



# Fundamental Considerations in Neuropsychological Assessment

Brent Van Dorsten PhD

President: Colorado Center for Behavioral Medicine

720-315-3530 (cell); [vandorsten@ccbm.com](mailto:vandorsten@ccbm.com)



# Introduction to Neuropsychological Testing: Purpose, Goals and Use of Results

- ▶ Assess the presence, nature and severity of cognitive dysfunction. Can provide baseline standard against which to monitor future changes in cognitive ability.
- ▶ Evaluate the relative contribution of both cognitive and psychiatric factors to cognitive dysfunction
- ▶ Provide recommendations for treatment planning, including a profile of strengths and weaknesses to guide rehabilitation, work or school services
- ▶ Assess functional readiness for school, work, driving, financial planning, or assume major life roles

# Diagnosing Injury to the Brain

## ► Concussion/mTBI

- A concussion is a traumatic brain injury that affects brain function. Effects are usually temporary and can include headaches and problems with concentration, memory, balance and coordination, vision and hearing.
- Concussions are usually caused by a blow to the head. Violently shaking of the head and upper body also can cause concussions.
- Some concussions can cause loss of consciousness, but the vast majority do not. Most people usually recover fully after a concussion within days to weeks.
- Falls are the most common cause of concussion. Additionally, contact sports, auto accidents, accidental strikes to the head or physical assault can produce concussion symptoms

## ► Diagnostic Criteria for Concussion/mTBI

- American Congress of Rehabilitation Medicine Traumatic Brain Injury Special Interest Group **(1993)**.
- (+/- loss of consciousness), (+/-) post-traumatic amnesia, ANY verbal report of alteration of cognitive status (e.g., “saw stars, bonked my head, dizzy, confused, dazed, out of it”). **VERBAL DIAGNOSIS**

# Diagnosing Injury to the Brain

- ▶ **NEW** Diagnostic Criteria of Concussion/mTBI
  - ▶ American Congress of Rehabilitation Medicine Traumatic Brain Injury Special Interest Group **(2023)**.
  - ▶ ONE OR MORE clinical **SIGNS** following **biomechanically plausible mechanism of injury to brain**
    - ▶ LOC **immediately** following the injury
    - ▶ Alteration of mental status **immediately** following injury (reduced response to external stimuli, slow to respond to questions, inability to follow 2-step commands, disorientation to person/place/time/circumstance)
    - ▶ Complete or partial amnesia to events **immediately** following injury
    - ▶ **Immediate** neurological signs (documented discoordination w/ standing, seizure, tonic posture)
  - ▶ TWO OR MORE acute **SYMPTOMS** after **plausible** injury to brain
    - ▶ Acute alteration in mental status: confused, disoriented, feeling dazed
    - ▶ Physical symptoms: headache, nausea, dizziness, balance, vision, light/sound sensitivity
    - ▶ Cognitive symptoms: feeling slow, “mental fog,” decreased attention/concentration/memory
    - ▶ Emotional lability or irritability
- ▶ **Neuroimaging** abnormalities, **Clinical exam** findings (cognitive, balance, vision, hearing)

# Diagnosing Injury to the Brain

## Diagnostic Criteria of Brain Injury Severity

**VA/DOD (2016).** Clinical Practice Guidelines for the Management of Concussion- Mild Traumatic Brain Injury – Version 2.

	<u>DoD/VA Criteria</u>		
	<b>Mild</b>	<b>Moderate</b>	<b>Severe</b>
<b>Structural imaging</b>	normal	Normal or abnormal	Normal or abnormal
<b>LOC</b>	LOC < 30 min with normal clinical CT/ MRI	LOC < 6 hours with normal or abnormal CT/MRI	LOC > 6 hours with normal or abnormal CT/MRI
<b>GCS</b>	GCS 13-15	GCS 9-12	GCS < 9
<b>PTA</b>	PTA < 24hr	PTA < 7days	PTA > 7days
<b>AOC</b>	up to 24 hours	> 24 hours	>24 hours



# Diagnosing Injury to the Brain

## ➤ Mild, **Complicated** TBI

- Diagnostic criteria consistent with mTBI, but with **positive imaging** (hematoma, etc.)
- Prognosis for recovery commonly considered more similar to moderate than mild injury\*

## ➤ “Post-Concussive Syndrome”

- A **non-diagnostic** term frequently used to describe transient persistent symptoms following concussion. Typically refers to symptoms extending more than six months post-injury
- **NOT A SPECIFIC DIAGNOSTIC LABEL** – Symptoms are non-specific and do not associate with a specific condition. Symptoms widely reported by **non-head injury** medical patients, personal injury claimants with **no** injury to the head, and healthy undergraduate students

Lees-Haley et al. (2001), Lees-Haley & Brown (1993), Gouvier et al. (1988), Stucky et al. (2020), World Health Organization (2011)

- **High** incidence of symptoms in fibromyalgia, CX fatigue syndrome, pain, depression, anxiety
- Chronic PCS symptoms more closely related to depression and anxiety than to TBI

Donnell et al. (2012), Iverson 2006, Meares et al. (2008, 2011), Ponsford et al. (2012), Vanderploeg et al. (2019)

# Components of Comprehensive Neuropsychological Examination

## Record Review

- ▶ Accident Report, EMT/Ambulance, ER evaluation records
  - ▶ LOC time, PTA, confusion, disorientation, sensory/balance symptoms
- ▶ Report of “Developing” symptoms over 1-2 Weeks
- ▶ Consistency over time in report of accident, LOC, PTA, confusion
- ▶ Educational History: Grades/GPA/Achievements
  - ▶ Special education, repeated grades, remedial education
- ▶ Employment History: Cognitive demand, achievements
- ▶ Medical History
  - ▶ ER evaluation/observations, neuro exam, GCS scores, MRI/CT results
  - ▶ Prior history of injury to head, hospitalizations, extent of recovery
- ▶ Mood/Cognitive History
  - ▶ Mood disorders, diagnoses/treatment, ADD/ADHD
  - ▶ Prior neuropsychological testing, SLP/Cognitive test results\*

# Components of Comprehensive Neuropsychological Examination

## Interview Assessment

- Self-report of injury event, acute symptoms, acute assessments and treatment recommendations, change in symptoms across time
- Diagnosis, *perception of prognosis*, *information received* regarding diagnosis, prognosis, recovery time – ***injury beliefs***
- **Changes in physical, affective, cognitive, functional factors over time since injury and attributed to injury to head**
- Any prior testing since injury, recall of results
- Mood history, medications, diagnoses, treatment
- Comprehensive **assessment of pre-injury functional ability**/hobbies/employment/education
- Influence of injury on current/future function
  
- Strong focus on change in function since injury vs. report/test results



# Neuropsychological Testing

- ▶ Administered in Person via Telepsychology, Length of Battery
  - ▶ Fixed vs. Flexible Battery/"Hypothesis Testing"
  - ▶ Most Common Areas Assessed
    - ▶ Memory (visual, verbal, working, non-verbal)\*
      - ▶ Immediate Memory/Novel Learning vs. Delayed Recall
    - ▶ Concentration/Attention/Sustained Attention (Serial 7's, coding)
    - ▶ Processing Speed\*
    - ▶ Language/Verbal
    - ▶ Visuo-Spatial
    - ▶ Executive Function\*
    - ▶ Psychomotor Speed/Dexterity
- ▶ Did they receive comprehensive feedback regarding neuropsych testing results? Verbal or in writing so they could review later? Are these results being utilized for treatment?

# Finding “Something” vs Finding Something Meaningful with Testing

Neuropsychological tests are written to be “sensitive” and NOT “specific.” These factors mathematically describe the accuracy of a test to report the presence or absence of a specific condition (depression, memory dysfunction)

- ▶ Sensitivity: The probability of a “positive” test result accurately representing that an individual truly has the condition in question (true positive rate)
- ▶ Specificity: The probability of a “negative” results accurately representing that an individual truly does not have the condition (true negative rate).
- ▶ A test which reliably **detects** the presence of a condition (high number of “**true positives**” and low number of “false negatives” = “high sensitivity”)
- ▶ A test which reliably **excludes** those who **do not** have a condition (high number of “**true negatives**” and low number of “false positives” = “high specificity”)
- ▶ Testing is a trade off between sensitivity and specificity – important to detect/treat serious conditions, and exclude others due to potential expense, additional testing, threat of treating a false condition (0.9 specificity criterion)

# Performance and Symptom Validity Testing

Purpose: To mathematically determine the probability of “credible **effort**” on neuropsych performance tests (PVT), and “credible **symptom report**” on symptom validity tests (SVT)

- ▶ Existing literature consistently shows “non-credible” performance in **20-40%** of neuropsychological cases with medico-legal/“incentives”
  - ▶ 32% VA benefits (Shura et al), 33% WKCP (Bianchini et al), 45% SSDI (Clark, Martin, Schroeder et al.)
- ▶ Widely accepted in professional neuropsychological literature that ALL clinical and forensic cases **MUST** employ a variety of PVT/SVT
- ▶ Average # tests - **6-8**, if  $\geq 2$  PVT/SVT failed, results “non-credible”
- ▶ Will not tell you **WHY** a PVT/SVT test is failed, only that the result is “non-credible” in comparison to other populations who pass
  - ▶ PVT’s can be “stand-alone” single tests, “forced choice,” or “embedded”
  - ▶ SVT’s can be “general pathology” or condition specific (e.g., PTSD)

# Performance and Symptom Validity Testing

Premise: Validity tests are designed to be sufficiently simple that populations of patients with verified injury/deficits routinely pass them. When those with “minor” deficits fail more than one of them....

Factors other than injury which might falsely lead to “invalid” results?

- Depression/Anxiety **not** associated with invalid PVT Boone (2021), Schroeder & Martin (2021)
- “Cry for Help” **not** associated with invalid PVT Goedendorp et al. (2013)
- Pain **not** associated with invalid PVT Gervais et al. (2001), Greene (2009)
- Medication/Opioid use **not** associated with invalid PVT Dorociak et al. (2018), Rohling (2013)
- Fatigue **not** associated with invalid PVT Dorociak et al. (2018), Kalfon et al. (2016)
- Somatic Symptom Disorder **not** associated with invalid PVT Boone (2021)

Symptom validity assesses the probability that a patient’s reported symptoms are consistent with those of populations with even significant disease or injury



# Neuropsychological Testing Fallacies

- ▶ Normal, healthy people will produce “normal” results on all neuropsych tests
  - ▶ Schretlen et al. (2003). Administered 15 tests to 197 adults in “normal aging” study. Results: **60%** produced results with 3 SD (97.5%) difference between highest and lowest scores. HIGH variability in scores is the NORM and NOT the EXCEPTION. High variance in scores is NOT “evidence of injury.”
  - ▶ Russell et al. (2005). When 1 SD is used as criterion for “impaired,” 1/6<sup>th</sup> (**16.7%**) of scores will be impaired by random variability or chance.
- ▶ Smart people will produce superior results in all areas of neuropsych testing
  - ▶ Zakzanis & Jeffay (2011). Tested 20 PhD's from across multiple divisions on a university faculty. Results: As a **group**, produced high average to superior scores across all test measures. Individually, demonstrated significant variability across test domains.
    - ▶ In **20%**, more than half the scores were more than 1.5 SD BELOW the IQ-related mean
    - ▶ In **10%**, at least one score was “borderline, In **15%** at least one score ranged as “intellectually disabled”
  - ▶ Jeffay, Binder & Zakzanis (2021). Tested 24 doctoral students (all > MA/MS equivalence)
    - ▶ Highest to Lowest scores AVERAGED 1.25 SD difference (~90% difference)
    - ▶ **46%** with at least one score > 2 SD below group mean, **92%** with one score > 1 SD below group mean



# Interpretation of Neuropsychological Test Results

- ▶ Validity Results– Having an opinion versus having a **VALID** opinion
- ▶ Normal comparison range – Age, education
- ▶ High score variability – the NORM, not the EXCEPTION
- ▶ Education and variability (PHD)
- ▶ Identification of Patterns in test results -  
memory/concentration/attention, all verbal/non verbal deficits
- ▶ Are deficits consistent with **verbal report** of symptoms AND **daily behavioral abilities??**
- ▶ Do score deficits reasonably match location of reported head strike and/or imaging issues?

# Prognosis for Cognitive Recovery

15

## ➤ Mild TBI/Concussion

- Full **cognitive** recovery within days to weeks with –or without- treatment
- Persistent symptoms – or worsening of symptoms – contrasts prognosis

Belanger et al. (2005), Carroll et al. (2014), Frenchham et al. (2005), Granacher (2015), Iverson et al. (2019)

## ➤ Moderate/Severe TBI

- Data is **Equivocal**: Recovery *may* occur over longer period of time (up to 18 months) and *may* be partial in recovery in some domains
- Many studies suggest that microbleeds on imaging **NOT** associated with more persistent concussion symptoms or longer return to work.

Hanlon et al. (1999), Hughes et al. (2004), Huovinen et al. (2021)

# Factors Influencing Cognitive Test Results and Recovery

- ▶ TBI Severity (severe/coma vs mild/transient injury)
- ▶ **MULTIPLE INJURIES – in very close proximity (72 hours)**
- ▶ Age > 65-70
- ▶ History of Neurological Disorder
  - ▶ MS, SLE, Parkinson's Disease, CVA/MI/TIA, Hypoxia/Anoxia with deficits, ADD/ADHD, Epilepsy, Chronic Fatigue Syndrome, Fibromyalgia, Thyroid disease, Alzheimer's/Dementia, Aneurysm, HIV infection, Tumor, Encephalitis/Meningitis
- ▶ Low Levels of Education: Level, grades/GPA, MR/DD, Learning disability
- ▶ Mood: High Levels of Somatization or Emotional Distress/Anxiety/Depression
- ▶ Motivation/Secondary Gain: Litigation, Disability Seeking/Incentives, Worker's Compensation, Overt/Covert Incentives for Persistent Impairment
- ▶ High Levels of Distress/Somatization of Emotional Distress

# Factors Influencing Test Results and Cognitive Recovery

## ➤ Depression/Anxiety

- Major depression/anxiety associate with impaired cognitive performance on executive function, processing speed, verbal reasoning and memory, cognitive flexibility, number and persistence of concussion symptoms. **Strong association: mood and PCS symptoms**

Terry et al. (2019)

DeVito et al. (2019), Iverson (2006), Ponsford et al. (2012), Snyder (2013),

## ➤ Orthopedic Injury

- Patients with orthopedic injuries report a wide variety of cognitive, affective and somatic/sensory complaints similar to mTBI
- Orthopedic injury populations commonly recommended as the best comparison group for TBI complaints in patients injured in auto/work accidents given common physical complaints

De Koning et al. (2016), Ettenhofer & Barry (2012), Ponsford et al. (2011)

## ➤ Litigation

- Shown to associate with stable or worsening cognitive complaints over time

Belanger et al. (2005), Kashluba et al. (2008), McRae et al. (2009), Wortzel & Granacher (2015)

## ➤ Fatigue/Non-Restorative Sleep/Obstructive Sleep Apnea

- Widespread impairment on Cognitive Scores

Bucks et al. (2013), Olathe & Bucks (2013), Pilcher & Huffcutt (1996), Vanek et al (2020)

# Factors Influencing Test Results and Cognitive Recovery

## ► Pain

- Numerous studies demonstrate neuropsychological impairment in patients with chronic pain or pain of moderate/severe intensity – particularly on measures of attention, processing speed, memory (working and delayed), executive function, mental flexibility, language, problem solving and grooved pegboard.


Hart (2000), Heyer et al. (2000), Higgins et al. (2018), Mazza et al. (2008), Nery et al. (2022), Nicholson (2000)

- Landro (2013), Schultz et al. (2018). **20%** of patients with pain performed below cut-off for clinically significant impairments. Weiner et al. (2006). Pain severity **inversely correlated** with neuropsych performance
- Results readily suggest cognitive deficits up to **1 SD** below mean in patients with pain



# Factors Influencing Cognitive Recovery

- ▶ Prior Concussion/Multiple Concussions over Lifetime
  - ▶ Widely portrayed in the media, and considered by many “experts” to predict long-term failure to recovery following a subsequent injury
  - ▶ Despite this “common knowledge” assumption, preponderance of empirical literature suggests *minimal and insignificant effect* of more than one concussion on cognition
    - ▶ **Minimal and insignificant effect** of multiple injuries – meta-analysis Belanger et al. (2010)
    - ▶ **No evidence of cumulative effect** of 1, 2, or 3 or more TBI in children Bijur et al. (1996)
    - ▶ **No significant linear association** between cognitive outcomes and total number of concussions, concussions with LOC, or years played in NFL Fields et al. (2019)
    - ▶ **Minimal effect of cumulative TBI events on outcome.** Full recovery expected within 90 days and 7 days for mild sports injuries – meta-analysis Karr et al. (2014)
- ▶ “Myths and Misconceptions” about TBI Bradford (2015)
  - ▶ Surveyed 181 mental health professionals about 19 **common TBI myths and misconceptions**
  - ▶ Total correct (51%) with primary errors in “lengthy recovery” and “poorer overall outcome”



# Factors Which Must Be Considered When Interpreting Neuropsychological Test Results

- ▶ Injury Characteristics to Brain
- ▶ Education history, intellectual job demands, achievements
- ▶ Baseline health/psych/functional characteristics
- ▶ Mood: depression, anxiety, PTSD, bipolar disorder, ADD/ADHD, additional psychiatric conditions requiring medication
- ▶ Medications/Side Effects: neurologic, opioid, sleep, psych meds
- ▶ Substance use: Abuse, withdrawal, cannabis, alcohol, others
- ▶ Pain – chronicity, multiple sites, intensity
- ▶ Orthopedic Injury: severity, location, chronicity
- ▶ **Would have to confidently rule these out to conclude that any cognitive deficits on testing were solely due to “accident”**



# Factors Which Must Be Considered in Interpreting Neuropsychological Test Results

- ▶ Neurological conditions or injury characteristics: hearing, vision, speaking, dizziness, dominate hand use. Do injuries potentially interfere with testing performance?
- ▶ Sleep disorders, fatigue, non-restorative Sleep, OSA
- ▶ Motivation: Adherence vs. Resistance (timed tasks, memory)
  - ▶ PVT, SVT results
- ▶ Neuropsychologist must evaluate and eliminate each potential confound to confidently consider brain injury alone

# Summary

- ▶ Standard Questions Posed for Evaluation
- ▶ Constructing the Test Battery to Answer the Question
  - ▶ Fishing expedition or are we answering a particular question ?
- ▶ Validity Determination
- ▶ Scoring/Interpretation for Patterns in Comparison to Clinical Complaints and Daily Behavioral Functional Abilities
- ▶ Determining Prognosis/Treatment Recommendations
- ▶ Establishing Value of any Re-Testing
- ▶ Clearly Stating what Neuropsychology WILL Tell Us and what it WON'T Tell Us