The Usefulness of Neuropsychological Testing in Neurotoxicological and Head Injury Cases

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Introduction: Neurotoxicology is a developing scientific discipline If we look at some classical texts on Neuropsychology (1981)[1] and Neuropsychological Assessment (1983)[2] we see most of the references to neurotoxicological damage are about alcohol and controlled substances. Bernad (1998)[3] shows that we face greater hazards from environmental neurotoxins that we encounter in our daily lives and in our work. We have shifted our concerns regarding neurotoxins from how we can damage ourselves with them, as with alcohol, to the damage neurotoxins inflict on us, as with metals, solvents and pesticides. Hartman (1995)[4] reports that neurotoxic disorders are one of the ten leading contributors to work related diseases and injury. He presents a comprehensive table showing potential neurotoxic substances in the work place and the estimated number of workers at risk. He also shows the kinds of neurotoxins that people may be vulnerable to in different occupations.

Neurotoxins Defined: Bernad (1998) defines neurotoxins as substances, or poisons, that can temporarily or permanently damage the nervous system. We can see neurotoxic damage in. the central, peripheral, and autonomic nervous system. Neurotoxic damage can be either acute or chronic. Though acute damage can diminish nervous system structures and functions, the body

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[1]Filskov, S. B., and Boll, T. J., (eds.) (1981) **Handbook of Clinical Neuropsychology** New York: John Wiley and Sons.

[2]Lezak, M. D., (1983) **Neuropsychological Assessment** (Second Edition) New York: Oxford University Press.

[3]Bernad, P. B., (1998) **Neurotoxicology: A Clinical Source Book** Charlottesville, Va. Lexis Law Publishing

[4]Hartman, D. E., (1995) **Neuropsychological Toxicology** (second edition) New York, Plenum Press

can reverse and heal this harm. Chronic damage shows itself through deterioration of the functions and structures of the nervous system. Chronic alcoholism, for example, leads to depleted CNS neurones that reduce our ability to think. Chronic alcoholism also leads to liver damage, reducing our ability to flush neurotoxins from our system. Hartman (1995)[5] shows that environmental toxins can harm the young nervous system by damaging central nervous system growth and developmental potentials. Older people face risks because neurotoxins can deplete central nervous system resources and damage our bodies' filtering system. Working adults, face similar hazards.

More classic forms of neurological disorders show themselves in available neuroimaging techniques. Through CAT scans and MRI s we can see lesions created by tumors, ruptured blood vessels associated with strokes, subdural hematomas associated with some closed head injuries, and brain abscesses created by infection. Neurotoxic damage to cortical and subcortical structures may leave no such signs. Lead may bind to hemoglobin to deprive the central nervous system of needed oxygen. Still, neuroimaging processes may not show us potential damage to myelinated nerves and their message carrying properties. Neurotoxins may block synaptic cleft actions that transfer information from axon to dendrite.

Neuropsychological Assessment:

Kolb and Wilshaw(1990)[6] write that neuropsychology is the relationship between brain

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[5]Ibid

[6]Kolb, B., and Wilshaw, Q., (1990) **Fundamentals of Neuropsychology** (3rd ed.) New York, Freeman.

and behavior. A psychologist uses neuropsychological assessment tasks to ask questions and pose problems for the patient to solve. The clinician compares the content and quality of patients' responses to scoring criteria and to standardized norms published in evaluation manuals. So, the psychologist learns about the levels and patterns of performance the patient displays. The psychologist can also see how the patient works on evaluation tasks (Kaplan, 1988)[7]

Bernad (1998)[8] writes that behavior involves feelings thoughts and actions, with due attention to how we modulate and control our behavior. When doing neuropsychological assessments Reitan and Wolfson (1993)[9] recommend we attend to:

✓ **1.** How we receive information through our senses.

✓ **2.** How we maintain appropriate levels of alertness, retention and recall, concentration and memory.

✓ **3.** Skill we show with both over learned and newly learned verbal processes. These are skills that we probably mediate through our left hemisphere.

✓ **4.** Visual acuity and spatial organization skills that we may mediate through our right hemisphere.

✓ **5.** Skills in sequencing and planning. These are important dimensions to our abilities to modulate and control our behavior.

✓ **6.** Ability to think abstractly and flexibly.

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[7]Kaplan, E., (1988) "A Process Approach to Neuropsychological Assessment" in T. Boll and B. K. Bryant (eds.) **Clinical Neuropsychology and Brain Function: Research, Measurement and Practice.** Washington, D.C. American Psychological Association.

[8]ibid

[9]Reitan, R., Wolfson, D., (1993)**The Halstead-Reitan Neuropsychological Test Battery: Theory and Clinical Interpretation** Tucson, AZ: Neuropsychology Press.

We can use the neuropsychologist's descriptions, analysis and conclusions to consider the patient's cognitive, emotional, social, and vocational adjustments (Becker, 1986)[10] We find these dimensions critical when gathering information for medical legal purposes. This may be important to distinguish between patients we see that will require medical nursing case management and patients who show potentials for further life recovery.

Through neuropsychological evaluations patients present their complaints through their descriptions of their troubles and by the way they respond to evaluation tasks. A psychologist can assess the broader reliability and consistency of the patient's work. Still as Barth (1998)[11] reports both psychologist and patient do well to discuss how important it is that both provide their best efforts to the assessment.

Psychologists are retained by attorneys for the plaintiff and defense. Regarding the claimants complaints the psychologist has the responsibility for telling the fairest story she or he can. When considering the precipitating damage the psychologist should know that which is relevant regarding the claimant's condition. This means assessing evaluation findings to see if they are consistent with what the psychologist knows about damage related facts. Are the evaluation levels of performance and patterns consistent with the reported damage? Or do they seem out of proportion?

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[10]Becker, B., Kay, G., ***Neuropsychological Consultation in Psychiatric Practice.*** Psychiatry. Clin. N. Am. 1986: 9: 255-265.

[11]Barth J. B. 1998 Personal Communication

The psychologist also wants to know whether the patterns of evaluation findings are internally consistent. Certain groups of tests seem to co vary. Markedly discrepant test scores that, other things being equal, warrant further investigation. Through more work the psychologist may find understandable reasons for the claimants discrepant performance. Still, these differences are sometimes so baldly incongruous that they defy clinical explanation and the psychologist should so report them.

As best she can the psychologist should learn of the claimant's life circumstances that contribute to evaluation findings. A psychologist will want to know and say more if she finds that a man says that he cannot think straight because of solvent exposure. Still, his medical records show a history of heavy drinking. The psychologist who evaluates a man who has experienced a head injury will want to reevaluate his findings when he learns that the claimant has twice before been out of work because of automobile accidents and head injuries.

What we Can Learn from Neuropsychological Assessments:

Bernad (1998)[12] tells us that we cannot expect to see a signature pattern from neuropsychological assessment findings that identify a specific neurotoxin. Hartman (1995)[13] shows that, at one time or another, we can expect to see many different deficits when we assess neurotoxilogically challenged patients. Considering chronic exposure to solvents and fuels Lezak

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[12] Ibid.

[13]Ibid.

(1995)[14] finds that in different studies different subjects showed trouble with attention and memory (Anger, 1992[15]), reasoning (Linz, 1986),[16] visual spatial functions (Morrow, 1990)[17] and verbal functions (Bowler et al, 1991).[18] Lezak (1995)[19] cities the same kind of vulnerabilities for pesticides and metals.

Psychologists have used both flexible and fixed batteries to assess neurocognitive difficulties. Using information like research findings, psychologists may find selection of specific psychological assessment tasks to look at potentially endangered neuropsychological processes. Flexible battery advocates cite flexibility that the evaluating neuropsychologist can create and time saving. Flexible battery approaches work well when evaluating groups of neurotoxicologically challenged patients. Still, when evaluating an individual patient with a flexible battery, we risk overlooking patterns of strengths and weaknesses that can inform us about the patient. Kenneth

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[14] Lezak, M. D.; (1995) **Neuropsychological Assessment** (3rd ed.) New York, Oxford University Press.

[15] Anger, W. K.(1992) ***Assessment of Neurotoxicity in Humans*** in H. Tilson and C. Mitchell (eds) **Neurotoxicology** New York, Raven Press

[16] Linz, D. H, deGarmo, P. L. Morton, W. E. et. al. "Organic induced encephalopathy in Industrial Patients." *Journal of Occupational Medicine, 28, 119-125.*

[17]Morrow, L. A. Ryan, C. M., Hodgson, M. J., and Robin N. "Alterations in cognitive and psychological functioning after organic solvent exposure.": *Journal of Occupational Medicine, 32,* 444-449.

[18]Bowler, R. M., Mergler, D., Heuler G., et. al. "Neuropsychological impairment among former microelectronics workers." *Neurotoxicology,* 12, 87-104.

[19]ibid

Rickler[20] reports that if we do not look we may not see.

Prominent fixed assessment batteries have stood the test of time. Creators and advocates of these batteries propose that common cognitive processes hold the battery and its parts together. Over the years test makers and developers have chosen sub tests for comprehensive batteries that inform the clinician about diagnostically salient processes. Clinicians also look to the patterns of strengths and vulnerabilities to give information about evaluation patterns pointing to the presence and damage potentials of different disorders.

Any single evaluation process or battery of tests has trouble standing alone to show us that we need to know concerning an individual patient. So, as she or he sees evaluation patterns develop the clinician does well to supplement his or her battery with more specific tests. These tests can provide further information about receptive speech (Kaplan, 1983)[21] verbal fluency (Spreen and Benton, 1977,)[22] sustained concentration under challenging conditions found in the Paced Auditory Serial Addition Test (Gronwall and Sampson, 1974).[23] Lezak (1995)[24] and Spreen

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[20]Rickler, Kenneth Personal Communication

[21]Kaplan, E.. F., Goodglass H, and Weintraub S. (1983) (2nd ed. *The Boston Naming Test.* Philadelphia, Lea and Ferbiger.

[22]Spreen, O., and Benton A. L., (1977) ***NeuroSensory Center Comprehensive Examination for Aphasia,*** Victoria, University of Victoria Psychological Laboratory.

[23]Gronwall, D. M. A., and Sampson H., (1974) **The Psychological Effects of Concussion.** New Zealand, Auckland University Press,

[24]ibid

and Strauss (1998)[25] give comprehensive description and norms for other tests.

Batteries and Tests That Work:

The Wechsler Adult Intelligence Scale-III is the third edition of a robust intelligence test that David Wechsler created in 1939. Wechsler and test developers have taken the WAIS through subsequent revisions in 1955, 1981 and 1997 making the WAIS more clinically and neuropsychologically sensitive. The WAIS-III gives information about levels and patterns of performance for verbal comprehension, visual acuity and perceptual organization, and working memory. Using the standardization sample, test makers found difference levels between different WAIS-III level of performance measures that are statistically significant and infrequent in the standardization sample of people free of psychiatric and neurological disorders. So, we have reason to feel concern if a patient shows performance differences rare in the standardization sample. WAIS-R variants (1991)[26] let the clinician codify qualitative aspects of the WAIS that give more news about neuropsychological processes.

The Wechsler Memory Scale-III is a stronger instrument because test developers have co normed it with the WAIS-III. So we can compare the patient's levels of performance on different WMS-III indexes with her or his WAIS-III determined level of general level of intellectual functioning. The WMS-III assesses components of auditory and visual memory both immediate

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[25]Spreen O., and Strauss, E., (1998) **A Compendium of Neuropsychological Tests** (second ed.) New York, Oxford University Press,

[26] Kaplan E, Fein, D., Morris R., and Delis D. C.. , **(1991)The WAIS-R as a Neuropsychological Instrument.** San Antonio TX. , The Psychological Corporation.

and delayed. The WMS-III also gives the clinician estimates of the patient's demonstrated retention and recall of recently learned information.

Bernad (1998)[27] has comprehensively described the Halstead Reitan battery (HRB). We described Reitan's analysis of behavior earlier. He uses this model to organize the HRB. Reitan consistently included a WAIS battery as part of the HRB. For that and other reasons no HRB sub test stands alone to describe a specific neuropsychological behavior without reference to the context of the patient's assessment performance. Reitan and Wolfson created three interdependent Neuropsychological Deficit Scales (NDS)[28] Based on their knowledge of neuropsychological performance levels with impaired patients they assigned impairment levels to different performance levels for each "sub test." These levels are "perfectly normal, (0), within normal limits (1), moderately impaired (2), and severely impaired (3). They summed the scores for each "sub test" into a General Neuropsychological Deficit Scale (GNDS). They created ranges for the GNDS that are "normal," "mildly impaired," "moderately impaired," and "severely impaired." Some of Halstead and Reitan's sub tests lateralize showing left or right hemisphere vulnerability. These batteries give salient information about neuropsychological processes we associate with neurotoxicological vulnerability. They also can inform us about other salient processes like sequential planning, abstract thinking, that we might overlook by only administering a set of tests focusing on presumed sequella.

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[27]Ibid.

[28]Reitan R., and Wolfson D., (1998) **Traumatic Brain Injury Volume II**. Tucson AZ. Neuropsychology Press.

We give a comprehensive mental status evaluation when we administer the MMPI-2. Through the patient's response patterns to different clinical scales we can see how the patient looks at himself and his illness. MMPI-2 protocols contain critical items. We can use these critical items as interview prompts. Through these prompts we can learn about the sturdiness and consistency of the patient's complaints. Also, we may learn of their fragility and inconsistency. Through the Rorschach we can learn about the patient's emotional state in ways that the patient does not consciously control.

A Case in Point:

Mr. Smith first showed enough depression to warrant psychiatric hospitalization when he was a young adult. Later, he married, started a family and maintained himself as an independent business man. Over the years he saw different physicians who prescribed different antidepressants. When he reached mid life one of his parents died and his marriage failed. So, he again entered a psychiatric hospital for depression. A physician prescribed an MAO inhibitor. According to the claimant it worked wonders. This kind of medication, combined with certain foods and medications can result in hypertensive crises. Medical records showed that over the several years Mr. Smith used this antidepressant his blood pressure stayed within normal limits. Later, the claimant developed shoulder pains. A specialist prescribed a potent analgesic. Mr. Smith checked with his primary care physician about taking this medication with his antidepressant. He heard no contraindications. Mr. Smith took the medications and had a strong right hemisphere stroke.

We administered neuropsychological assessment tasks to learn if the claimant was organically intellectually impaired. He was. We also wanted to learn whether neuropsychological

vulnerabilities he showed were consistent with a right hemisphere stroke. They were. Mr. Smith showed a fan shaped array of motor and sensory vulnerabilities that reflected compromised brain structures in the frontal and prefrontal motor areas along with posterior primary and secondary tactile association areas. He also showed concentration troubles with material he saw compared with material he heard. Also, we wanted to know whether the vulnerabilities in sensing, concentrating, and thinking were more consistent with a stroke than depression. They were. Many troubles we found involved basic sensory and motor operations. Depression would not necessarily compromise these operations. Also, we found that Mr. Smith's more basic troubles lateralize to the left side going to the right hemisphere. side. We do not expect this pronounced an imbalance with depression. Neither did the Jury considering his case.

Traumatic Brain Injury Defined.

Bernad (1994)[29]writes "a closed head injury occurs when the soft tissue of the brain is forced into contact with the hard bony outer covering of the brain, the skull. If we look at skull models, we see several bony prominences at the front of the skull. They hold the temporal lobes, the frontal lobes and the mid brain. A brain rubbing against these hard sharp areas can be bruised and torn.

As we drive 20 to 50 miles per hour so do our brains. If we hit something, we stop. Our brains do not as they slide forward against the brain's basal prominence stopping at the skull's frontal bones. Then the brain snaps back over the same areas. We can think of our brains as great

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[29]Bernad, P. (1994) **Closed Head Injury, A Clinical Source Book.** Charlottesville, Va. page 2.

knots tied at the end of a "rope" the spinal chord. This "knot" can be snapped back and forth and around by the accident's force and subsequent torque. Axons can snap and shear. Bernad (1994)[30] writes "head injuries can cause . . . concussions, contusions, brain stem injuries, . . . anoxia, . . . lacerated and blocked blood vessels."

Incidence and Prevalence:

Bernad (1994)[31] also details the incidence and prevalence of head injuries He reports approximately two million head injuries per year. Of the 5,000,000 hospitalized brain injured patients 90,000 are disabled for life. Young men between 15 and 24 are most vulnerable for head injuries. Health service providers describe 75% of each year's head injuries as mild.

Neuropsychological Sequella of Closed Head Injuries.

Lezak (1995)[32] defines mild head injuries as "with loss of consciousness less than 25 to 30 minutes, if any and Post Traumatic Amnesia measured in hours rather than days." She reports that patients experiencing mild closed head injuries are not likely to immediately consult physicians about mental troubles. Patients are more likely to be concerned with physical damage, getting back to work and on with their lives. Weeks after the accident patients may notice neuropsychological vulnerabilities associated with mild closed head injuries. Citing many research studies, Lezak describes these troubles. They include troubles with retention and recall, difficulties in maintaining

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[30]ibid pp 3-4

[31]Ibid.

[32] Lezak, M. D., **Neuropsychological Assessment** (3rd ed.) New York, Oxford University Press, page 182

focused concentration in the face of distractors, trouble processing two activities simultaneously. Closed head injury patients may have troubles with word finding and with verbal fluency under controlled conditions. Lezak says that patients can conduct their daily affairs but at cost. They become tired more quicky. Their feelings are rawer. People conducting their lives with closed head injuries may feel like they are driving a car with the hand brake on.

Closed head Injury Assessment:

We have already described our preference for well-established assessment batteries. They keep us grounded regarding a person's levels and patterns of thinking. Also, we know the importance of using selected assessment tasks that will clarify closed head injury performance troubles.

A Case to Consider:

We evaluated a woman who had been in an automobile accident. She was a rear seat passenger in a car parked in a parking lot. She and her colleagues were going to lunch. Another car struck this parked car and the claimant struck her head on the door post.

Before the accident the claimant worked as a consultant on high tech projects. Coworkers and supervisors said that she had salient information at her fingertips. She had the lioness' share of responsibility for raising her two daughters. They were adults when she was hurt. They said she did well. Following the accident the claimant complained of troubles in thinking and concentrating. Her supervisor reported she had trouble recalling information she knew well before. Her daughters reported that she was much more emotional and prone to frustrated, angry outbursts. We saw her express catastrophically toned anxiety when she could not complete evaluation tasks. Health

service providers established that the claimant had left hemisphere mediated partial complex seizures.

When we evaluated the claimant, we first found that she did not show summary Neuropsychological Deficit Scale scores in the impaired range on the Halstead Reitan battery. Still, Retain believes we need to look at overall levels of performances, patterns of performance, and troubles with specific evaluation tasks to come to diagnostic conclusions.

We did find that the claimant did less well with intelligence test verbal tasks than she did with action oriented performance tasks. Also, we discovered that she had more trouble with verbal memory tasks, where she operated in the low average range, at the 14th percentile than she did with visual memory tasks, where she operated in the average range at the 67th percentile. The claimant's level of performance with short term memory tasks were in the borderline range at the 5th percentile. The claimant was right-handed. Still, she showed more trouble with right sided, left hemisphere mediated motor strength and motor coordination tasks. She showed greater strength and coordination with left sided, right hemisphere mediated motor tasks.

The claimant showed cognitive adequacies. Still she showed trouble with verbal memory tasks, with short term memory and with delayed recall that was at the 4th percentile. Because of these evaluation findings supplemented with reports about her past and current functioning, we did not believe that the claimant could resume the kind of work she did before. A Jury agreed.