

Neuropsychology of Brain Injury

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Case 1: The Delivery Man

- 48 years old
- MVA
- Brief loss of consciousness
- CT negative
- Brain injury?

Case 2: The High School Coach

- 19 years old
- Significant concussion with LOC
- Multiple prior concussions
- No hospital trip but lingering symptoms
- Brain injury?

Case 3: The Grandmother

- 73 years old
- Slip and fall at work, no LOC
- CT finds small bleed in left/frontal
- Family concerned about dementia
- Brain injury?

The Delivery Man

- Multiple cognitive symptoms quickly emerge
- Patient is afraid to drive
- More irritable and depressed, wife and kids notice
- Neurologist identifies a post concussive syndrome
- Is this brain injury?

The High School Coach

- Quickly resumes coaching sessions
- Headaches diminish after a few weeks
- Parents/teachers/students notice a change
- Grades failing at college
- More depressed/withdrawn
- Starts skipping practices
- Is this brain injury?

The Grandmother

- Daughter moves in after the fall
- The grandmother does not seem the “same”
- Rapidly forgetting information
- Physical injuries with fall take their toll
- Family considers moving her to a full-time care center
- Is this brain injury?

The Grandmother

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- The grandmother does not seem the “same”
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- Is this brain injury?

Well, how do we find out?

Neuropsychology

- A discipline merging psychology and neurology to better understand brain-behavior relationships
- Evolved from behavioral neurology
- Transition from strictly diagnostic to diagnostic + functional

Neuropsychology

- Objectively measures and quantifies cognitive functioning
- Psychiatry, neurology, and psychology cannot do this
- The brain is complex and so there is not a 1:1 correspondence between the size of an injury and functional consequences

AMA Chapter 13

- Neuropsychological assessment is required to identify mental status, cognition, and highest integrative functioning in all but the most severely impaired individuals (in which screening measures can serve)
- Clinical Dementia Rating (CDR)
- Includes a 0-3.0 scale for memory, orientation, judgement/problem solving, community affairs, home and hobbies, and personal care
- Neuropsychological testing objectively assesses all six domains (latter three vis-à-vis independent living scales)
- Overall CDR score directly maps onto WPI scores
- GAF still used for psychiatric disorders

DSM-5 and CDR

- Neuropsychologists diagnose mild and major neurocognitive disorders
- A mild neurocognitive disorder generally corresponds to a CDR score of 0.5 to 1.0 (1-29% WPI)
- A major neurocognitive disorder corresponds to a CDR score of 1.0 to 3.0 (15-70% WPI)
- Neurologists, psychologists, and psychiatrists cannot diagnose these conditions without a neuropsychologist's examination

Medical-Legal Context

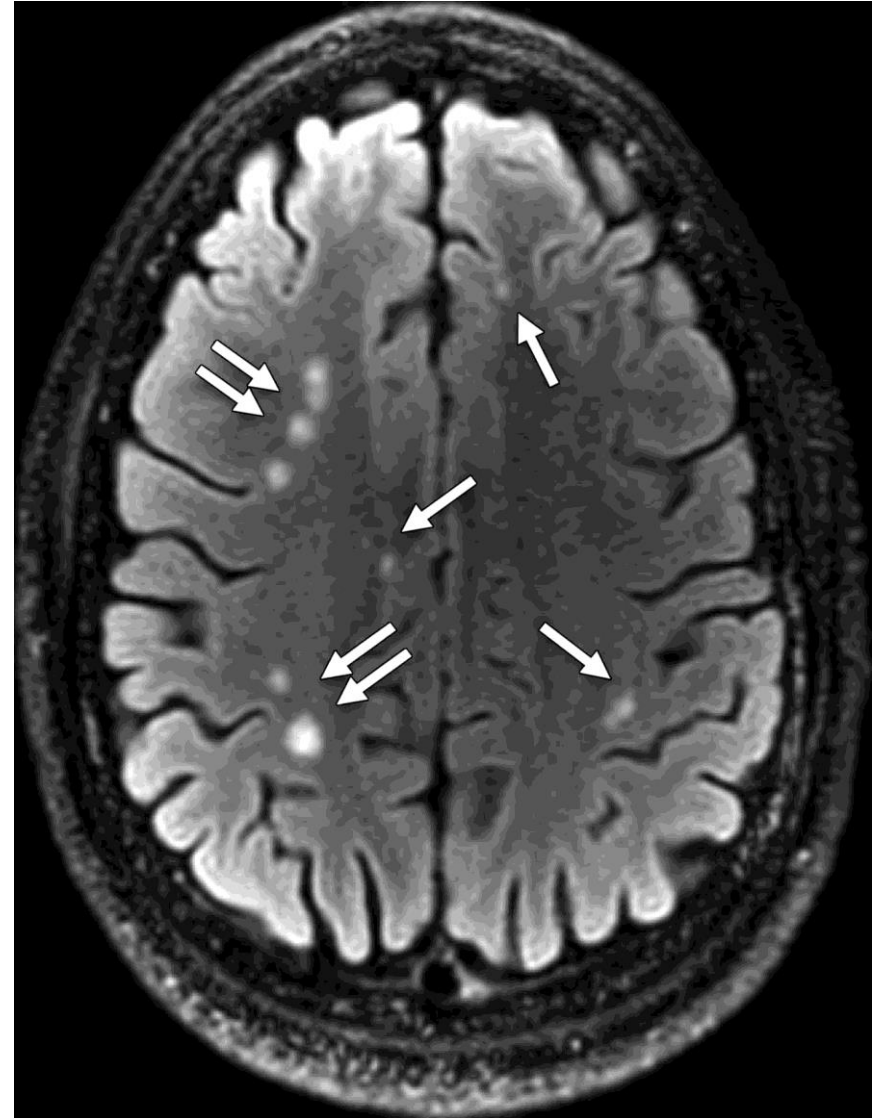
- Without a neuropsychologist's examination, mild and major neurocognitive disorder diagnoses can and will be contested (and ultimately necessitate a neuropsychological examination to be upheld)
- As such, an applicant's WPI in regard to cognitive functioning is called into question without the examination
- Neuropsychological examinations have the added benefit of ruling in/out non-neurological explanations for poor test scores (as described later), which cements the validity of a neurocognitive disorder diagnosis

Neuropsychology

- Even if the MRI shows brain damage, it is the functional manifestation of that injury that is salient.
- Is there disability?
- How does it impact work, school, social functioning, treatment planning?

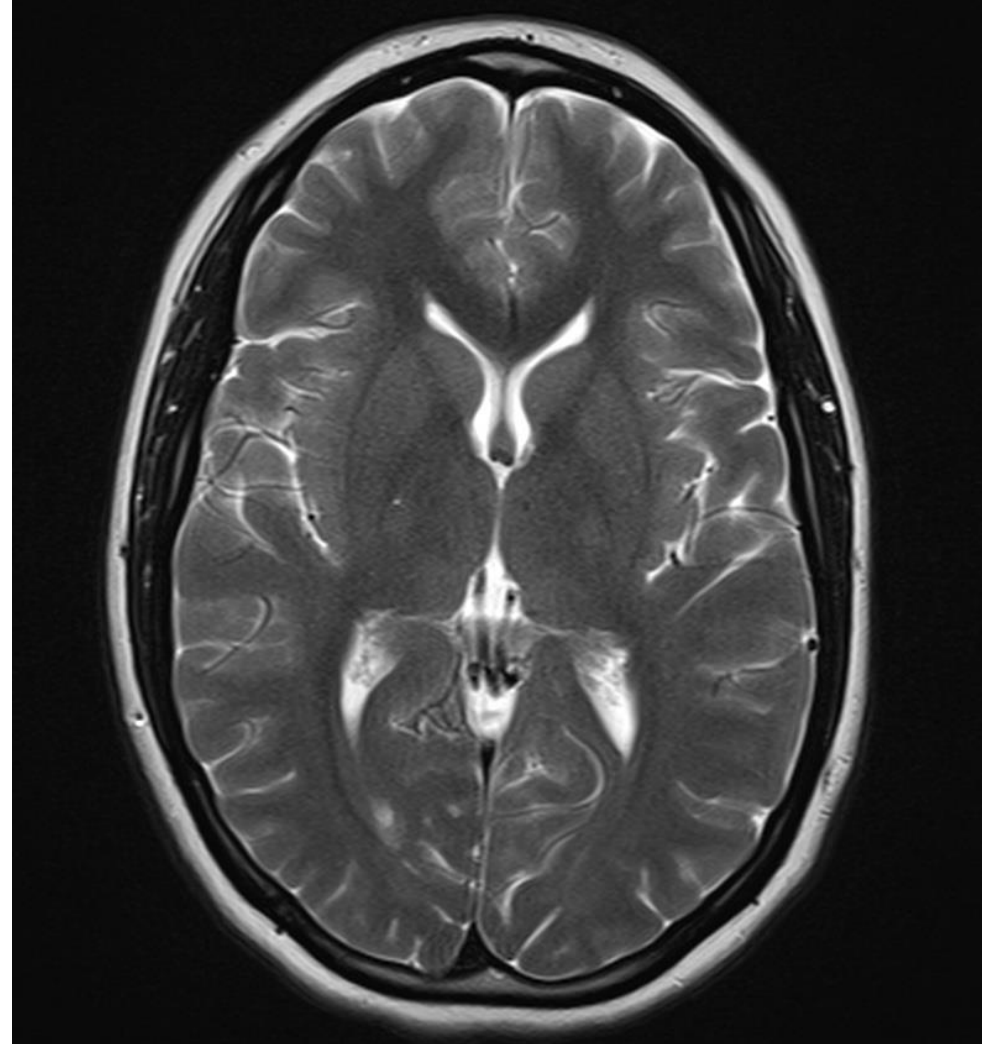
Ex 1: Blast injury

- Multiple white-matter lesions
- The patient is depressed
- Neuropsychological testing shows the patient can likely resume work and the depression is a psychological, not neurological, reaction to the injury



Ex 2: Motor vehicle accident

- Unremarkable MRI
- The patient complains of slowed thinking and poorer memory
- Neuropsychological testing confirms objective decline of cognitive functioning
- The patient cannot function at the level of the pre-accident injury



Assumptions

- All human behaviors rely on the nervous system (including the brain).
- Reflexive: limb withdrawal from pain
- Intentional: reaching/grabbing/etc.
- Cognitive: Mental processes reflecting higher-order abilities

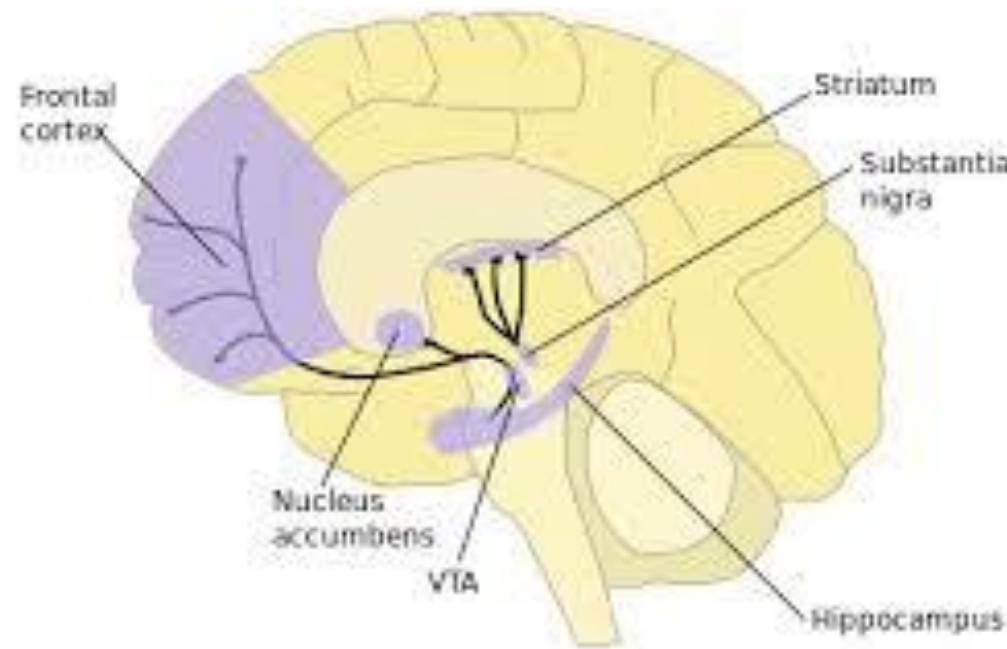
Methods

- Application of a neurological and psychological examination toward cognitive functions
- Performance on standardized measures inform on one's level of ability relative to
 - Others of a similar background
 - One own's expected and observed performance across domains

Validation

- Different cognitive tasks use different parts of the brain
 - “Language” network
 - “Frontal systems” network
 - “Memory” network
- Many of our tests have been validated from lesion studies and neuroimaging methods

Example: Frontal/striatal network



“Neuropsychological”

- Poor performance on measures may be due to neurological factors
- Evidence supporting this if patterns of scores match:
 - Clinical history
 - Neurobehavioral features
 - Neuroimaging findings
 - Prototypical neurocognitive profiles
 - Medication and pain

Neuro“psychological”

- Poor performance on measures may also be due to non-neurological factors
 - Depression and anxiety
 - Post-traumatic stress disorder
 - Personality traits
 - Somatization
 - Poor effort

Effort

- Standalone measures
- Embedded measures
 - Scattered throughout the battery within actual tests
 - Failure on two or more is of concern
- Malingering?

Functional Outcome

- Neuropsychological testing can provide broad estimates of general functioning
- Mild versus Major Neurocognitive Disorder
- Research on deficits correlating with impairment in the real world
- Functional capacity measures
- Opinions on specific cases contingent on multiple factors

Challenges with Diagnosing TBI

- About 80% of all reported TBIs are mild in nature
 - Not synonymous with concussion
- Most mild TBIs are uncomplicated and do not show acute structural neuroimaging findings
- About 85% of individuals who experience a single uncomplicated mild TBI will make a full recovery within 3 months (if not days)

Definitions

- “Concussion” – a temporary alteration of consciousness due to a blow to the head
- “Mild TBI” – a category measuring the severity of an injury contingent on specific clinical factors (GCS, PTA, LOC)
- “Head injury” – any injury involving the head (including facial fractures, damage to cranial nerves, scrapes to the face, etc.)
- “Brain injury” – an injury that has directly affected the brain

Miserable Minority

- About 15% of individuals continue to have persistent post-concussive symptoms that last for months or even years after the initial injury
- Many post-concussive symptoms overlap with somatic and psychological complaints
 - Did PCS cause depression or did the depression mimic PCS?

Scenario 1: “They’re Faking!”

- Of course some individuals seek litigation strictly for secondary gain and hope for a payout
- Effort testing can weed out a majority of these cases
- If in doubt, consult with an expert you have worked with to see if the case makes clinical sense

Scenario 2: “They have psychological disturbance”

- Some individuals have made a cognitive recovery but the experience of the accident or fears of a brain injury contribute to subjective problems
- Neuropsychological testing can help differentiate between psychological dysfunction and neurological dysfunction to address this
- Depression, anxiety, PTSD, somatization disorders that are linked to the accident can still be compensable

Scenario 3: “They have a brain injury”

- Some individuals have sustained long lasting neurological damage from a mild TBI
- Neurocognitive testing with specific patterns will support signs of this damage
- Cognitive rehabilitation and medication can help control symptoms and aide in recovery

Risk Factors

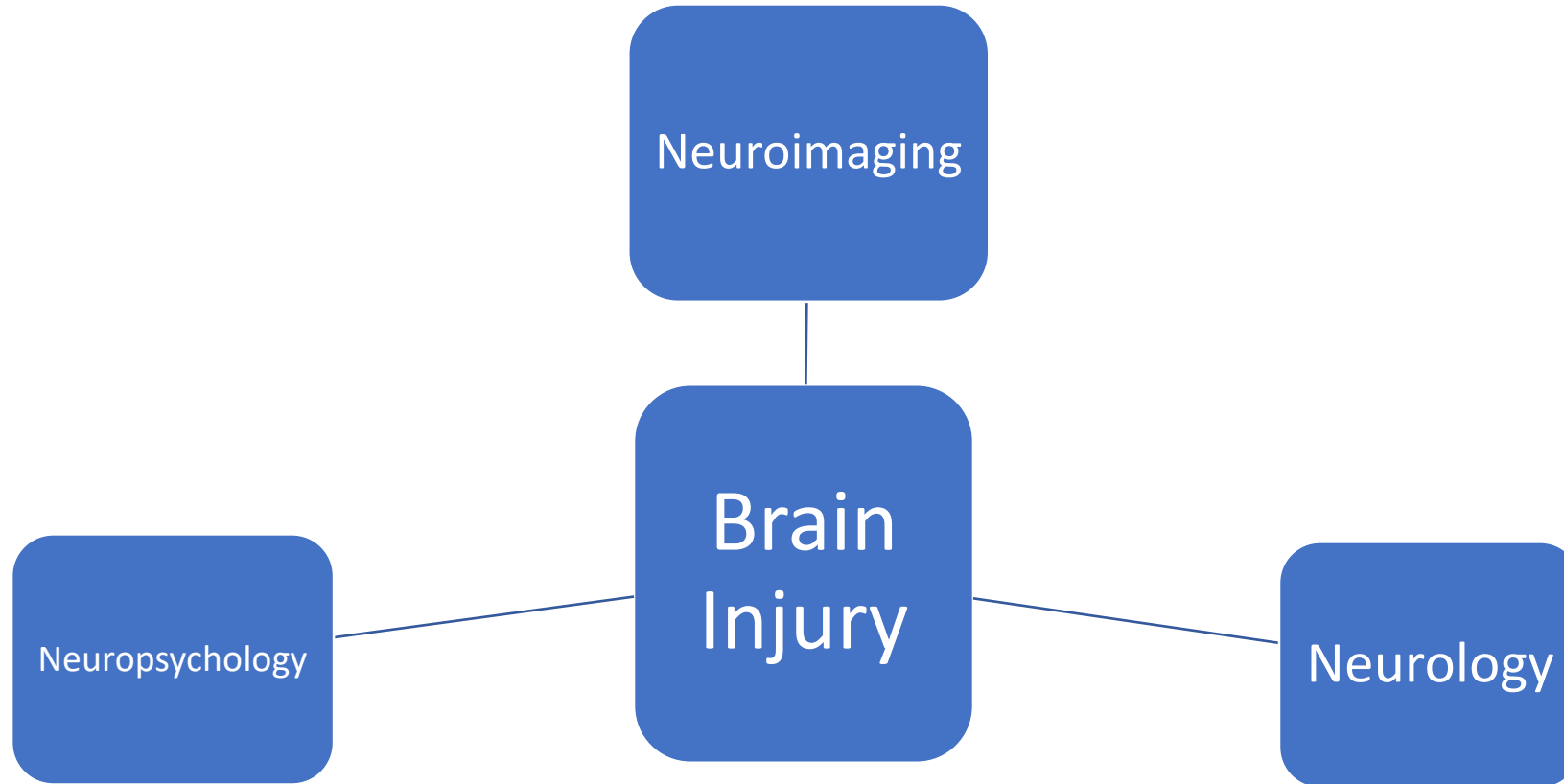
- Age
 - Young versus old brain
- Mechanism
 - Car accidents and other coup countrecoup injuries
- Cognitive reserve
 - Lower general abilities
- Medical comorbidity
 - Hypertension, diabetes, other vascular risk factors

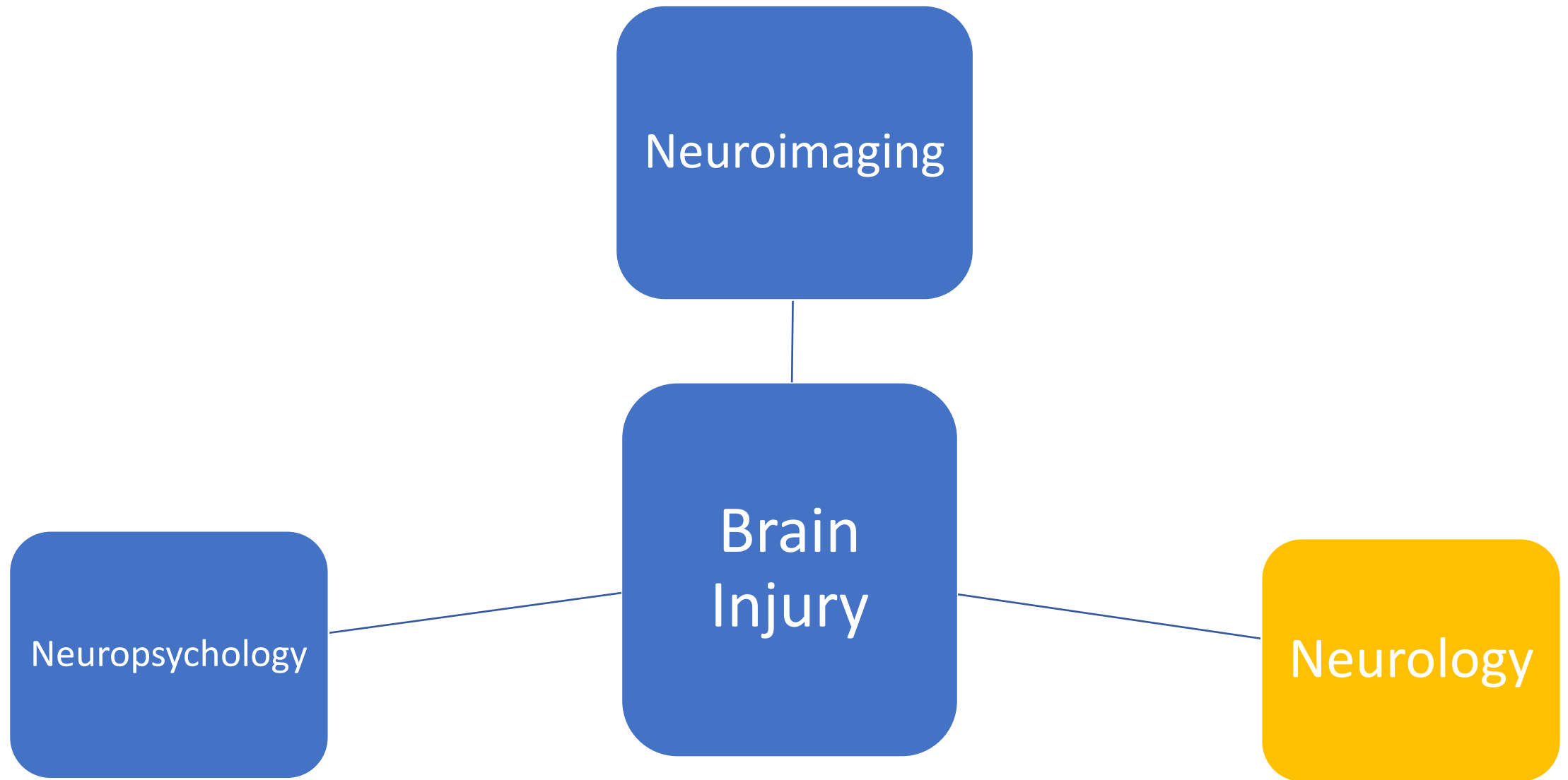
Neurological Explanations

- White matter disruption
- Autonomic disturbance
- Microvascular bleeds (e.g. TIAs)
- Secondary infections
- Severity estimates are still observational and not precise

So How Do We Diagnose a
Brain Injury?

Three Legs





The Neurological Examination

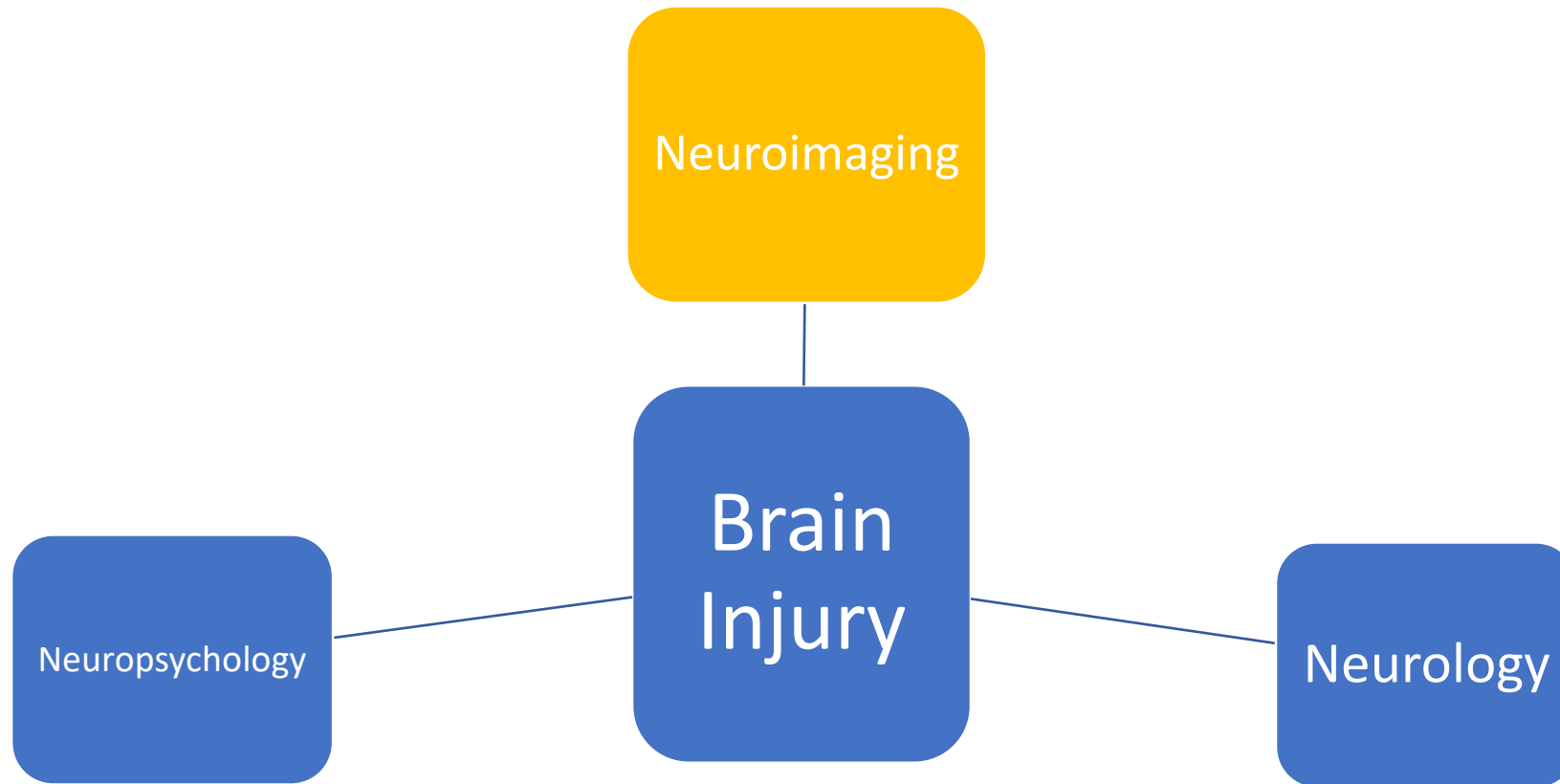
- Examination of central and peripheral nervous system functions
- Sometimes evidence of CNS dysfunction can be found through motor/sensory tests
- Brief cognitive screeners can identify signs of cognitive disturbance
- A thorough review of medical factors that might explain presentation

Strengths

- Provides a medical examination that can rule-in/out other causes of subjective problems (e.g. medication side-effects, preexisting conditions)
- Examines sensory/motor functions that may be affected by a brain injury
- Provides a brief screener of cognitive dysfunction
- Neurologists are often the first to diagnose a brain injury and persistent post-concussional state

Limitations

- The neurology examination does not provide specific estimates of cognitive dysfunction
- Other reasons for poor performance on cognitive testing are typically not addressed
- The elemental examination may not be sufficient to pick up subtler signs of brain damage



Neuroimaging

- Structural imaging does not always show acute bleeds
 - CT and subdural hematomas
- Standard methods of imaging the brain in the ER can miss milder signs of damage
- MRI/DTI can show more precise changes

Functional Neuroimaging

- Functional methods can identify abnormal brain functioning
- fMRI/ASL rely on deoxygenated blood to estimate oxygen use
- MRA examines brain metabolites
- PET scans look at functioning through the use of a metabolic tracer
- EEG/ERP looks at electric activity in the brain

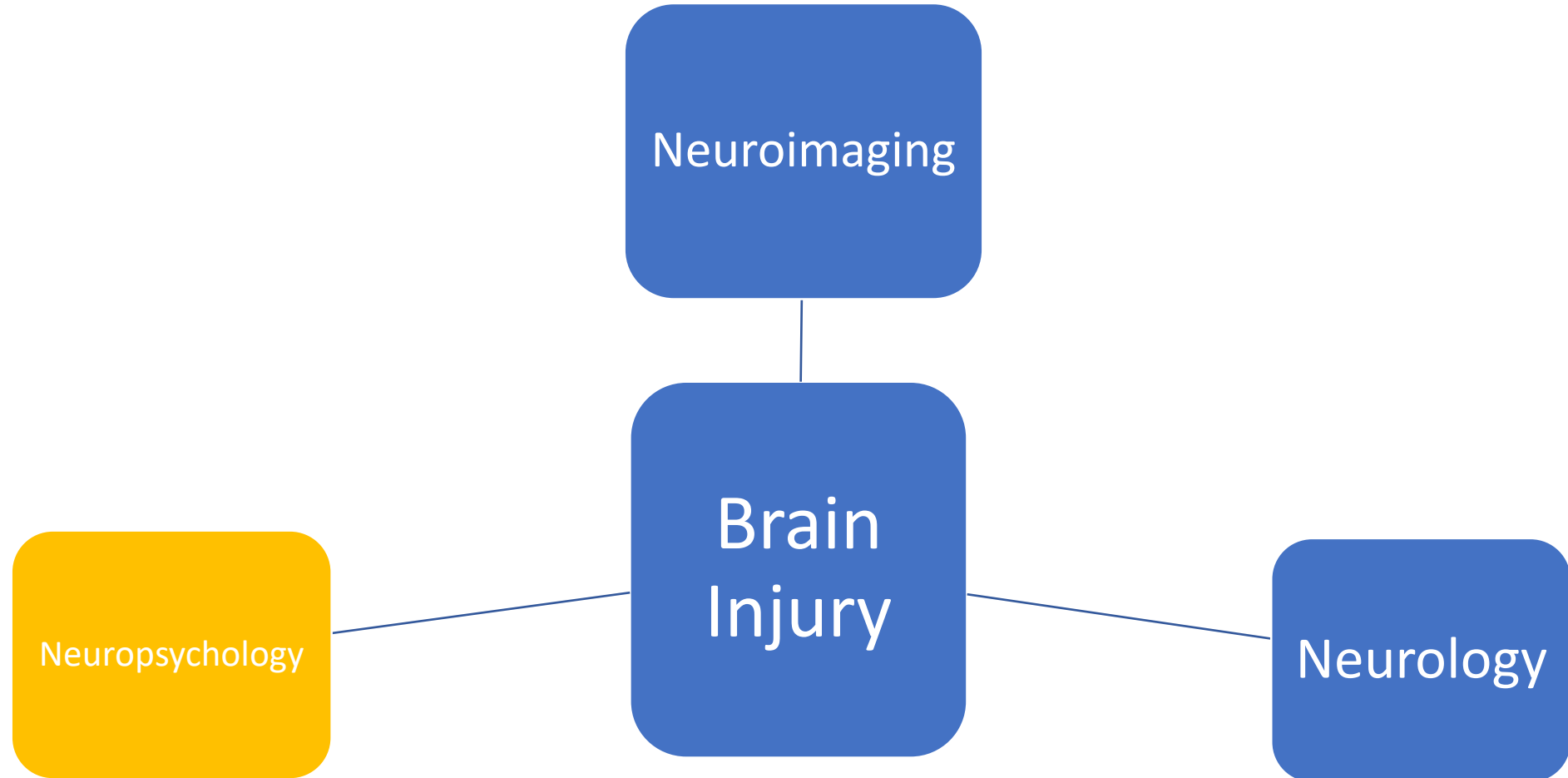
Strengths

- Provide objective evidence of abnormal brain functioning
- Functional methods and DTI can be sensitive to subtler signs of brain damage that a neurological examination might miss
- Findings are often powerful when supplemented with behavioral evidence

Limitations

- “Abnormal” is still a qualitative interpretation in neuroimaging
- Many neurological/psychological conditions overlap with regard to functional findings
- Imaging does not comment on functioning
 - Even significant imaging findings may not translate to poor functional outcome

Three Legs



The Assessment

- A 1-2 hour long clinical interview
- Collateral reports when warranted and available
- Multiple measures are given across multiple modalities
- Specific patterns of scores are supportive of brain dysfunction versus other factors
- The assessment takes at least one full day given the number of measures given and the necessity of including personality measures

Strengths

- In-depth look at cognitive dysfunction
- Sensitive to injuries secondary to mTBI
- Other factors of a person's background (e.g. age, education, intelligence) are taken into account
 - “High average” falling to “average” may represent brain damage
- Psychological and other non-neurological factors are examined
- Functional capacity and outcome are considered

Limitations

- Although sensitive, neuropsychological testing is not specific to brain injury
 - Psychological measures *must* be obtained
 - PTSD and mild TBI might look similar on testing, but mild TBI would be validated by neuroimaging
- Easy to misinterpret data with unqualified professionals
 - Tests are ultimately behavioral expressions of ability
 - Plenty of patients can perform poorly on measures for non-neurological reasons

Each Method Plays a Role

- Neurology:
 - Identify and rule-out medical explanations for the patient's condition
 - Provide a thorough medical work-up of the patient's status
- Neuroimaging:
 - Provide evidence of brain pathology
 - Narrow the cause of such pathology

Each Method Plays a Role

- Neuropsychology:
 - Provide objective measurement of cognitive impairment and functional manifestations of brain injury
 - Rule-out non-neurological explanations
 - Provide estimates of long-term functioning
 - Provides information regarding potential long-term outcomes/prognosis
 - Provides recommendations for treatment and improvement of cognitive and psychological symptoms

Moderate/Severe TBI

- Diagnosis is almost never an issue
- The question is how permanent is the brain damage?
- Neuropsychological testing can predict long-term functioning secondary to the brain damage
 - Most gains are seen in the first year post injury, with slower gains that stop by the second year
- Severe brain damage may lead to personality changes and dementia, which testing can address

Steps After the Evaluation

- Actuarial estimates
 - May require a vocational assessment as well
- Treatments
 - Cognitive rehabilitation
 - Psychotherapy
 - Pain management programs
 - Medication
- Long-term planning
 - More severe injuries may increase the risk of early-onset dementia
 - Children may require permanent specialized educational environments to meet their developmental needs

Thank you!

Questions/Comments