

## From Concussion to Consequence: A Primer on Traumatic Brain Injury



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### Traumatic Brain Injury (TBI)

“...an **insult to the brain** caused by an external force that results in an altered state of consciousness and one or more impairments of brain functioning. Effects may be temporary or permanent.”

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### TBI's Vary in Severity

	Mild	Moderate	Severe
Glasgow Coma Scale Score	13-15	9-12	3-8
Length of Loss of Consciousness	less than 30 minutes	30 minutes to 24 hours	more than 24 hours
Length of Post-traumatic Amnesia	up to 1 day	1 day to 1 week	more than 1 week

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<b>American Academy of Neurologists Guidelines</b>	Grade I: < 15 minutes of symptoms	Grade II > 15 minutes of symptoms	IIIa secs loc IIIb mins loc		

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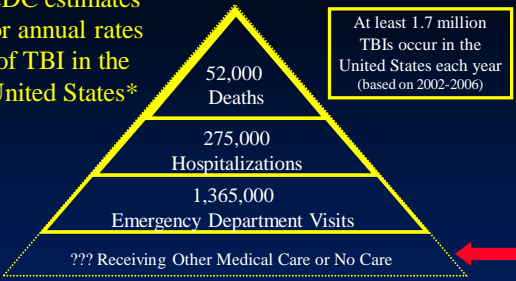
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CDC estimates for annual rates of TBI in the United States\*



\* Faul M, Xu L, Wald MM, Coronado VG. *Traumatic Brain Injury in the United States: Emergency Department Visits, Hospitalizations and Deaths 2002-2006*. Atlanta (GA): Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2010.

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### CDC Estimates Applied to Ohio (weighted by 2010 population)

- 2,000 die each year due to TBI
- 11,000 are hospitalized each year with a TBI
- 54,000 emergency room visits each year
- 3,000 over the age of 15 each year survive moderate to severe TBI
- 5,000 each year continue to experience disability one year after hospitalization for TBI
- 125,000 live with a permanent TBI-related disability

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### Civilian Risk Factors for any TBI

- Males 2:1 more than female
- Very young and very old due to falls
- Adolescents and young adults due to intentional injuries and moving vehicle crashes
- Greatest behavioral risk factors:
  - violence prone or exposed to those who are
  - misuse substances or exposed to those who do
- More likely in lower socio-economic groups

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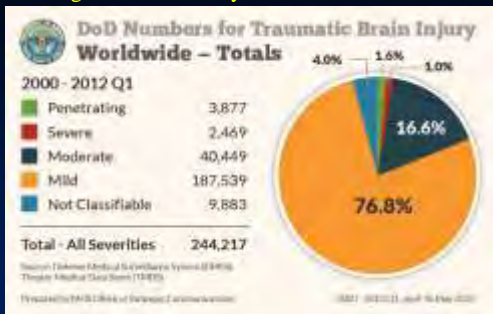
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### TBI Diagnosed in Military Personnel (combat & non-combat)



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### TBI among U.S. Military Populations

- during peacetime, over 7,000 annually admitted to military and veterans hospitals with diagnosis of TBI (IOM, 2009)
- 80% of TBIs since 9/11/01 have been non-combat related
- more common among non-combat military personnel than in the general population:
  - high concentration of service members in the highest incidence age groups (18-44)
  - greater risk for injury associated with non-combat military duties
  - greater consumption of alcoholic beverages by military personnel

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### TBI during OEF & OIF

- During Vietnam War, 12%-14% of combat casualties included a TBI vs. at least 22% for OEF/OIF—**IEDs are the primary reason for the difference**
- not all TBI diagnosed in theater—estimates range from 10%-20% of combatants may have had mild TBIs (suggesting more than **300,000 service members**)
- **caution necessary** because identification based on subjective experience of both exposure and symptoms

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### Mild TBI in U.S. Soldiers Returning from Iraq (Hoge et al., 2008)

- 2,525 Army infantry surveyed post-deployment
- 4.9% reported TBI with loss of consciousness (loc)
  - 10.3% reported TBI without loc
  - 17.2% reported other injuries
  - "dose effect" for co-occurrence of TBI and PTSD:
    - TBI with loc: 43.9%
    - TBI without loc: 27.3%
    - Injury without TBI: 16.2%
    - All other soldiers: 9.1%

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### Symptoms of Mild TBI (concussion)

- Headaches or neck pain
- Light-headedness, dizziness, or loss of balance
- Difficulty remembering or concentrating
- Feeling tired, having no energy or motivation
- Changes in sleep patterns (sleeping a lot more or having a hard time sleeping)
- Mood changes (feeling sad or angry for no reason)
- Increased sensitivity to lights, sounds, or distractions
- Blurred vision or eyes that tire easily

If symptoms do not resolve — "Post-Concussive Syndrome"

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### Post-concussive Syndrome (PCS) vs. PTSD

<u>PCS</u>	<u>PTSD</u>
Insomnia	Insomnia
Impaired memory	Impaired memory
Poor concentration	Poor concentration
Depression	Depression
Anxiety	Anxiety
Irritability	Irritability
Fatigue	Emotional Numbing
Headache	Hypervigilance
Dizziness	Flashbacks/Nightmares
Noise/Light intolerance	Avoidance

Source: Lisa Brenner, PhD

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### TBI due to Blasts—the “signature injury” of OEF & OIF



- Can blast forces alone cause mild TBI?
- If so, is it the same pathology as TBI caused by mechanical forces?
- What about multiple blasts?

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### Civilian Groups Who Have Multiple Mild TBI's

- Athletes, particularly boxers, football players & hockey players
- Victims of intimate partner violence and childhood physical abuse
- People who misuse and abuse substances
- People who are homeless

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### Cumulative Effects of Concussion

- In 15,300 high school and college football player/seasons, those with a history of concussion were almost 6 times more likely to have another, almost twice as likely it would include loss of consciousness (Zemper, 2003).
- In 2,900 college football players, those with  $\geq 3$  concussions were 3 times more likely to have another; history of concussion was associated with slower recovery (Guskiewicz, et al 2003).

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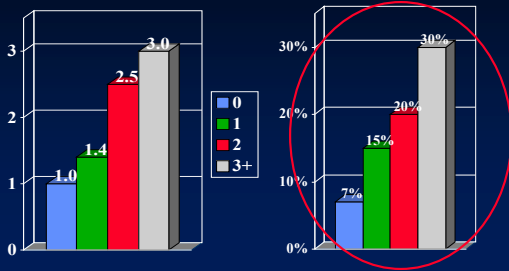
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### Cumulative Effects of Concussion

(Guskiewicz et al, 2003)

Adjusted Rate Ratio

% Prolonged Recovery



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### Colorado Injury Research Center funded by CDC

- Random digit dialed 2,700 Colorado residents and administered a computer assisted telephone interview based on OSU TBI-ID
- 200 called back no sooner than 6 months later

TBI with loss of consciousness, compared to adults without head injuries only, were:

- almost 3 times more likely to have **problems with learning or memory**;
- greater than 3 times more likely to have a **disability**.

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**TBI with loss of consciousness, continued:**

- 1.5 times more likely to be **misusing alcohol**;
- almost 2 times more likely to be in **fair or poor health**;
- greater than 2 times more likely to have a **work-related limitation**;
- greater than 2 times more likely to have **any limitation due to physical, mental or emotional problems**; and
- 2.5 times more likely to be **dissatisfied with their life**.

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**The "Fingerprint" of TBI**

Frontal areas of the brain, including the frontal lobes, are the most likely to be injured as a result of TBI, regardless the point of impact to the head

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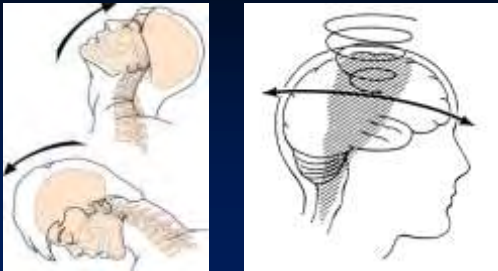
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**The brain is set into motion along multiple axial planes**



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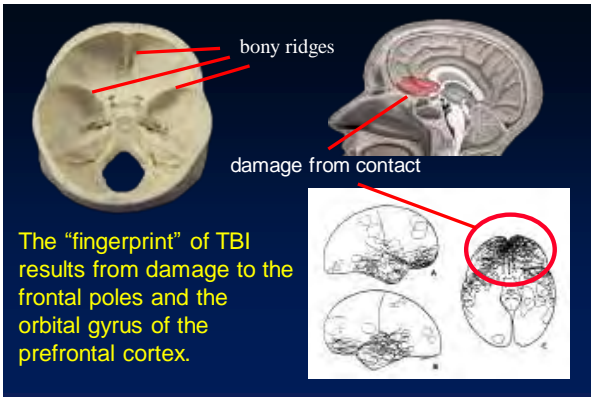
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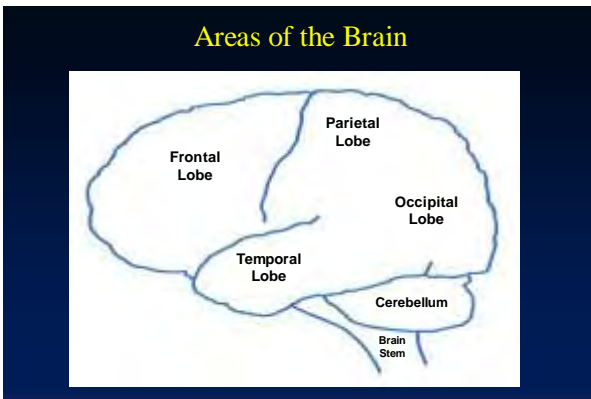
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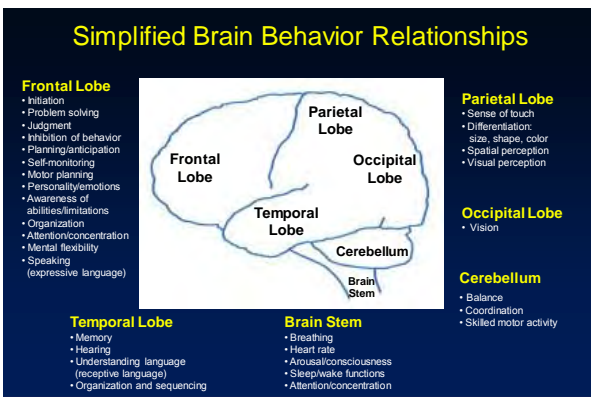
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## Neurobehavioral Impairments

- Attention deficits
- Memory problems
- Poor planning
- Impulsivity/disinhibition
- Unawareness of deficits

Ability to “Self-Regulate”

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## Being human is all about self-regulation

“...[we] tend to view impulsiveness as a problem or deficit, yet for most species that have a nervous system that learns from contingencies of reinforcement, there actually is not a ‘problem’ of impulsiveness--it is their default state. The ‘problem’ posed by impulsiveness is relatively unique to humans...” Russell Barkley (2001)

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## The “A-B-C’s” of Self-Regulation

- Affective modulation
- Behavioral planning
- Cognitive resource allocation

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### Delay Discounting:



the value of immediate vs. delayed rewards

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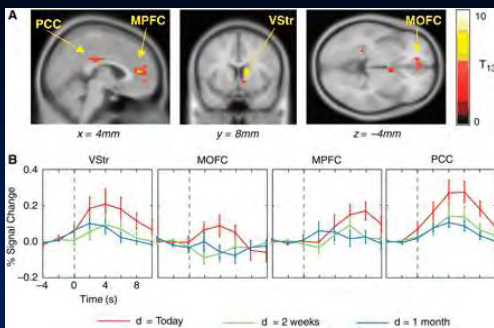
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### Regions of greater activation when considering immediate rewards



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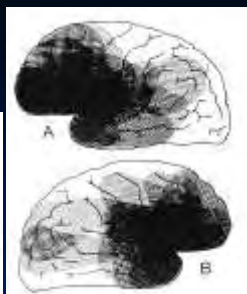
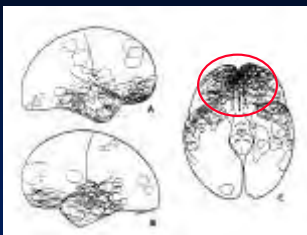
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### Areas of contusion in 40 consecutive cases of closed head injury (Courville, 1950)



Overlay of 100 consecutive CT scans of patients with closed head injuries (Bigler, 1984)

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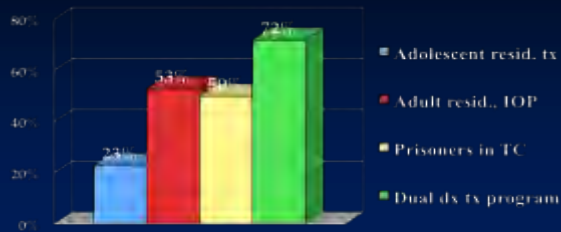
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### Substance Abuse Treatment Clients Who Have Had a TBI with Loss of Consciousness



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### TBI and Psychiatric Disorders

- Childhood TBI doubles likelihood of psychiatric disorder by early adulthood.
- Depression frequent following TBI; depressed clients with TBI more likely suicidal.
- Higher rates of anxiety disorders (generalized, OCD and PTSD)
- Higher rates of psychosis among persons with TBI
- Some studies have found higher rates of personality disorders among persons with TBI.

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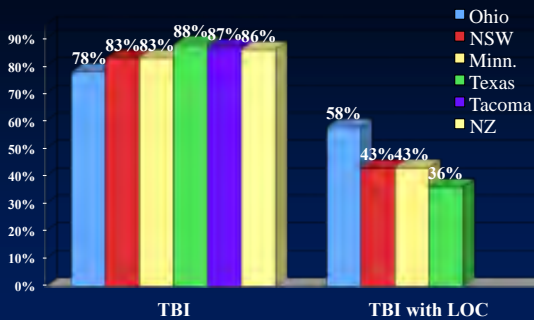
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### Rates of TBI in Prison Studies



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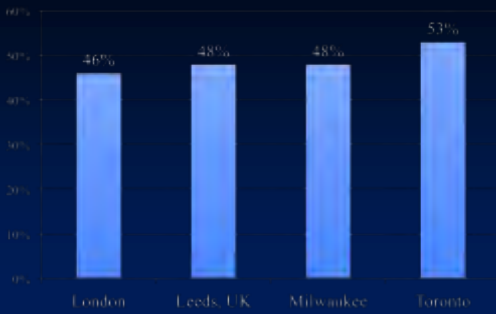
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### Rates of TBI among the Homeless



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### Further Resources

[www.OhioValley.org](http://www.OhioValley.org)

[www.BrainLine.org](http://www.BrainLine.org)

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