TBI and Aggression: Forensic Neuropsychiatric Evaluation

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VISN 19 ROCKY MOUNTAIN NETWORK

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Objectives

- Key concepts in evaluating/identifying TBI
  - Injury Severity
  - Preinjury, injury, and postinjury factors
- Identify the relationship between TBI and aggression as depicted in the medical literature
- Typologies of violence

General Definition of TBI

- Application to the brain of an external physical force or rapid acceleration and/or deceleration forces
  - not due to congenital, degenerative, vascular, hypoxic-ischemic, neoplastic, toxic-metabolic, infectious, or other causes
- Produces an immediately apparent physiological disruption of brain function manifested by cognitive or neurological impairments
- Results in partial or total functional disability (regardless of the duration of such disability)

American Congress of Rehabilitation Medicine Definition of Mild TBI:

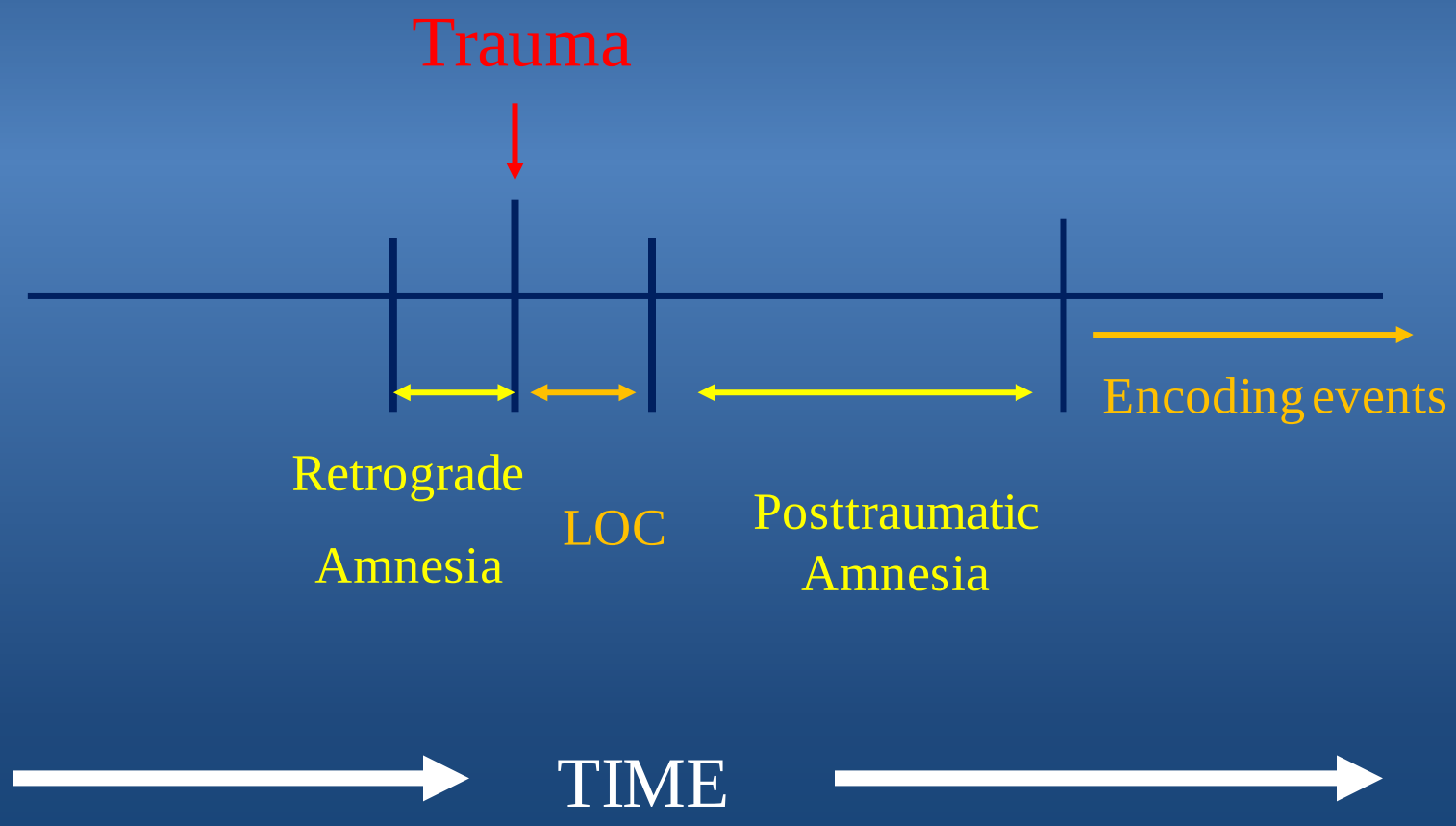
- A traumatically induced physiological disruption of brain function, as manifested by at least *one* of the following:
  - any period of loss of consciousness (LOC)
  - any loss of memory for events immediately before or after the accident (posttraumatic amnesia, PTA)
  - any alteration in mental state at the time of the accident (e.g., feeling dazed, disoriented, or confused)
  - focal neurologic deficit(s) that may or may not be transient

Kay, T., Harrington, D. E., Adams, R. E., Anderson, T. W., Berrol, S., Cicerone, K., Dahlberg, C., Gerber, D., Goka, R. S., Harley, J. P., Hilt, J., Horn, L. J., Lehmkuhl, D., & Malec, J. (1993). Definition of mild traumatic brain injury: Report from the Mild Traumatic Brain Injury Committee of the Head Injury Interdisciplinary Special Interest Group of the American Congress of Rehabilitation Medicine. *Journal of Head Trauma Rehabilitation, 8*(3), 86-87.

American Congress of Rehabilitation Medicine Definition of Mild TBI:

- The severity of the injury does not exceed the following:
  - LOC ≤ 30 minutes
  - after 30 minutes, Glasgow Coma Scale = 13-15
  - PTA ≤ 24 hours
- TBI producing disturbances that exceed these criteria is classified as moderate or severe

Posttraumatic Amnesia



Thanks John Kirk, PhD

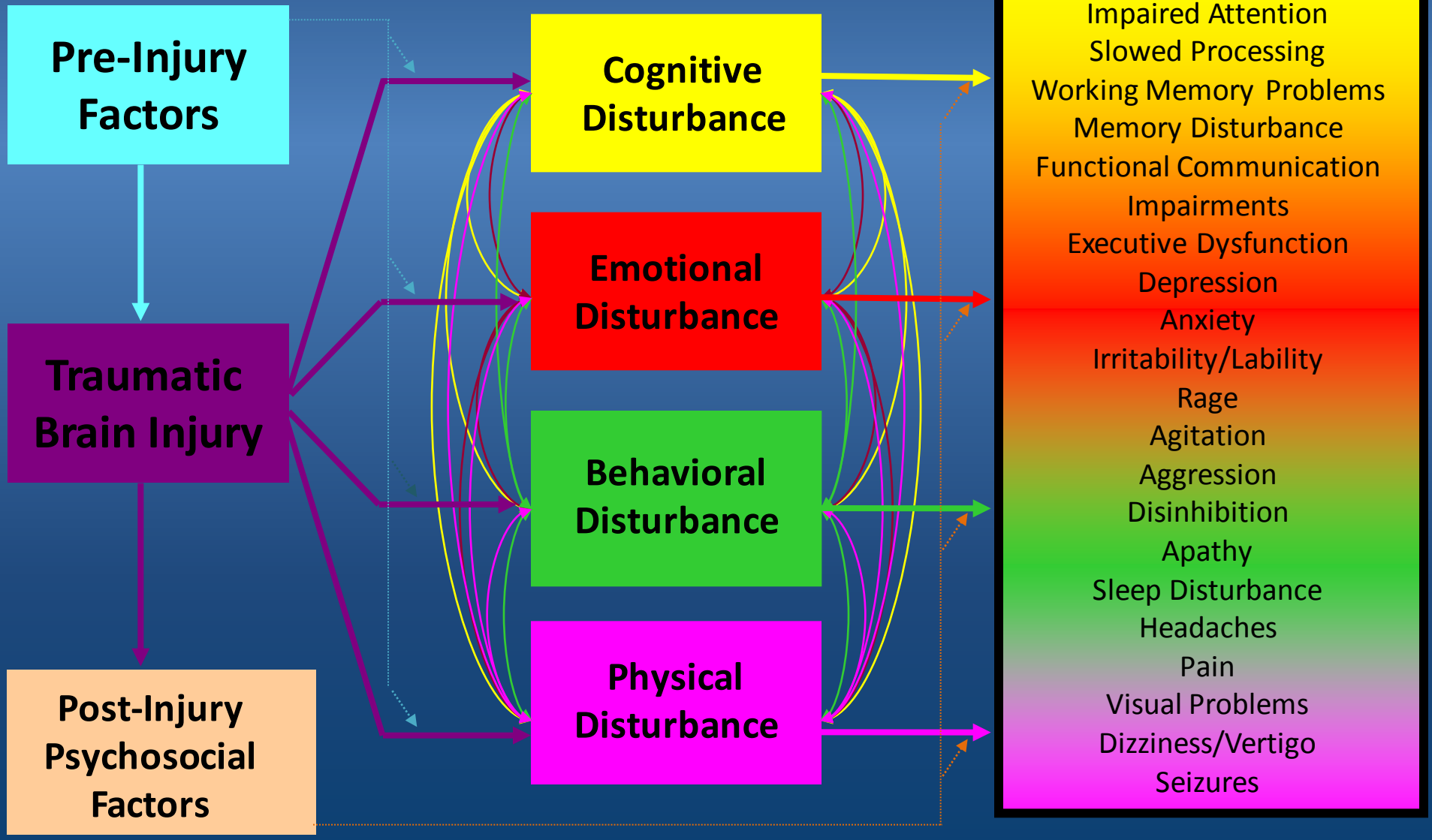
Self-diagnosis of TBI

- "Gold standard" for diagnosis of TBI remains self-report and requires caution:
  - under-reporting vs. over-reporting
  - poor understanding of TBI
  - misunderstanding symptoms as reflective of TBI when other diagnoses offer better explanations
  - stigma vs. secondary gains
- Avoid missed opportunities to target other treatable conditions (PTSD, MDD, etc.)

Self-diagnosis of TBI

- Reports of mild TBI without evidence in the medical record require careful evaluation of the history and other available evidence
  - use ACRM definition of mild TBI as an anchor for the clinical history
  - interview witnesses, if any, to the purported injury
  - review medical, neurological, and neuropsychological evaluations (including comparison to pre-injury whenever such data can be obtained)
  - review (by visual inspection, not just reports) any structural neuroimaging (CT, MRI) for findings consistent with *traumatic* brain injury
  - !! Biomechanical trauma frequently co-occurs with psychological trauma, especially in combat settings

A Model of Influences on Neurobehavioral Outcome after TBI



(Adapted from Silver and Arciniegas 2006)

”In order to understand the effects of brain injury, we must undertake full study of the individual’s constitution. In other words, it is not just the kind of injury that matters, but the kind of brain that is injured.”

Sir Charles Symonds, c. 1937

Pre-Injury Factors

- Age and gender
- Baseline intellectual function
- Psychiatric problems & substance abuse
- Sociopathy
- “Risk-taking” and “novelty-seeking” behavior
- Premorbid behavioral problems
- Social circumstances and SES
- Neurogenetic (ie, APOE-4, COMT, ?other)

Injury Factors

- Biomechanical Injury
  - acceleration/deceleration
  - translational/rotational
  - angular acceleration/deceleration
  - cavitation (“microexplosive”)
  - diffuse axonal injury (DAI)
- Cytotoxic Injury
  - cytoskeletal & axonal injury
  - disturbance of cell metabolism
  - Ca^{++} and Mg^{++} dysregulation
  - free radical release
  - neurotransmitter excitotoxicity
- Secondary Injury
  - traumatic hematomas
  - cerebral edema
  - hydrocephalus
  - increased intracranial pressure (ICP)
  - systemic complications
    - hypoxia/hypercapnia
    - anemia
    - electrolyte disturbance
    - infection

(Reviewed in: Meythaler et al. 2001; Nuwer 2005; Povlishock and Katz 2005; Bigler 2007)

Injury Factors: Translation, Rotation, & Angular Acceleration Forces

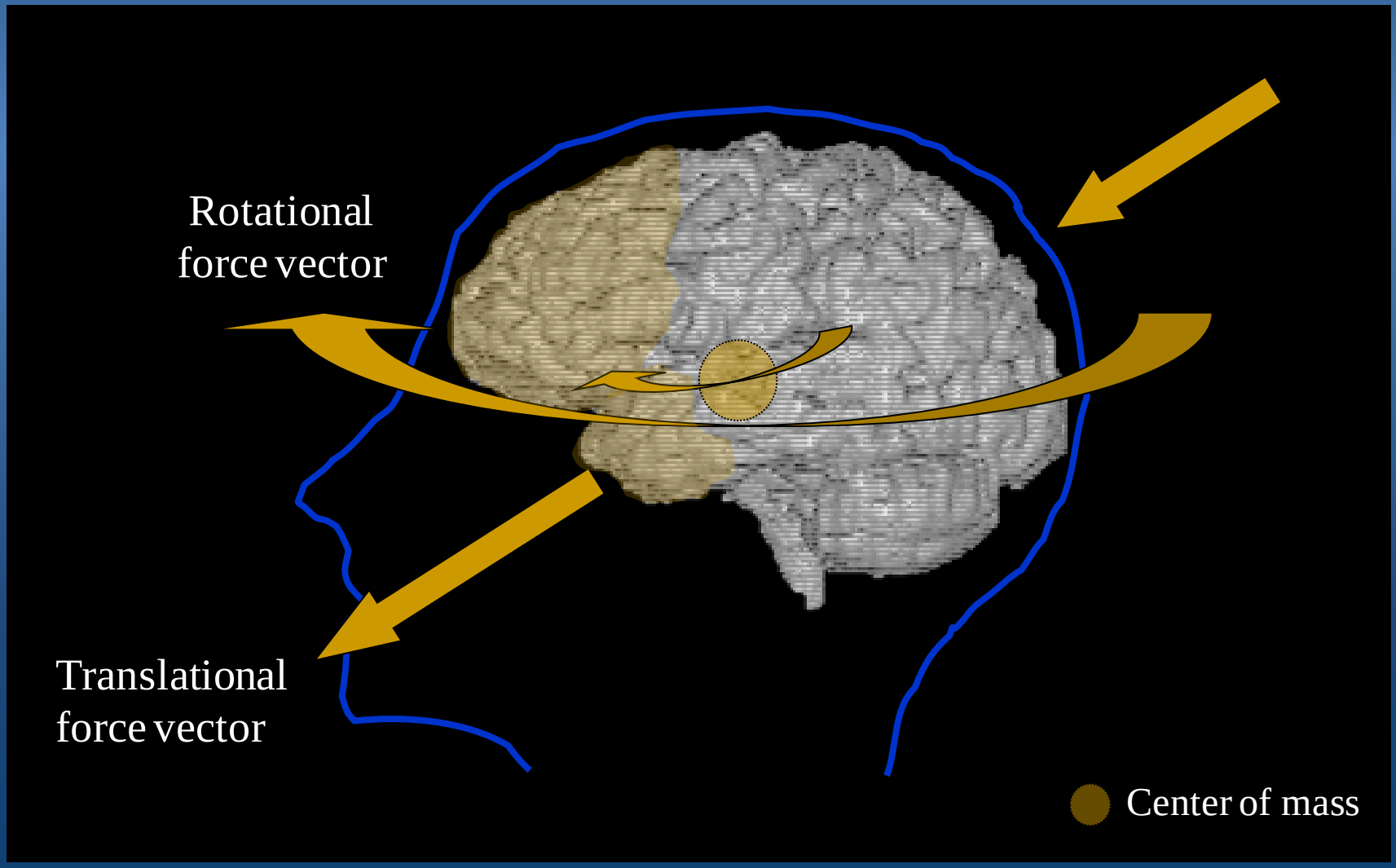


Figure adapted from Arciniegas and Beresford 2001

Post-injury Factors

- Untoward medical complications
- Failure to receive timely medical, neurological, psychiatric, or other needed rehabilitative services
  - early engagement in neurorehabilitation is associated with improved functional outcomes
- Lack of education regarding the course of recovery and interpretation of symptoms
- Lack of family, friends, or resources to support recovery
- Premature return to work/school with ensuing failure to perform at expected levels
- Poor adjustment to or coping with disability by injured person or family
- Litigation or other legal entanglements

Recovery from Mild TBI

- 1st week post-TBI: 90% (or more) endorse postconcussive symptoms
- 1 month post-TBI: ~50% are recovered fully
- 3 months post-TBI: ~66% are recovered fully
- 6-12 months post-TBI: ~10% still symptomatic
- Those who remain symptomatic at 12 months are likely to continue experiencing postconcussive symptoms thereafter

Recovery from Moderate-to-Severe TBI

- About 35-60% of persons with moderate to severe TBI will develop chronic neurobehavioral and/or physical symptoms related to TBI
  - more severe initial injury increases the likelihood of incomplete neurological, neurobehavioral, and functional recovery
- Successful return to work and/or school is inversely related to the severity of persistent neurobehavioral and physical symptoms

Posttraumatic Cognitive Impairments

- In the acute and late periods following TBI, the domains of cognition most commonly affected by TBI include:
  - arousal/disturbances of consciousness
  - processing speed/reaction time
  - attention (selective, sustained, alternating, divided)
  - working memory
  - memory (new learning, retrieval, or [usually] both)
  - functional communication (use of language)
  - executive function

(Reviewed in: Bigler 2007; Arciniegas and Silver 2006; Nuwer 2005; Meythaler et al. 2001)

Common Posttraumatic Emotional and Behavioral Problems

- Depression
- Mania
- Pathological Laughing and Crying
- Anxiety
- Irritability or loss of temper (“rage episodes”)
- Disinhibition
- **Agitation/Aggression** (“socially inappropriate behavior”)
- Apathy (loss of drive to think, feel, and/or behave)
- Psychosis
- Sleep disturbance

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Common Mild TBI/Posttraumatic Symptoms

- Headache
- Sleep Disturbances
- Fatigue
- Dizziness
- SLight sensitivity
- ound sensitivity

Immediately post-injury 80% to 100% describe one or more symptoms

Most individuals return to baseline functioning within a year

Ferguson et al. 1999, Carroll et al. 2004; Levin et al. 1987

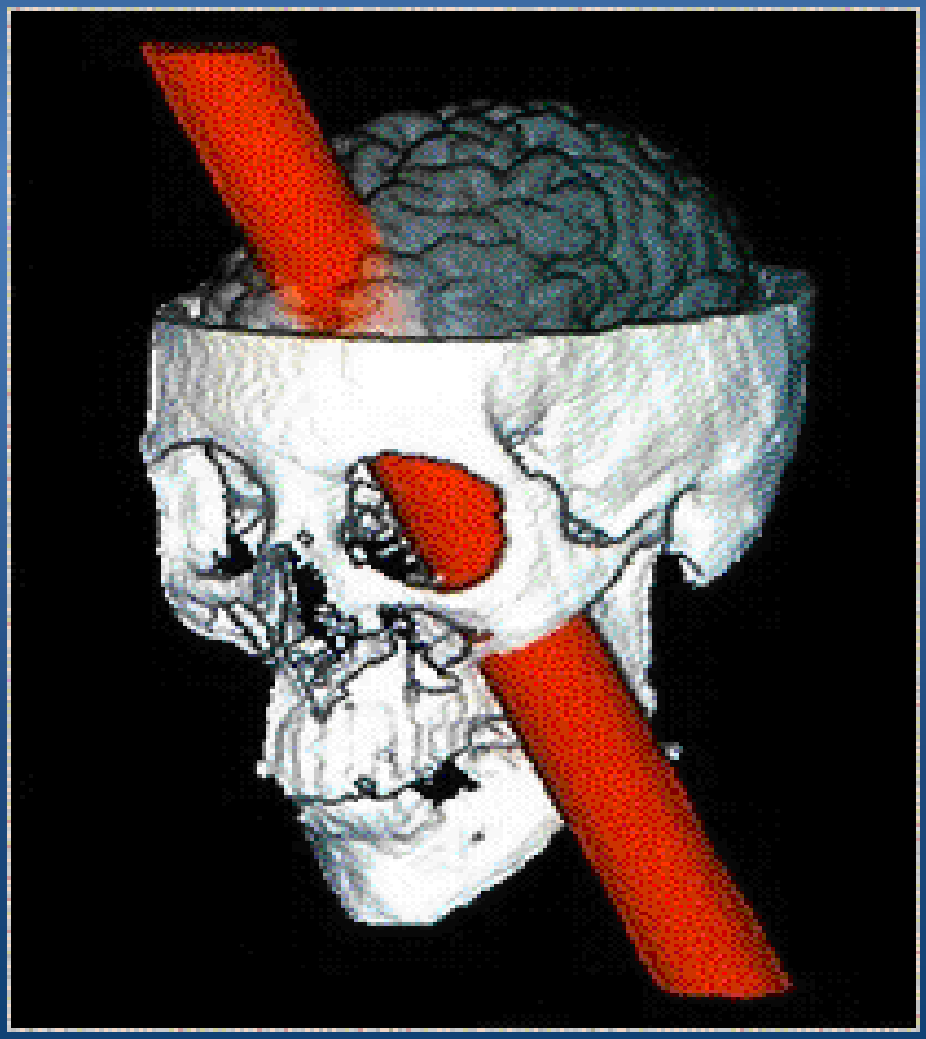
Common TBI Symptoms – NOT to be confused with the injury itself

TBI is a historical event

The Case of Phineas Gage (Harlow, 1848)

- 25 year old railroad foreman
- cognitively, emotionally, and behavioral normal
  - "a man of temperate habits, and possessed of considerable energy of character"
- while working tamping gunpowder into a blasting hole, he is momentarily distracted by coworkers
- an explosion occurs, blasting the tamping rod out of his hands and upwards through his face and skull

Phineas Gage



Reconstruction by H. Damasio and A.R. Damasio, University of Iowa

Phineas Gage

- Gage suffered a penetrating brain injury affecting the orbitofrontal lobes bilaterally
  - dramatic change in behavior occurs
    - becomes "childish, capricious, obstinate"
    - poor social judgment
      - frequently profane
      - sexually inappropriate
      - impulsive
      - loss of empathy for others
  - miraculously, he survives his injury and lives for 13 years
    - however, "Gage was no longer Gage."

Posttraumatic Aggression

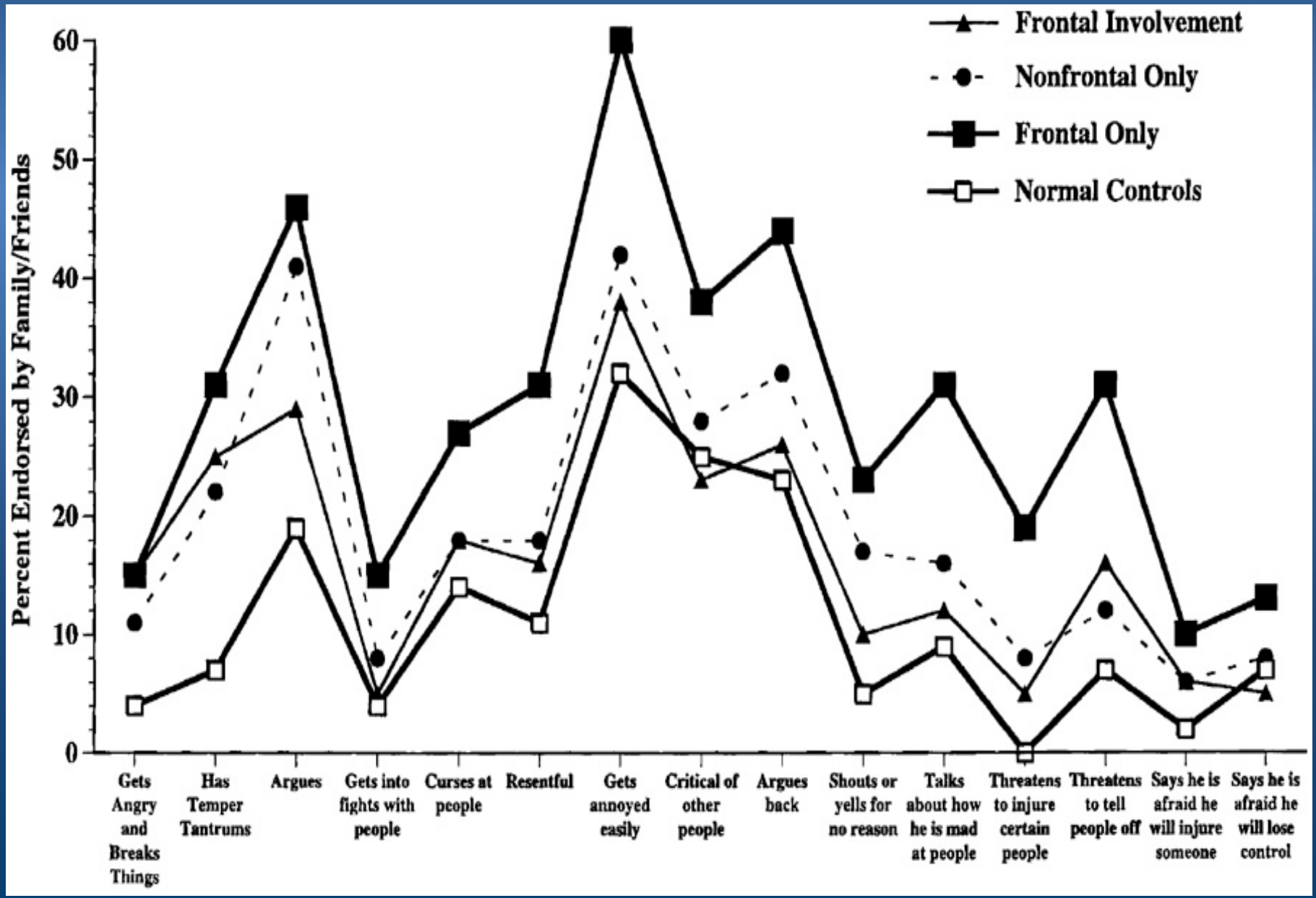
- Generally regarded as a common problem
- Literature is lacking and requires cautious interpretation
- ANPA Committee on Research Critical Review
  - Nosology of aggression and agitation particularly problematic with lack of rigorous definition
  - Minimal use of DSM diagnosis of personality change due to general medical condition, aggressive type
  - "Existing epidemiological studies… offer little insight into the prevalence and incidence of posttraumatic aggression… more research is needed to establish a consistent operational definition of posttraumatic aggression."

Kim et al. (2007)

Grafman et al. (1996)

- Examined relationship between frontal lobe lesions and aggressive/violent behavior
- 279 Vietnam vets with penetrating TBIs matched v. matched controls
- Family observations and self-reports
- Frontal ventromedial lesions significantly associated with higher scores for aggression and violence
- Higher aggression violence scores generally associated with verbal confrontations rather than physical assault

Percentage of items on aggression and violence endorsed by friends and family members of controls and patients



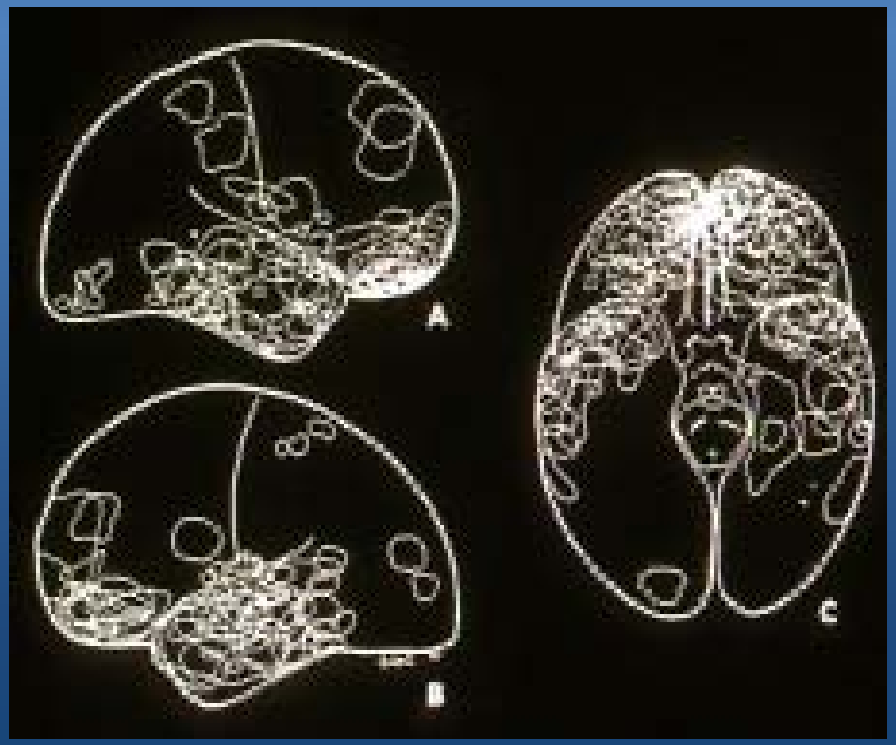
Tateno et al. (2003)

- Assessed aggressive behavior in 89 TBI patients and 26 patients with multiple trauma but no TBI using the Overt Aggression Scale and examined its clinical correlates
- Aggressive behavior in 33.7% of TBI patients and 11.5% of no TBI patients during first 6 months post-TBI
- Aggressive behavior significantly associated with presence of major depression, frontal lobe lesions, poor premorbid social functioning, and history of alcohol and substance abuse
- Suggest that interventions aimed at treatment of depression and substance abuse and enhancing social support may help reduce severity of disruptive behavior

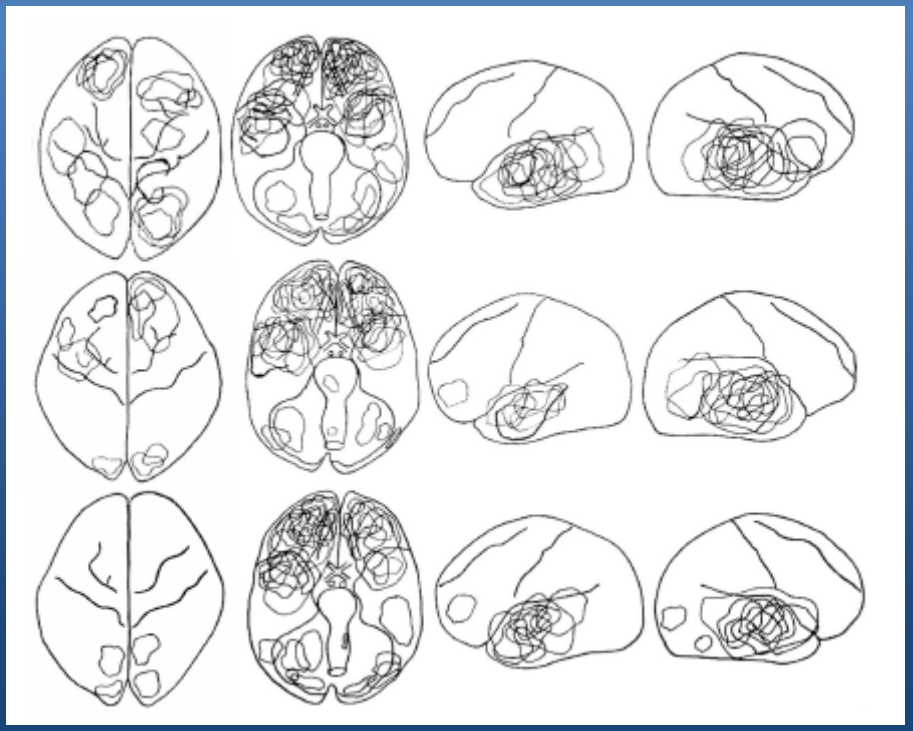
Posttraumatic Aggression

- Common problem after TBI, usually on setting in 1st year post-injury
- Associated with frontal lobe lesions
- Associated with presence of major depression
- Patients with pre-injury substance abuse or impulsive aggression at greater risk

Typical Locations of Cortical Contusion after Severe TBI

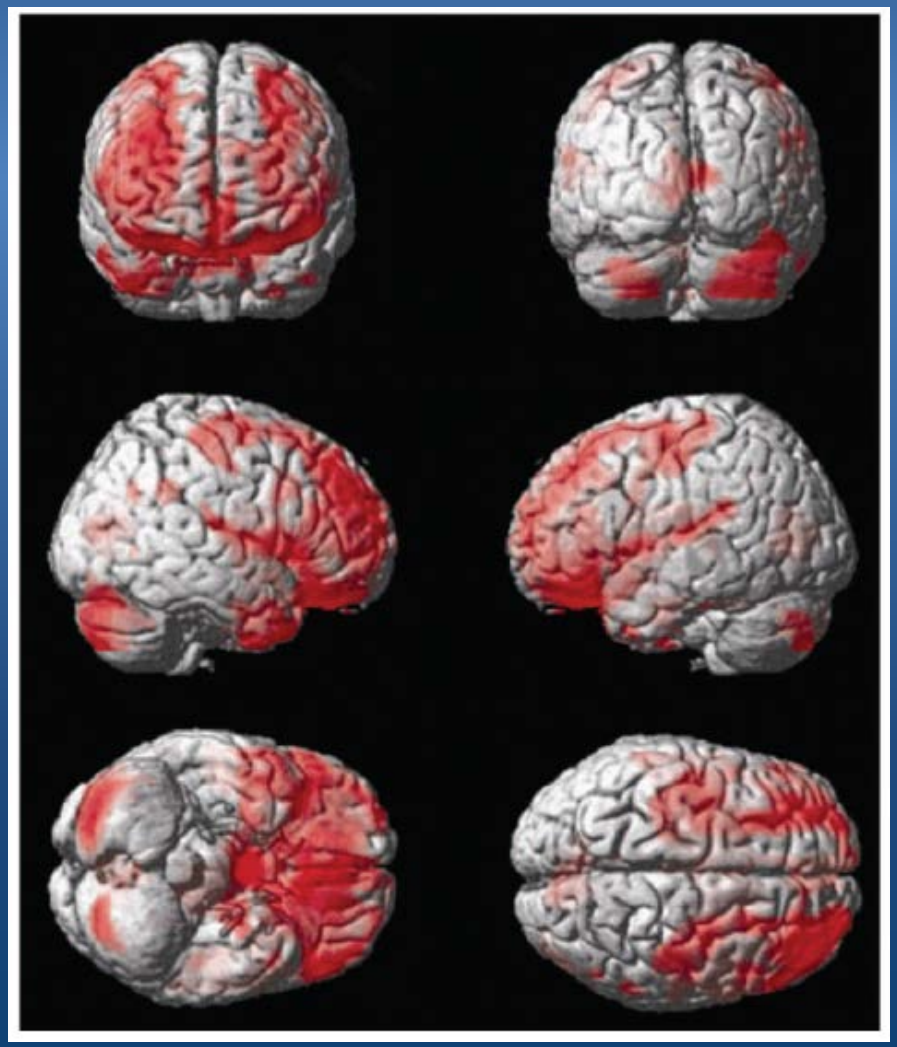


Coureville 1937; image courtesy of Thomas W. McAllister, MD (Dartmouth-Hitchcock Medical Center)

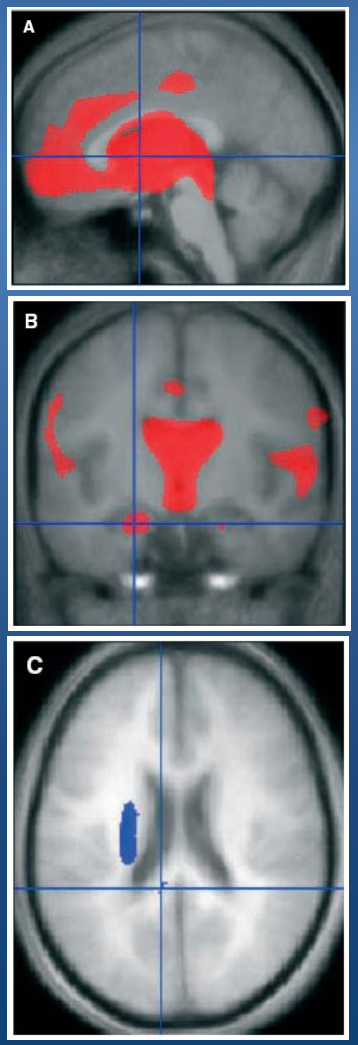


Coureville 1950 and Gurdjian 1975; adapted from Bigler 2007

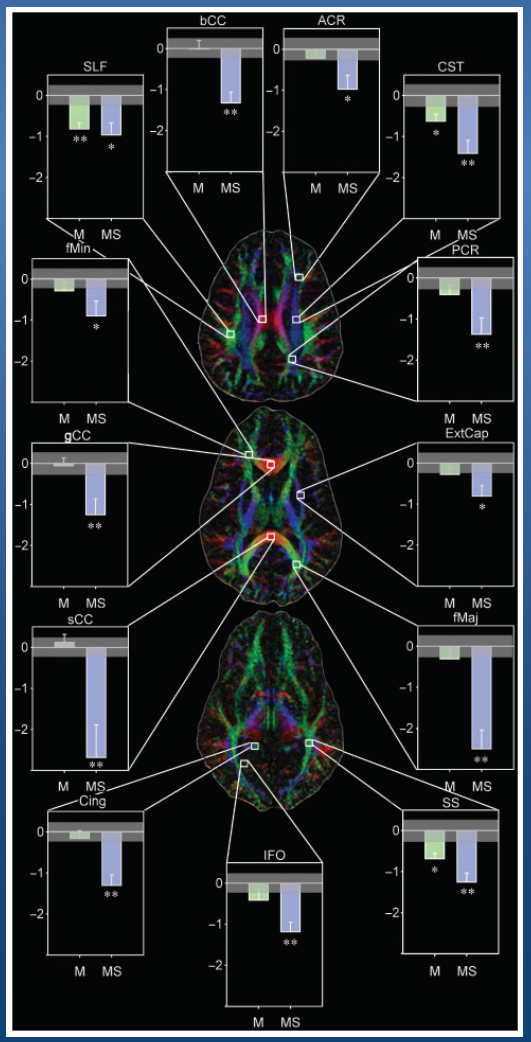
Regional Vulnerability to TBI



Yeates et al. 2007

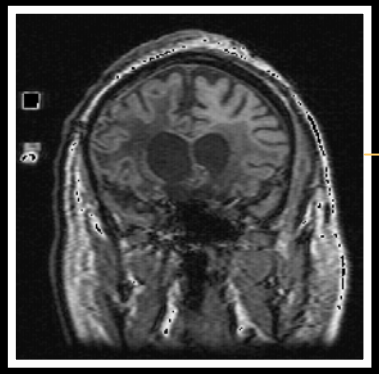


Salmond et al. 2005

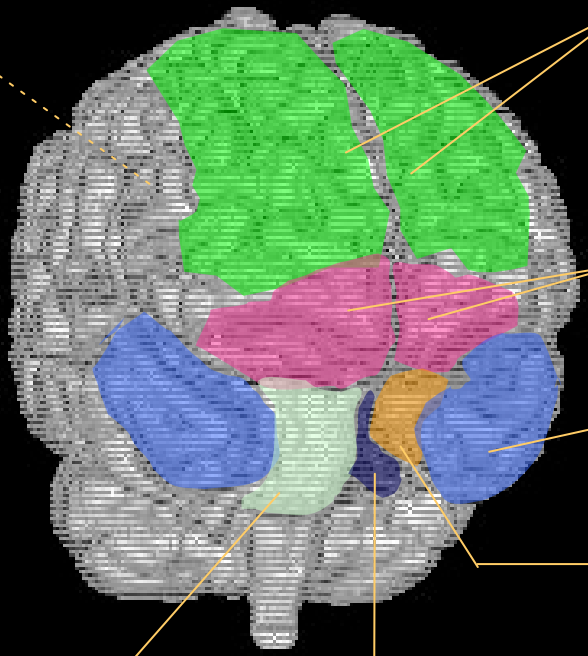


Kraus et al. 2007

Regional Vulnerability to TBI and Brain-Behavior Relationships



White matter
(processing speed/efficiency)



Dorsolateral prefrontal cortex
(executive function, including sustained and complex attention, memory retrieval, abstraction, judgement, insight, problem solving)

Orbitofrontal cortex
(emotional and social responding)

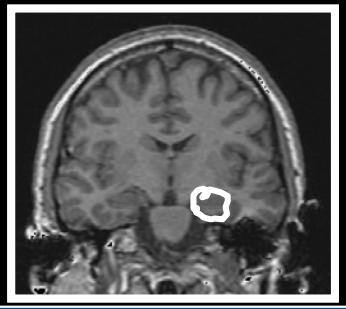
Anterior temporal cortex
(memory retrieval, sensory-limbic integration)

Amygdala (emotional learning and conditioning, including fear/anxiety)

Ventral brainstem
(arousal, ascending activation of diencephalic, subcortical, and cortical structures)

Hippocampal-Entorhinal Complex (declarative memory)

Viewed on coronal MRI →



(Figure adapted from Arciniegas and Beresford 2001)

Toward and Understanding of Violence... Aspen Neurobehavioral Conference Consensus Statement

- Behavior is variably governed by interaction of factors… genes, early life experience, acquired brain damage, learned behavior patterns, and situational contingencies.
- "Aggression and violence, like any behaviors, ultimately derive from the normal or abnormal operation of the brain."
- TBI is associated with increased risk of aggression and violence
- TBI with frontal dysfunction appears to threaten the capacity to inhibit violent behavior
- "Illness is not destiny"

Filley et al. 2001

Not All Violence is Alike

- The nature and quality of violent behavior guides formulations regarding relationship to TBI
- Aggression of any kind may arise among persons with TBI as a function of issues with no direct relation to TBI

– States of intoxication, medical conditions (e.g., delirium due to other non-TBI causes), pre-morbid personality traits/disorders (especially antisocial, borderline, narcissistic), or as a premeditated, purposeful, instrumental violent act

- Attribution of aggressive behaviors to TBI should be undertaken with caution, and only after careful consideration of the totality of the circumstances surrounding behaviors

– Including (but not limited to) specific details of the TBI, pre-and-post psychosocial factors, the context in which the particular violent act occurred, and any potential precipitants and/or possible objectives

Organic Aggressive Syndrome

- Reactive
  - Triggered by modest or trivial stimuli
- Nonreflective
  - Usually no premeditation or planning
- Nonpurposeful
  - No obvious long-term goals or aims
- Explosive
  - Buildup is not gradual
- Periodic
  - Brief outbursts punctuated by long periods of relative calm
- Ego-dystonic
  - Patients upset, concerned, embarrassed by outburst as opposed to blaming or justifying behavior

Silver et al. 2005

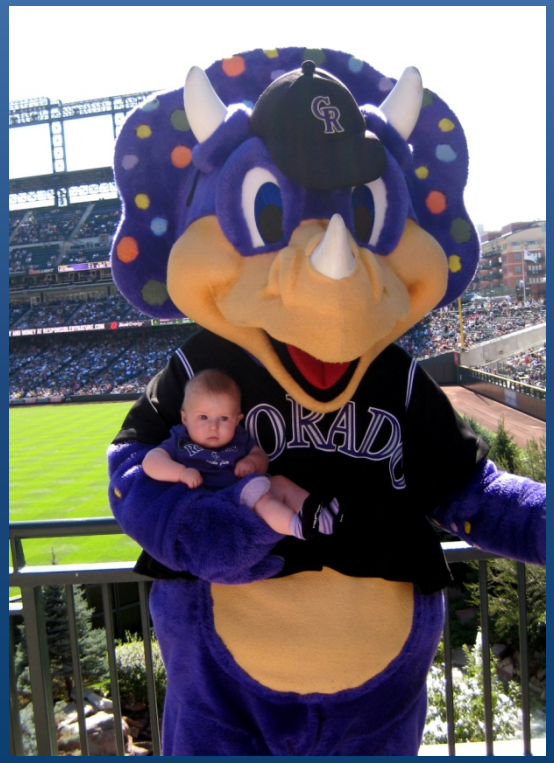
Typologies of Violence

- In purposeful, instrumental violence aggressive behavior used as means to consciously achieve gainful ends, or to intimidate or manipulate another into some desired behavior
  - violence for revenge or violence for hire
- Somewhere on the middle of this proposed spectrum of aggressive behavior is targeted but impulsive violence, wherein unplanned aggressive behavior is directed at a specific person in response to a perceived threat
- The further we get from OAS, the more tenuous any causal relationship between TBI and a specific violent act

Reid & Thorne 2008

Thanks!

Questions & Comments…



Baby Daphne loves Dinger!