RIGHT EAR. ✓ & puts Left Hand to Left Ear
Reading I	Place LEFT HAND TO RIGHT EAR Left Hand to Left Ear
Reading II 1) He is friendly dog winner at all dog shows. 2) …at all dog shows. 3) ok	Place LEFT HAND TO LEFT ELBOW Left Hand to Right Elbow

Fig. 2. Aphasia Screening Test protocol for CL.

"methodology" of the experts, and not the conclusions that they generate. This does not mean, however, that a conclusion will be admissible merely because some part of the methodology is scientifically valid. The entire reasoning process must be valid. A credible link must be established between the reasoning and the conclusion. Once that is accomplished, the inquiry

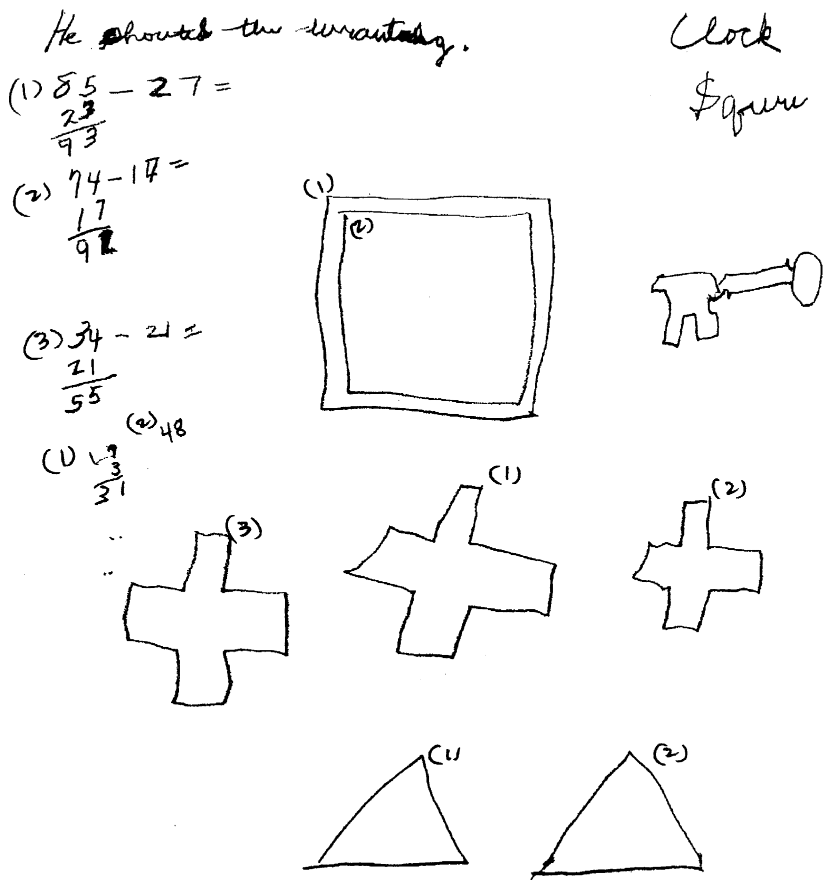

Fig. 3. Aphasia Screening Test drawings for CL.

crosses the line from one of admissibility to one of the weight the trier of fact should accord to the conclusion” (from *Chapple*, 1481 at 1496).

3. Halstead-Reitan Neuropsychological Test Battery

The HRB is the most extensively researched and validated neuropsychological battery in use today in regards to the neurological condition of the brain. Of particular interest to the forensic neuropsychologist is the extensive published research on the HRB. The approach in developing the HRB was to compare control subjects to patients with known cerebral damage or dysfunction (Reitan, 1955, 1959b; Reitan & Davison, 1974). Comparisons were made of the sensitivity of the HRB with other widely used psychological tests, in particular the Wechsler intelligence scales (Reitan, 1959a). Additional research was done to determine the differential sensitivity of the tests to lateralized dysfunction, as well as to acute versus chronic cerebral lesions (Fitzhugh, Fitzhugh, & Reitan, 1961). Further, the effects of age and education have been studied (Finlayson, Johnson, & Reitan, 1977; Reitan & Wolfson, 1995b). Research has also been done on particular conditions, e.g., aphasia, emotional problems, and sensorimotor deficits (Dikmen & Reitan, 1974, 1977; Doehring & Reitan, 1961; Heimberger & Reitan, 1961; and Hom & Reitan, 1982). Its sensitivity has been established for various neurological conditions including cerebrovascular disease, head injury, brain tumors, multiple sclerosis, Parkinson's disease, Alzheimer's disease, epilepsy, aging, and mental retardation (Boll, Heaton, & Reitan, 1974; Dikmen, McLean, & Temkin, 1986; Dikmen & Reitan, 1976; Grant, Mohns, Miller, & Reitan, 1976; Hom, 1991, 1992; Hom & Reitan, 1984, 1990; Matthews & Reitan, 1961, 1962, 1963; Reitan, 1962, 1967, 1976; Reitan & Boll, 1971; Reitan & Fitzhugh, 1971; Reitan, Reed, & Dyken, 1971; Reitan & Wolfson, 1985, 1988a, 1988b, 1993, 2000; Ross & Reitan, 1955). Further, there are numerous examples published regarding the clinical application of the HRB (Reitan & Wolfson, 1993). This extensive body of research will assist the forensic neuropsychologist in answering the Forensic Question.

Most importantly, the accuracy of the HRB in clinical diagnosis has been well established. In 1964, Reitan conducted a study to determine the clinical accuracy of the HRB in a variety of neurological conditions. In this seminal study, he established that clinical diagnoses, *made through consideration of the HRB test results alone*, were accurate in identifying the patients' neurological conditions. In this study, patients were used who had definite medical diagnoses based on comprehensive medical and neurological evaluation. Using only the patients' HRB test data, Reitan was able to classify correctly the following patients by diagnosis: intrinsic tumor, 12 of 16; extrinsic tumor, 8 of 16; cerebrovascular lesions, 28 of 32; traumatic head injury, 30 of 32; and multiple sclerosis, 15 of 16. To my knowledge, a comparable study, addressing such a range of neurological conditions and blind test interpretation, has not been completed on any other battery or approach in clinical neuropsychology.

In a subsequent study that further illustrates the strength of the HRB methodology, Finkelstein (1977) developed a computerized decision tree interpretive system to classify patients with various neurological conditions as well as control subjects. Specifically, the interpretive system provided information regarding: presence or absence of brain damage, lateralization of brain damage, nature of the cerebral lesion, and diagnosis of specific neurological condition. The neurological conditions employed in this study included: metastatic carcinoma, slowly growing intrinsic tumor, rapidly growing intrinsic tumor, extrinsic tumor, vascular anomaly with bleeding, vascular anomaly without bleeding, cerebrovascular accident, Parkinson's disease, primary neuronal degeneration/generalized arteriosclerosis, multiple sclerosis, and head trauma. Using 144 patients with brain disease or damage and 36 controls, Finkelstein found that the interpretive system correctly determined the presence of brain damage in 95% of the cases (96% of brain-damaged and 92% of controls), correctly lateralized the damage in 75% of cases (67% of left hemisphere lesions, 86% of right hemisphere lesions, and 74% of diffuse lesions), correctly determined the nature of the cerebral lesion in 83% of cases (83% for those with evidence for recent tissue destruction, 83% for those without such evidence), and correctly diagnosed the specific neurological condition in 69% of cases. Among the specific diagnoses, the interpretive system identified each one in more than 50% of the cases, with the exception of the vascular anomalies. The vascular anomalies were correctly classified only 38% of the time, with most of the misclassifications being called head trauma. In contrast, CVAs and trauma were correctly identified most often, 75 and 83%, respectively.

This interpretive system clearly shows the clinical utility of the HRB methodology and provides validated algorithms for differential neurological diagnosis based on a patient's neuropsychological test performances. Moreover, the Finkelstein (1977) and Reitan (1964) studies demonstrate the power of the HRB methodology to provide independent information regarding a causative link between cognitive deficits and brain impairment, often the most critical aspect of the Forensic Question.

The following case example illustrates the issues discussed above and is representative of cases seen in a forensic neuropsychology practice.

3.1. Case CR

CR is a 44-year-old married female who was involved in a motor vehicle accident 2 years ago in which she sustained multiple injuries of her head and shoulder. She apparently did not lose consciousness, in that she was able to provide a complete account of the event and its aftermath. She was taken to a local ER for evaluation and treatment, and was discharged the same day. Since the accident, she has been treated for numerous physical problems including headaches, shoulder problems, pain, vision difficulties, dizziness, weakness, and reduced range of movement. Subsequent CT of the head and quantitative EEG are reported to be normal.

In addition to the physical symptoms, CR reports multiple cognitive problems that she attributes to the accident and injury to her head. These include problems with memory, attention and concentration, word finding, learning, and reading. She indicated that she no longer functions at her previous levels. For example, she reported bouncing many checks since the accident, forgetting to pay bills, and losing or misplacing items. She indicated that her abilities to perform as a college professor have been significantly compromised. CR indicated that her cognitive symptoms have been basically stable since approximately 3 months after the accident. She denies any significant recovery of her deficits.

CR denied any significant past medical history. At the time of testing, she was experiencing significant headaches and had been treated for hypertension. She was also in therapy for psychological problems associated with the accident. She reported problems with sleep and nightmares about the accident. Her medications included Paxil and Dexedrine. She denied any previous psychological or psychiatric treatment.

Her test results (Figs. 4 and 5) show that she earned IQs in the average and high–average ranges. A notable difference was demonstrated between her Verbal and Performance IQs. Her Verbal IQ is lower than would be expected, considering her educational and professional background, and thus raises the question of possible loss of abilities in this area. A considerable degree of variability was noted among her subtest performances that ranged from the impaired range to the superior range. In particular, her Digit Span and Digit Symbol scores were outstandingly low in comparison to the other subscale scores. While Digit Span has not been found to be neuropsychologically specific, Digit Symbol has been found to be somewhat sensitive to brain-related impairment. Thus, one can raise a question as to whether this poor score is a reflection of brain impairment.

The patient's academic abilities, as indicated by her scores on the WRAT3, fell below expectation given her reported history of academic and professional attainment.

Case: CR **Age:** 44 **Education:** 20 **Gender:** F **Handedness:** R

Wechsler Adult Intelligence Scale - Revised

VIQ	99
PIQ	118
FSIQ	108

Verbal Subtests	
Information	13
Comprehension	11
Arithmetic	11
Similarities	9
Digit Span	3
Vocabulary	11

Performance Subtests	
Digit Symbol	5
Picture Completion	9
Block Design	11
Picture Arrangement	15
Object Assembly	15

Wide Range Achievement Test – 3

	Standard Score	Grade Equivalent
Reading	95	HS
Spelling	83	7
Arithmetic	109	Post HS

Halstead-Reitan Neuropsychological Test Battery

Halstead Impairment Index 0.6

Category Test	37				
Tactual Performance Test					
Total Time	17.9	Dominant hand	8.1	Blocks in	10
Memory	6	Non-dominant hand	7.0	Blocks in	10
Localization	2	Both hands	2.8	Blocks in	10
Seashore Rhythm Test	26				
Speech-sounds Perception Test	15				

Finger Tapping Test	Dominant hand	47	Trail Making Test	Part A	79
	Non-dominant	33		Part B	221

	Right	Left
Strength of Grip (kg)	38.8	17.0
Bilateral Simultaneous Sensory Stimulation		
Tactile	3	4
Auditory	1	0
Visual	0	0

Visual Fields: Rt Periph

	Right	Left
Tactile Finger Recognition	3	4
Finger-Tip Number Writing	0	7
Tactile Form Recognition Test		
Time (sec)	9	16
Errors	0	0

* No dysphasia

Fig. 4. Test results for CR.

On tests that are more sensitive to the biological integrity of the brain, the patient earned a Halstead Impairment Index of 0.6. On the General Neuropsychological Deficit Scale, she earned a score of 56. This score typically indicates an overall clinical severity level within the moderate range of brain impairment. In particular, CR demonstrated significant impairment in the areas of complex psychomotor problem-solving, incidental memory and

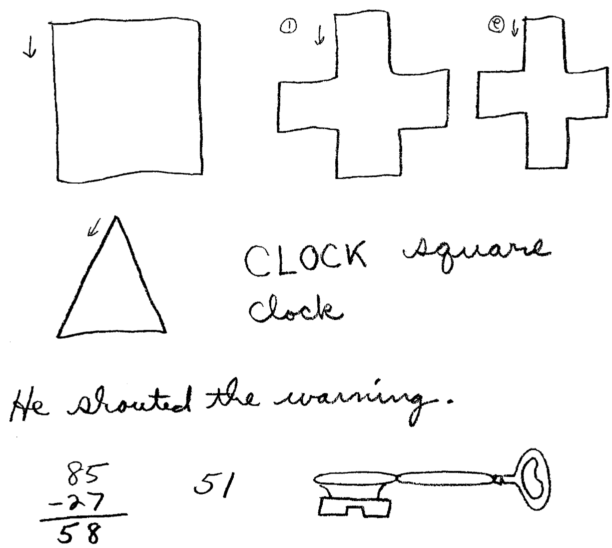

Fig. 5. Aphasia Screening Test drawings for CR.

learning, and simple and complex flexibility of thought. However, her performances were within normal limits for abstract reasoning and for auditory attention to rapidly-presented material.

While variability in cognitive function is typical in head injury, the extent of this patient's variability is somewhat greater than expected. In particular, her scores on the Category Test and Trail Making Test are discrepant from each other. Patients who perform this well on Category do not have the level of difficulty she demonstrated on either Trails A or Trails B. Further, the extremely poor performance on Trails B tends to be reflective of a very severe neurological condition, which is not consistent with her presenting history or neurological findings. Further, this very poor Trails B score is inconsistent with her very capable performance on the Tactual Performance Test using both hands.

With regards to the neuropsychological functioning specific to each cerebral hemisphere, the patient demonstrated a highly lateralized pattern of neuropsychological impairment that would typically suggest significant involvement of the right cerebral hemisphere. This is reflected by scores of 16 on the Right Neuropsychological Deficit Scale and 3 on the Left Neuropsychological Deficit Scale. She had lateralized sensorimotor deficits, and problems in both verbal and figural memory. In contrast, she demonstrated no dysphasic symptoms and no problems in visual constructional abilities from the Aphasia Screening Examination.

Examination of the patient's sensorimotor functions indicated almost exclusively right cerebral hemisphere deficits. This included poor performances on left-handed tapping speed, grip strength, and complex psychomotor problem-solving. In addition, she had greater difficulty with her left side on tactile perception, finger recognition, fingertip number writing recognition, and tactile form recognition. She had some constriction of the visual field of her right eye.

In addition to the neuropsychological findings, the patient was found to have indications of significant psychological features. This included an unusual degree of concern regarding her physical functioning, as well as anxiety and panic attacks.

Preliminary review of the patient's neuropsychological results would seem to show a pattern of significant brain-related impairment. In particular, the pattern shows variability in cognitive function along with sensorimotor findings. Thus, a tentative conclusion of brain impairment from a head injury would seem appropriate. However, closer review of the findings shows numerous inconsistencies that raise questions about this conclusion. In fact, the pattern of results may not represent any neurological condition whatsoever. For example, as noted earlier, the variability in higher cognitive function is much greater than is usually seen. That is, patients who perform as well as CR on the Category Test do not have the level of difficulty she had on Trails B. Further, the patient showed no specific neuropsychological findings (no aphasia or constructional dyspraxia), which again is an unusual situation in light of the other, very significant findings. Finally, the sensorimotor results are highly lateralized, which is not typical in head injury, especially when there are no neurological findings. Thus, from a consideration of these results in light of known neuropsychological patterns in neurological conditions, questions would be raised as to whether the results validly reflect a neurological condition.

In this case, we had access to additional information regarding this patient's function, in that she had been evaluated about a year earlier by another neuropsychologist. Direct comparisons were made with this earlier testing, showing significant deterioration in function in several areas. Specifically, she exhibited notable declines on several verbal subtests of the WAIS-R, along with significant declines on the reading and spelling subtests of the WRAT3. Sensorimotor findings were different on the two occasions, becoming highly lateralized to the right hemisphere by the time of our evaluation whereas they were bilateral before. There were also new signs of impairment seen in formerly intact sensorimotor functions. More importantly, on the most sensitive brain-related measures, she exhibited significant deterioration in overall abilities, as indicated by a 10-point decline on the GNDS. Overall, this pattern of results is clearly inconsistent with expectation. In uncomplicated head injury, significant deterioration of neuropsychological abilities is not expected to occur 2 years post-injury.

Given the inconsistencies found within the results of the second test battery and the unexpected changes from prior testing, the validity of the patient's test performances was suspect. The extent of the inconsistencies was further examined by computing the scores from Reitan and Wolfson's Dissimulation Index. The Dissimulation Index is computed from scores based on the consistency of specific responses on two testing occasions (Response Consistency Index; Reitan & Wolfson, 1995a), as well as the consistency of test scores on two testing occasions (Retest Consistency Index; Reitan & Wolfson, 1997a, 1997b). In CR's case, her responses and test scores were found to be highly inconsistent, and both of her index scores were at the mean for the group of litigating head-injured patients.

Thus, the forensic neuropsychologist in this case could provide important information to the court beyond a simple recitation of the patient's strengths and weaknesses. With the methodology available, the forensic neuropsychologist can offer opinions regarding the causative link of the claimed deficits to the event under litigation. In this instance, it was concluded that the patient's results were not a valid reflection of brain impairment from her accident.

4. Concluding remarks

Forensic neuropsychology is a rapidly developing field that has shown its potential for providing important and relevant information regarding brain-behavior relationships in legal situations. The forensic neuropsychologist provides the court with information about an individual's current neurocognitive function and dysfunction and, most importantly, with information regarding the cause of any dysfunction found. Our contributions to the legal field will be dependent upon the appropriate application of scientifically-validated methodology in our efforts to answer the Forensic Questions that are posed. As has been pointed out, there is a body of research and clinical knowledge that allows neuropsychologists to accomplish this. It is incumbent upon forensic neuropsychologists to be well versed in these findings and techniques in order to fulfill our responsibilities. Ultimately, future progress of the field will depend upon our success in applying sound scientific methodology to questions from the legal arena.

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