

the injured brain,  
*the injured mind.*

mary et boyle, ph.d.

department of cognitive science

ucsd



Traumatic Brain Injury (TBI) is caused by a bump, blow or jolt to the head or a penetrating head injury that disrupts the normal function of the brain. **Not all blows or jolts to the head** result in a TBI. The severity ranges from 'mild' to 'severe'."

Centers for Disease Control and Prevention



# MTBI – Mild Traumatic Brain Injury

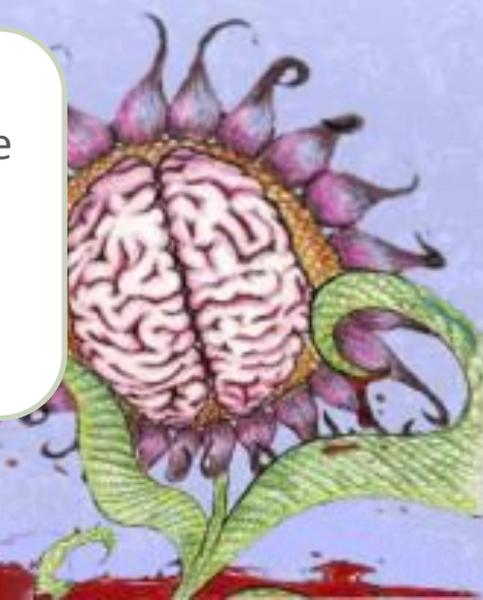
- Any period of observed or self reported:
  - Transient confusion and/or disorientation
  - Impaired consciousness
  - Dysfunction of memory around the time of injury
  - Loss of consciousness lasting less than 30 minutes

## Neurological dysfunction signs:

- Seizures following injury
- irritability, lethargy, vomiting
- Headache, dizziness, poor concentration

## Consequences:

- Most do not get medical care at the time of the injury
- Persistent attention, concentration and memory problems.



# Get the Facts...

[http://www.cdc.gov/concussion/pdf/Fact\\_Sheet\\_ConcussTBI-a.pdf](http://www.cdc.gov/concussion/pdf/Fact_Sheet_ConcussTBI-a.pdf)

**Facts about Concussion and Brain Injury**

**About Concussion**  
 A concussion is a type of traumatic brain injury (TBI) caused by a bump, blow, or jolt to the head. Concussions can also occur from a fall or a blow to the body that causes the head and brain to move quickly back and forth. Doctors may describe a concussion as a "mild" brain injury because concussions are usually not life-threatening. Even so, their effects can be serious.

**Concussion Signs and Symptoms**  
 Most people with a concussion recover quickly and fully. But for some people, symptoms can last for days, weeks, or longer. In general, recovery may be slower among older adults, young children, and teens. Those who have had a concussion in the past are also at risk of having another one and may find that it takes longer to recover if they have another concussion. Symptoms of concussion usually fall into four categories:

Thinking/Remembering	Difficulty thinking clearly	Feelings lowed down	Difficulty concentrating	Difficulty remembering new information
Physical	Headache Fuzzy or blurry vision	Nausea or vomiting (early on) Dizziness	Sensitivity to noise or light Balance problems	Feeling tired, having no energy
Emotional/Mood	Irritability	Sadness	More emotional	Nervousness or anxiety
Sleep	Sleeping more than usual	Sleep less than usual	Trouble falling asleep	

**Getting Better**  
 Rest is very important after a concussion because it helps the brain to heal. Ignoring your symptoms and trying to "tough it out" often makes symptoms worse. Be patient because healing takes time. Only when your symptoms have reduced significantly, in consultation with your doctor, should you slowly and gradually return to your daily activities, such as work or school. If your symptoms come back or you get new symptoms as you become more active, this is a sign that you are pushing yourself too hard. Stop these activities and take more time to rest and recover. As the days go by, you can expect to gradually feel better.

Tips to help you get better:

- Get plenty of sleep at night, and rest during the day.
- Avoid activities that are physically demanding (e.g., sports, heavy housecleaning, working-out) or require a lot of concentration (e.g., sustained computer use, video games).
- Ask your doctor when you can safely drive a car, ride a bike, or operate heavy equipment.
- Do not drink alcohol. Alcohol and other drugs may slow your recovery and put you at risk of further injury.

There are many people who can help you and your family as you recover from a concussion. You do not have to do it alone. Keep talking with your doctor, family members, and loved ones about how you are feeling, both physically and emotionally. If you do not think you are getting better, tell your doctor.

For more information and resources, please visit CDC on the Web at: [www.cdc.gov/Concussion](http://www.cdc.gov/Concussion)

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
 Centers for Disease Control and Prevention

CDC

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TBI is caused by a bump, blow or jolt to the head or a penetrating head injury that disrupts the normal function of the brain. **Not all blows or jolts to the head result in a TBI.** The severity ranges from 'mild' to 'severe'."

Centers for Disease Control and Prevention

TBI:  
Traumatic  
Brain  
Injury

prisoners

veterans

athletes





# Traumatic Brain Injury in Prisons and Jails:

## An Unrecognized Problem

### What is known about TBI and related problems in prisons and jails?

#### General:

- More than two million people currently reside in U.S. prisons and jails.<sup>1</sup>
- According to jail and prison studies, 25-87% of inmates report having experienced a head injury or TBI<sup>2-4</sup> as compared to 8.5% in a general population reporting a history of TBI.<sup>5</sup>
- Prisoners who have had head injuries may also experience mental health problems such as severe depression and anxiety,<sup>3</sup> substance use disorders,<sup>6-8</sup> difficulty controlling anger,<sup>6</sup> or suicidal thoughts and/or attempts.<sup>6,9</sup>

# How damaging is it?

Minor knocks can be damaging

1.7 million cases of TBI/year

8.5% of US population

60% of prisoners have TBI



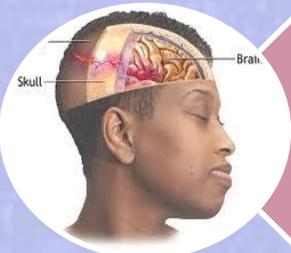
# Concussions – most common injury



85% will recover within one year.



Symptoms: headaches, anger, irritability, impulsivity, memory and attention deficits.



Most injuries are to front or top of head.



# Big problem in the prison population

Difficult to diagnose – symptoms are not unique to injury

Difficult to differentiate from other mental health issues

Each brain trauma is unique – difficult to generalize

Tracking problems – self reporting is difficult; lack of awareness



# TBI increases the likelihood...

Substance abuse –  
alcohol and drug  
addiction

Not able to follow  
directions – viewed  
as defiant

Bad  
behavior

Learning  
impairment –  
difficult to  
rehabilitate

Other mental  
disorders can  
emerge



# intervention

before committing a  
crime

screening – average age  
of first injury @ 14yrs

TBI Cognitive Treatment  
Program



# STBI – Severe Traumatic Brain Injury

- Two types of STBI
  - Closed
    - Caused by movement of the brain within the skull
  - Penetrating
    - Caused by a foreign object entering the skull

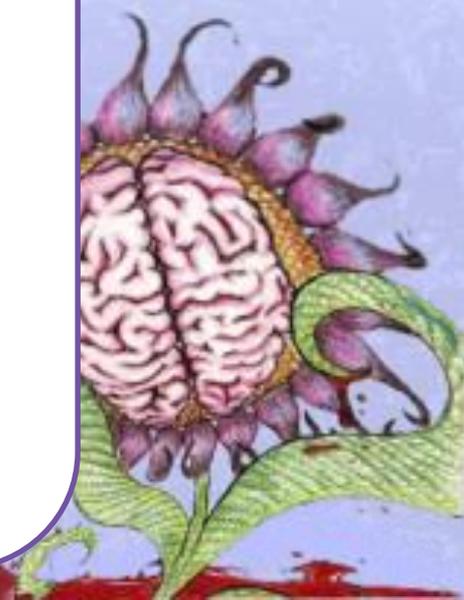
## Glasgow Coma Scale

- Assess coma and impaired consciousness
  - GCS score: 3-8 = severe TBI
  - GCS score: 9-12 = moderate TBI
  - GCS score: 13-15 = mild TBI



# Non-fatal consequences

- Coma and/or amnesia
- 43% of those hospitalized for TBI sustain a related disability for one year post injury.
- Cognitive dysfunction
  - Attention and memory
- Motor dysfunction
  - Extremity weakness
  - Impaired coordination and balance
- Sensation dysfunction
  - Hearing
  - Vision
  - Impaired perception and touch
- Emotional dysfunction
  - Depression
  - Anxiety
  - Aggression
  - Impulse control
  - Personality changes



# CDC Statistics:

## Falls

- Leading cause of TBIs
- Children 0-4 yrs
- Adults +75 yrs

## Car accidents

- Largest percentage of TBI related deaths (31.8%)
- All age groups

## Shaken baby syndrome

- Abusive head trauma
- Leading cause of child maltreatment deaths



# A-Head Check

## IMMEDIATE HEAD INJURY EVALUATION

### Alert

Is the person alert? Question him/her:

- Can you open your eyes?
- Can you explain to me what happened?

If there is no response to either question immediately call 911 for medical assistance.

### Ask

If the person is alert, ask him/her:

- Do you have a severe headache?
- Do you feel like you may vomit?
- Do you have difficulty staying awake?

If the answer is yes to any of these questions or if the person has any symptoms that concern you, seek medical assistance or call 911.

### Aid

All head injuries should be evaluated by an appropriate healthcare professional. A hit on the head can cause a brain injury.

- Brain injuries can range from mild (mild concussion) to severe (coma).
- Symptoms may appear hours or days later.

**After a brain injury, the person should rest and not engage in any activities requiring a lot of concentration or physical activity until symptom free.**

For more information, visit [www.braintrauma.org](http://www.braintrauma.org) or [www.cdc.gov/Concussion](http://www.cdc.gov/Concussion).



# Sports Related Head Injuries

Don't hide it,  
Report it.

# CONCUSSION

**A Must Read for Young Athletes** | Let's Take Brain Injuries Out of Play

### CONCUSSION FACTS

- A concussion is a brain injury that affects how your brain works.
- A concussion is caused by a blow to the head or body:
  - being hit by a piece of equipment such as a lacrosse stick, hockey puck, or field hockey ball.
  - being hit by a player, hitting a hard surface such as the ground, ice, or court, or
- A concussion can happen even if you haven't been knocked unconscious.
- If you think you have a concussion, you should not return to play on the day of the injury and until a health care professional says you are OK to return to play.

### CONCUSSION SYMPTOMS

- Concussion symptoms differ with each person and with each injury, and they may not be noticeable for hours or days. Concussion symptoms include:

- Headache
- Nausea or vomiting
- Confusion
- Dazed by light or noise
- Difficulty remembering or paying attention
- Double or blurry vision
- Balance problems or dizziness
- Slowed reaction time
- Sleep problems
- Feeling sluggish, hazy, foggy, or groggy
- Loss of consciousness
- Feeling irritable, more emotional, or "down"

### WHY SHOULD I REPORT MY SYMPTOMS?

- Unlike with some other injuries, playing or practicing with concussion symptoms is dangerous and can lead to a longer recovery and a delay in your return to play.
- While your brain is still healing, you are much more likely to have another concussion. Repeat concussions can increase the time it takes for you to recover and the likelihood of long term problems.
- In rare cases, repeat concussions in young athletes can result in brain swelling or permanent damage to your brain. They can even be fatal.

Only a health care professional can tell if you have a concussion and when it's OK to return to play. Sports have injury risks and player substitutions so that you can get checked out and the team can perform at its best. The sooner you get checked out, the sooner you may be able to safely return to play.

A concussion can affect your ability to do schoolwork and other activities. Most athletes with a concussion get better and return to sports, but it's important to rest and give your brain time to heal. If a concussion occurs while your brain is still healing, it can cause long-term problems that may change your life forever.

For more information on concussions, visit [www.cdc.gov/concussion](http://www.cdc.gov/concussion)

### What Should I do if I Think I Have a Concussion?

**DON'T HIDE IT, REPORT IT.** Ignoring your symptoms and trying to "tough it out" often makes symptoms worse. Tell your coach, parent, and athletic trainer if you think you or one of your teammates may have a concussion. Don't let anyone pressure you into continuing to practice or playing with a concussion.

**GET CHECKED OUT.** Only a health care professional can tell if you have a concussion and when it's OK to return to play. Sports have injury risks and player substitutions so that you can get checked out and the team can perform at its best. The sooner you get checked out, the sooner you may be able to safely return to play.

**TAKE CARE OF YOUR BRAIN.** A concussion can affect your ability to do schoolwork and other activities. Most athletes with a concussion get better and return to sports, but it's important to rest and give your brain time to heal. If a concussion occurs while your brain is still healing, it can cause long-term problems that may change your life forever.

**All concussions are serious. Don't hide it, report it. Take time to recover. It's better to miss one game than the whole season.**



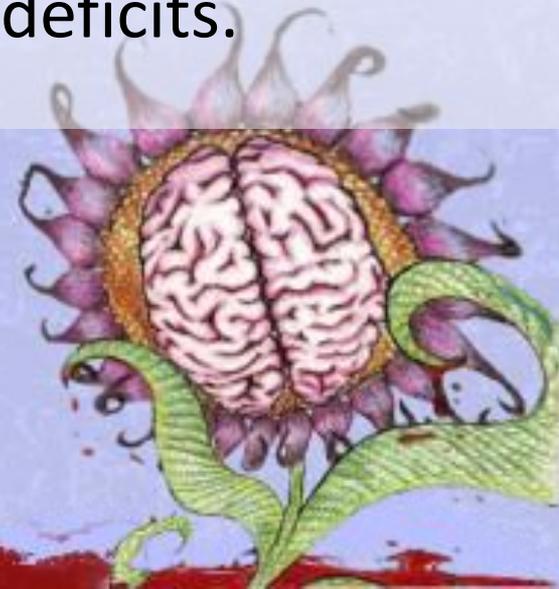
## What to look out for:

- Any change in behavior, thinking or physical function.
- Headache or “pressure” in head
- Nausea or vomiting
- Answers questions slowly
- Moves clumsily
- Forgets instruction
- Symptoms may not appear until hours or days post injury.



# More Consequences of TBI

- Epilepsy
- Increased risk for Alzheimer's disease and Parkinson's Disease
- Repeated TBIs (hours, days, weeks):
  - Catastrophic or fatal
- Repeated TBI's (months, years):
  - cumulative neurological and cognitive deficits.



Roya Saffary, MD, Lawrence S. Chin, MD, FACS,  
and Robert C. Cantu, MD, MA, FACS, FACSM

# Sports Medicine: Concussions in Sports

**Table 1.**

## American Academy of Neurology Concussion Grading Scale

Grade 1 (mild)	Transient confusion; no LOC; symptoms and mental status abnormalities
	Resolve <15 minutes
Grade 2 (moderate)	Transient confusion; no LOC; symptoms and mental status abnormalities
	Last >15 minutes
Grade 3 (severe)	Any LOC

Abbreviation: LOC, loss of consciousness.

**Table 2.**

## Cantu Evidence-Based Grading System for Concussion

Grade 1 (mild)	No LOC, PTA <30 minutes, PCSS <24 hours
Grade 2 (moderate)	LOC <1 minute or PTA ≥30 minutes <24 hours or PCSS ≥24 hours <7 days
Grade 3 (severe)	LOC ≥1 minute or PTA ≥24 hours or PCSS ≥7 days

Abbreviations: LOC, loss of consciousness; PTA, posttraumatic amnesia; PCSS, postconcussion signs and symptoms.

# Chronic Traumatic Encephalopathy

- Dementia Pugilistica
- Seen in former boxers
  - Repeated blows to the head
  - Slow movements, tremors, unsteady gait and speech difficulties
- Athletes that had sustained 3 or more concussions were 3x more likely to experience significant memory problems and 5x more likely to develop and early onset of Alzheimer's disease.





J A N Coursellis, (1989) *Boxing and the Brain*, BMJ VOLUME 298

## CHRONIC TRAUMATIC ENCEPHALOPATHY IN THE NATIONAL FOOTBALL LEAGUE

*Neurosurgery* 61:223–225

DOI: 10.1227/01.NEU.0000255514.73967.90

www.neurosurgery-online.com

CTE, or dementia pugilistica, was first described by Harrison S. Martland in his landmark *Journal of the American Medical Association* article published in 1928 (5) as being characteristic of boxers “who take considerable head punishment seeking only to land a knockout blow.” It was also “common in second rate fighters used for training purposes.” The early symptoms he described were a “slight mental confusion, a general slowing in muscular movement, hesitancy in speech, and tremors of the hands.” Later, marked truncal ataxia, Parkinsonian syndrome, and marked mental deterioration may set in, “necessitating commitment to an asylum” (5, p 1103).

Although Martland first described the clinical syndrome of CTE and Roberts (11) echoed the dangers of chronic brain damages in boxers in 1969, it was Corsellis et al. who first identified the neuropathology of this syndrome in the brains of 15 deceased boxers, eight of whom were either world or national champions (1).

# Relationship to Alzheimer's Disease

Symptoms earlier in CTE

CTE and AD are tauopathies

AD more extensive beta-amyloid plaques



# Symptoms

**TABLE 1.** Four main components of chronic brain damage in dementia pugilistica

Area damaged	Clinical symptoms/signs
Septum pellucidum, adjacent periventricular grey matter, frontal and temporal lobes	Altered affect (euphoria, emotional ability) and memory
Degeneration of the substantia nigra	Parkinson's syndrome of tremor, rigidity, and brachykinesia
Cerebellar scarring and nerve cell loss	Slurred speech, loss of balance and coordination
Diffuse neuronal loss	Loss of intellect, Alzheimer's syndrome

# Clinical progression of disease:

Psychotic symptoms and affective disturbances



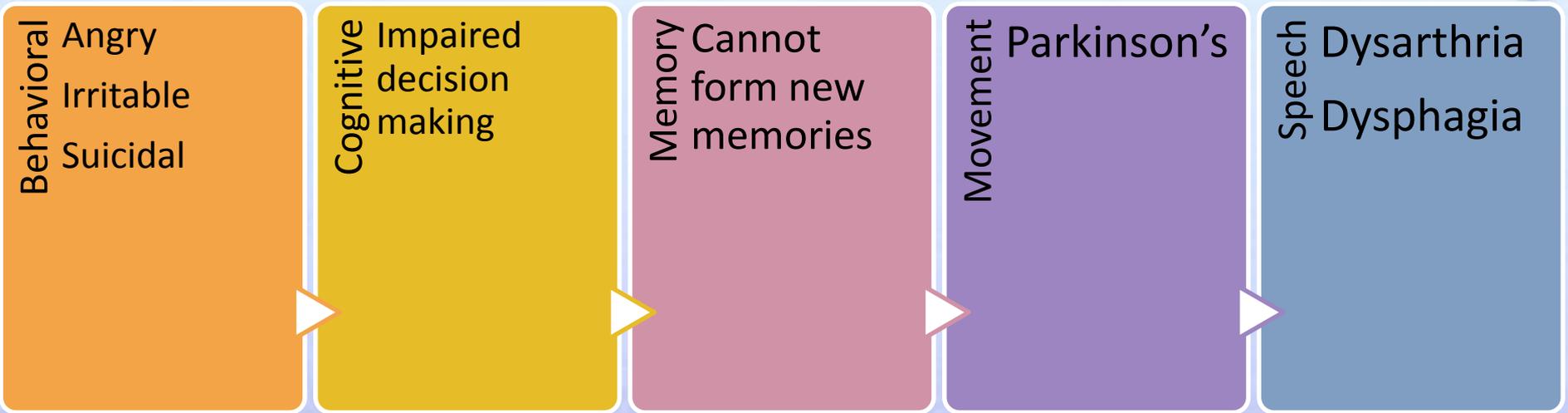
Parkinson-like symptoms - erratic behavior and memory dysfunction



Gait and balance disturbances along with dementia and full on parkinsonism



# Often years after retirement...



# Gross atrophy of:

Cortex

Basal ganglia

Brainstem

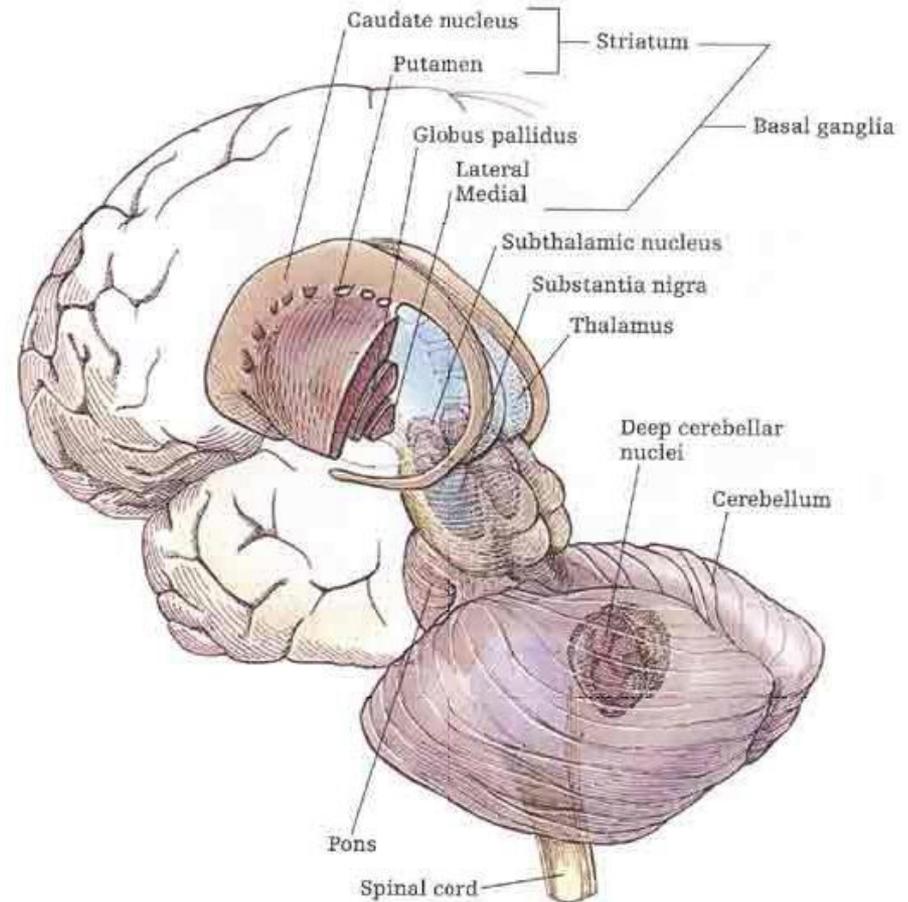
Cerebellum

Diacephalon

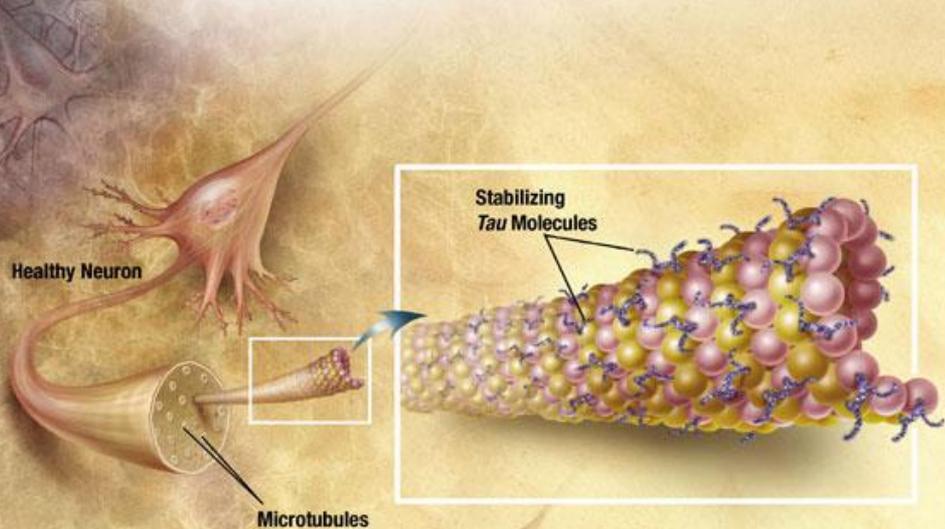
Hippocampus

Substantia nigra

Mammillary bodies



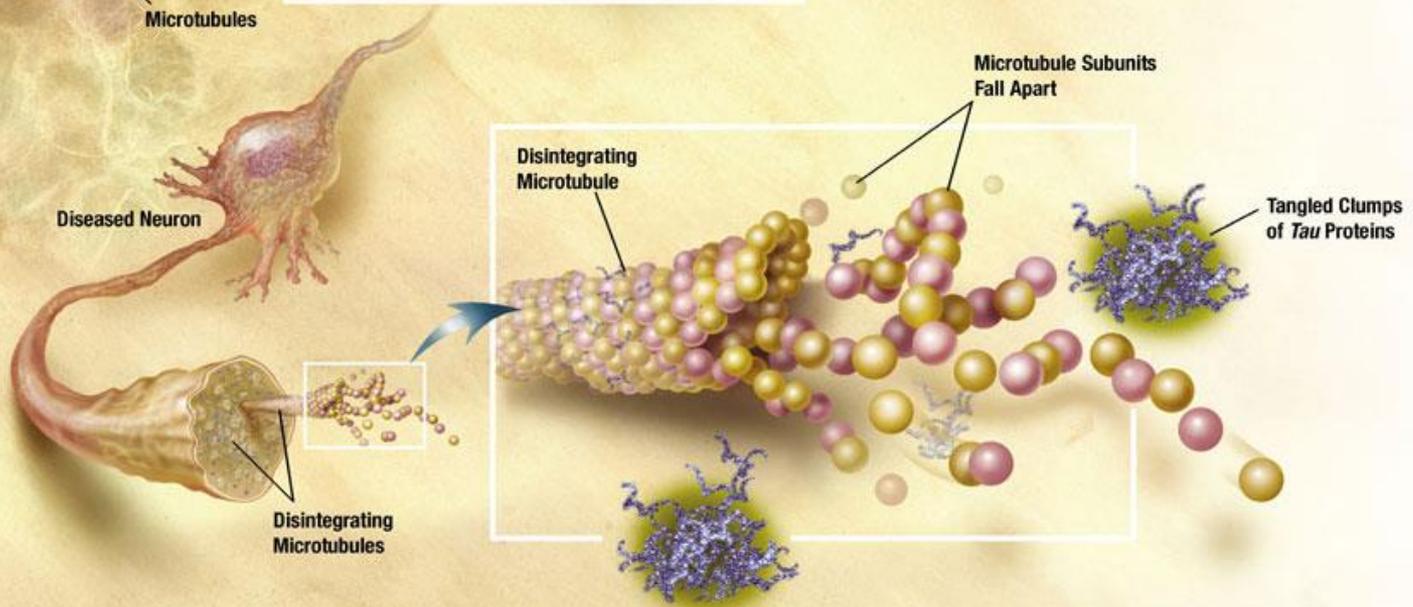
Healthy Neuron



Microtubules

Stabilizing  
Tau Molecules

Diseased Neuron



Disintegrating  
Microtubules

Disintegrating  
Microtubule

Microtubule Subunits  
Fall Apart

Tangled Clumps  
of Tau Proteins

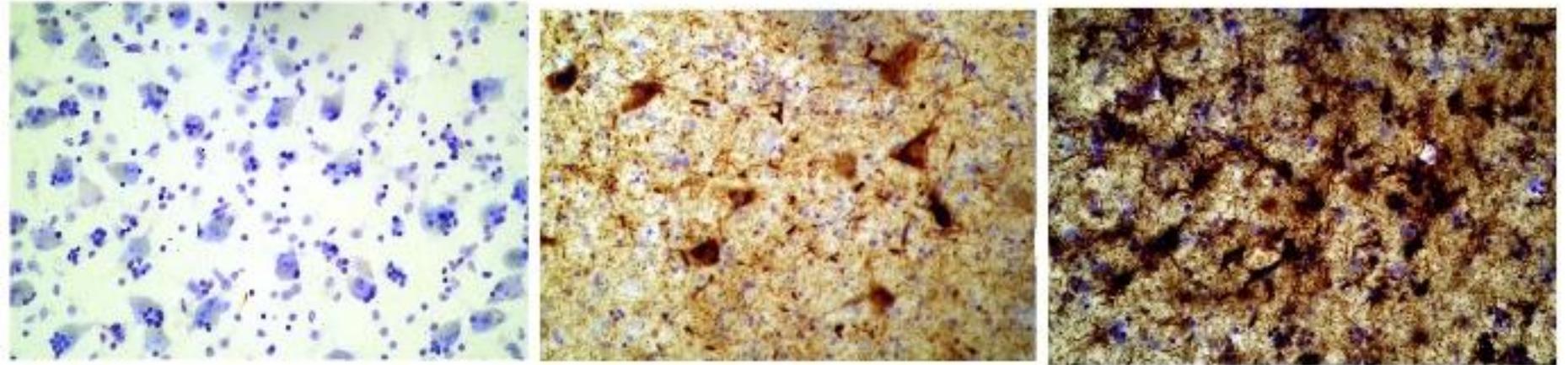
# Neuropathology:

Tau proteins

Neurofibrillary  
tangles &  
inclusions

Neuropil threads

Glial tangles



Tau immuno staining is only present in football player and boxer.

(l-to-r) 65-year old control, Football player , 73-year old boxer [Ann McKee]

# CTE progresses for decades

- Repetitive mechanical trauma
- Could be an inflammatory response
- Cumulative effects of TBI





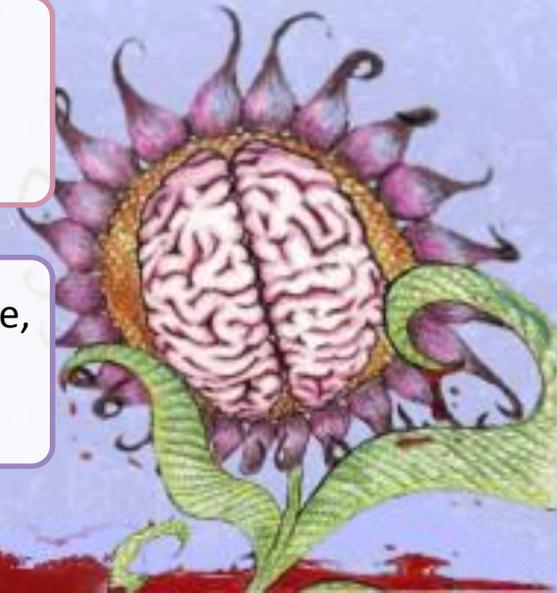
# John Grimsley

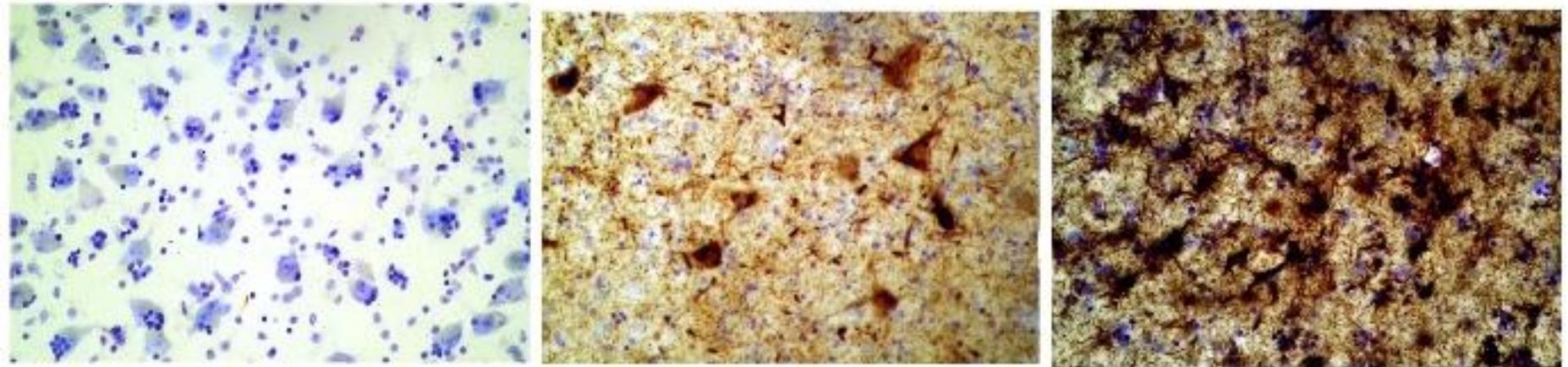
Oilers and Dolphins

8 known concussions

Died at 45 –  
accidental  
gunshot

Memory decline,  
emotional  
instability





The football player – this was John Grimsley’s brain!

(l-to-r) 65-year old control, JOHN GRIMSLEY, 73-year old boxer [Ann McKee]

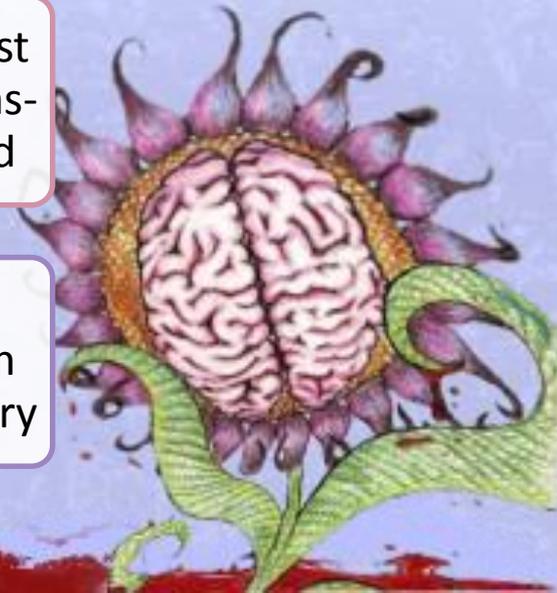
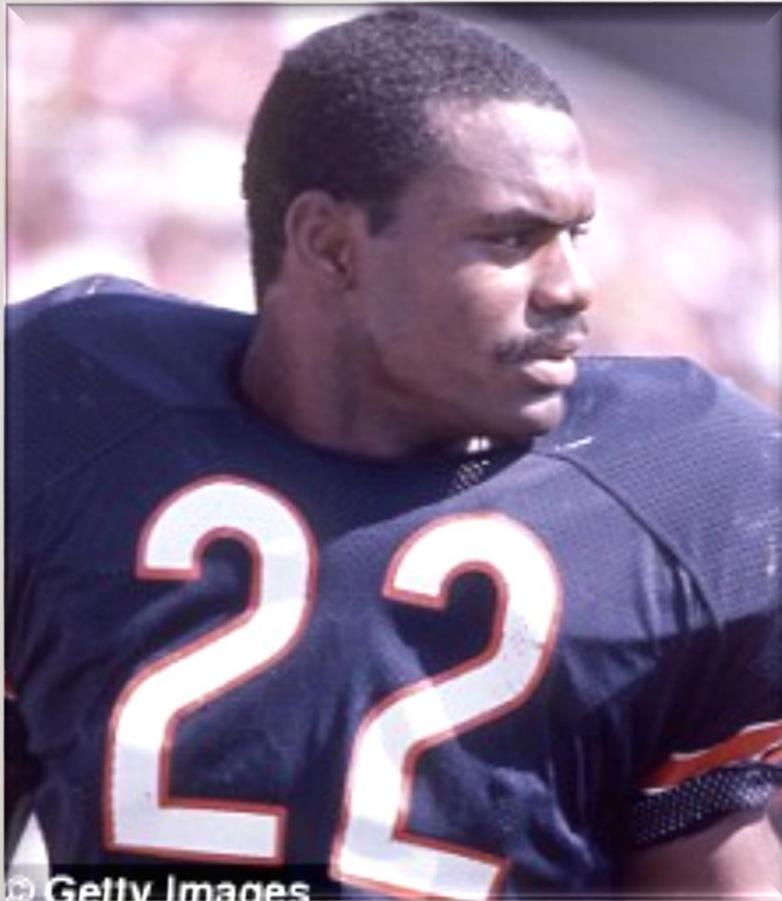
# Dave Duerson

Notre Dame  
Chicago Bears

All-American  
11 years in NFL

Family: at least  
10 concussions-  
never treated

Successful  
business man  
in food industry

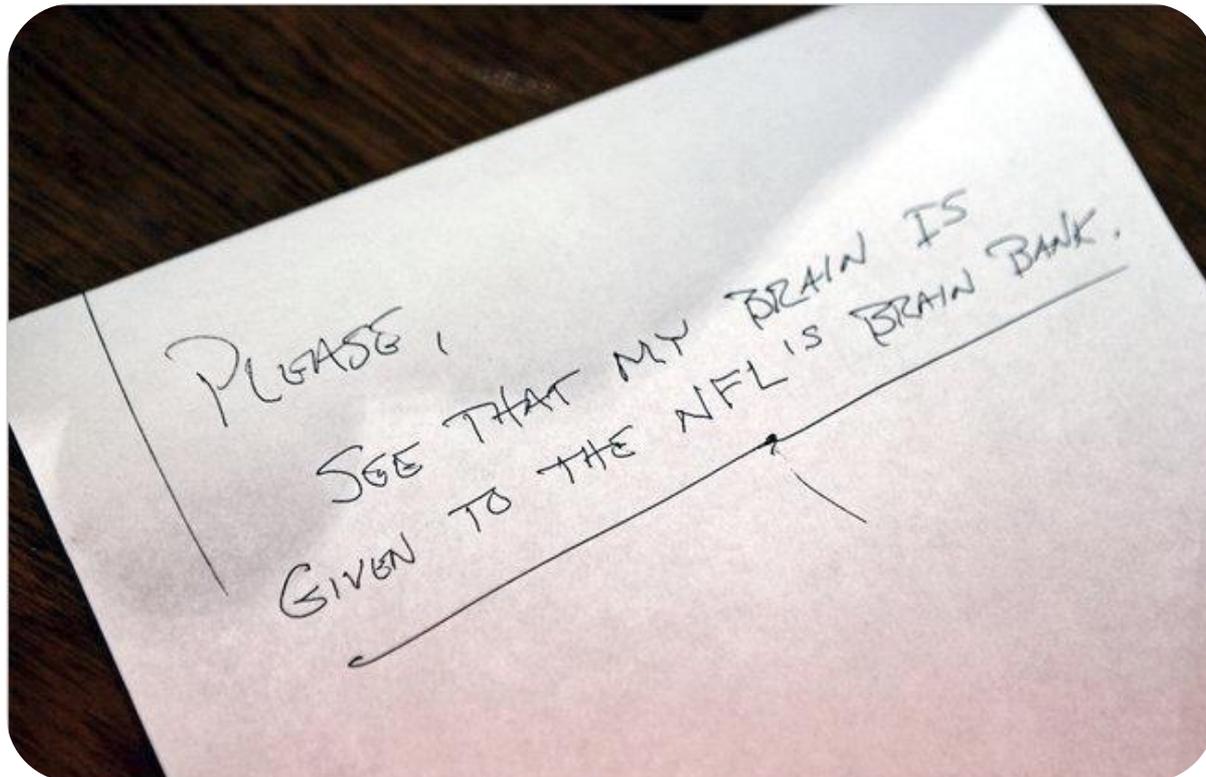


bankruptcy  
Business  
failed

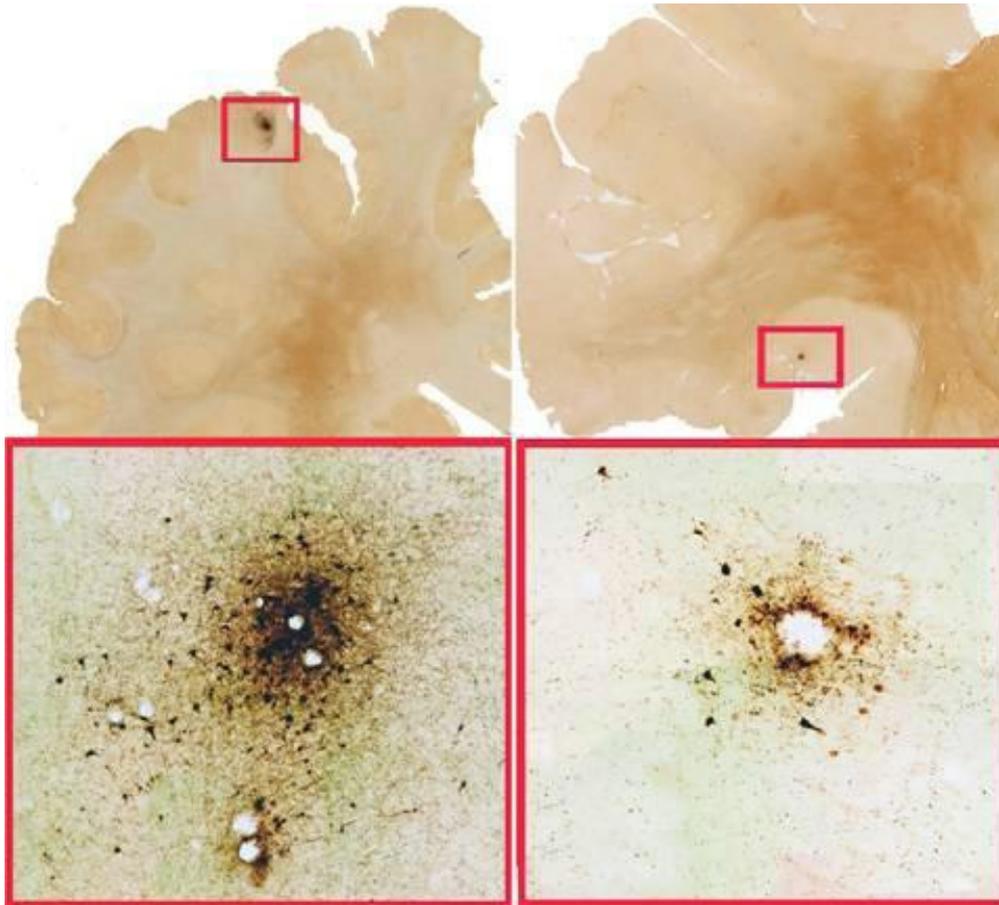
Personal life  
Failed  
marriage  
Abusive  
behavior

Brain damage  
Memory  
loss  
Impulse  
control

Suicide  
CTE  
diagnosis  
confirmed  
at  
autopsy



# Signs of damage start early



18 year old  
brain – visible  
tau protein  
expression-  
Multiple  
concussions  
playing high  
school football.

Center for the Study of Traumatic Encephalopathy



**CNN** -- An autopsy of a 21-year-old college football player who committed suicide has revealed mild stages of a type of brain damage **typically seen in retired or aging athletes** and can cause neurobehavioral disorders and bizarre behavior.

Teammates had described Owen Thomas as an affable college junior who had been overwhelmingly voted to be one of the captains by the University of Pennsylvania football team, and his coach had called him "**the most popular kid on our team.**" Thomas also was named to the Second-Team All-Ivy in 2009. His suicide in April stunned his friends and family.

Owen Thomas  
No known  
concussions  
in football  
career

Side effects  
No  
identified  
side effects  
of  
concussion

Suicide at 21  
Autopsy:  
CTE

September 17, 2010

## Penn Player's Mother to Testify About Concussions in Congressional Hearing

**New York Times - By ALAN SCHWARZ**

The mother of Owen Thomas, the University of Pennsylvania football player who killed himself in April and was recently found to have died with early stages of the same brain disease found in more than 20 professional players, will testify at a Congressional hearing on youth sports concussions on Thursday.

Thomas's mother, the Rev. Kathy Brearley of South Whitehall Township, Pa., will appear before the House Education and Labor Committee. It is the eighth hearing on the issue of brain injuries among athletes of all ages since October.

"This particular problem is very complex, reaches across the whole country and well beyond," Brearley said. "It reaches across a wide age range of athletes. It has implications for military personnel experiencing mild concussions in combat."

The committee is considering legislation requiring all public school districts to implement a concussion safety and management plan in all sports, provide special education services for students with lingering cognitive symptoms, and remove athletes from games and practices if they are suspected of having concussions.

"Student-athletes, parents, teachers and coaches all need to be more aware of the signs, symptoms and risks of concussions to ensure every player is safe and protected, on the playing field and after the game," the committee's chairman, George Miller, Democrat of California, said in a statement.

Other witnesses will include Dr. Gerry Gioia, chief of pediatric neuropsychology for Children's National Medical Center in Washington, and Alison Conca-Cheng, a senior at Centennial High School in Ellicott City, Md., who is recovering from a concussion she sustained while playing soccer.

Researchers at Boston University's Center for the Study of Traumatic Encephalopathy disclosed on Monday their finding that Thomas died with the beginnings of chronic traumatic encephalopathy, a progressive and incurable brain disease caused by repetitive brain trauma and tied with depression and impulse control.

While connecting the disease to Thomas's suicide is only speculative, doctors said the case was significant to youth sports because Thomas had developed the condition by age 21 and while playing only in amateur football.

Thomas had no documented concussion history, raising the question of whether the disease was catalyzed less by

concussions than by the accumulation of more routine blows to his head.

In a grim coincidence, the findings related to Thomas's brain trauma were announced only days after the death of an 11-year-old football player from Muskego, Wis. The player, Evan Coubal, sustained a concussion in a game and several days later accidentally hit his head during recess, according to the Milwaukee radio station WTMJ. He was rushed to the hospital and died two days later, on Sept. 5.

At least 32 high school and youth football players were killed by or made incomplete recoveries from head injuries from 2006 to 2009, according to a log kept by the National Center for Catastrophic Sport Injury Research at the University of North Carolina. That was almost twice the total from the previous four-year period.

Many states have passed or are considering legislation that requires concussion awareness for coaches, players and their parents, as well as strict rules about when and by whom public school players can be cleared to return to play after a concussion.

In March, the National Federation of High School Athletic Associations passed a rule that requires any player who shows any symptom of concussion to be removed from a game and not be allowed to return "until cleared by an appropriate health-care professional."

On the federal level, on Thursday, the Health Subcommittee of the House Energy and Commerce Committee approved the Concussion Treatment and Care Tools Act, which would require the Department of Health and Human Services to convene a conference of medical, athletic and education professionals to establish a set of concussion management guidelines for student athletes.

It also authorizes the Department of Health and Human Services to grant states money to implement new concussion policies as well as purchase testing equipment to better protect student-athletes.

"More and more of my colleagues in Congress are realizing what so many families across the country have realized," said Representative Bill Pascrell Jr., Democrat of New Jersey, who introduced the legislation after a New Jersey high school football player died of head injuries in October 2008. "A concussion is brain damage, pure and simple."

hit back  
... among Saints  
... suspensions, 1C

**Charged in FAMU hazing death** Experts say cases to stop endurance

line  
MAY 3, 2012



attacks a  
'get out'  
... for foreign  
... after Obama  
... ship deal, 2A

10 babies are  
study shows  
... are in Africa, Asia;  
... nels notion that this  
... or says, 3A

JUNIOR SEAU | 1969-2012



Superstar: Junior Seau, who ended his career with the Patriots, made 12 Pro Bowls as a Charger.

**'Zero warning' of NFL icon's apparent suicide**

But Chargers legend had struggled after football

By Jon Saraceno  
USA TODAY

**Dea  
retu  
acti  
test**

U.S.-China  
escapee fr

By Richard Wolf  
USA TODAY

BEIJING — The de-  
release mind human  
cheng back into China  
escape from local au-  
test for U.S.-China re-  
matic dialogue open-  
Six days of sin-  
Wednesday in Chen-  
bassy protection for  
was renitted with  
Chinese government  
cials after assuranc-  
he would not be in-  
It took only two  
ever, for the deal  
by senior State D-  
diplomats for com-  
Premier Wen Jiabao

# CTE confirmed

"One of the problems with CTE cases is that some of them end in suicide. The suicides are often precipitous, without warning," said neurosurgeon Julian Bailes, a co-author of the report and co-director of the NorthShore Neurological Institute in Evanston, Ill.

Gary Mihoces, USA TODAY Sports



Officially, Seau never suffered a concussion during a two-decade career with the San Diego Chargers, Miami Dolphins and New England Patriots that ended with his 2009 retirement. But Walczak, a former tight end and long snapper in the NFL, believes his friend suffered multiple undiagnosed concussions.

**"Junior just didn't report head injuries,"** Walczak said. "I had (unreported) concussions, too, especially back when guys were allowed to tee off on the long snappers. But you just don't report them. You're a football player. You're tough. If you did report stuff like that, next thing you know you're on waivers."

# Seau brain disease sends alarms among players, critics

Word came Thursday that Seau had a degenerative brain disease when he shot himself in the chest last May. Most shocking was that it was hardly a shock at all. His is merely the latest of dozens of cases of former pro football players who died with signs of chronic traumatic encephalopathy (CTE) and the third by suicide in recent times.

**"On initial examination the brain looked normal but under the microscope, with the use of special staining techniques, abnormalities were found that were consistent"** with a form of CTE, NIH said in a statement. It added that a small region of Seau's left frontal lobe showed scarring consistent with a small, old, traumatic brain injury.

Erik Brady and Gary Mihoces, USA TODAY Sports



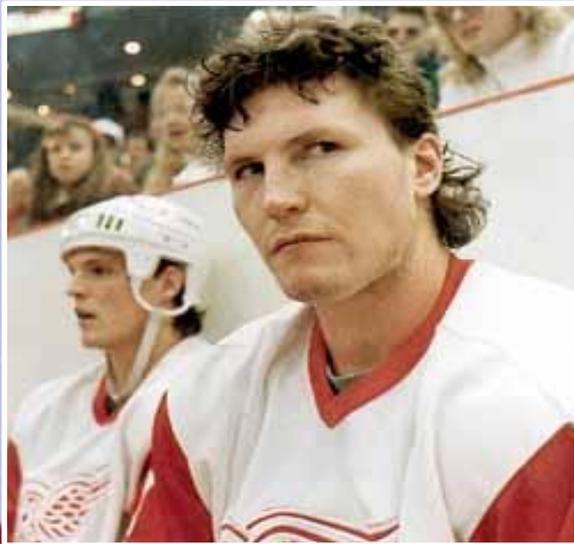
# It's not just boxing and football



Chris Benoit  
Wrestling



Reggie Fleming  
Hockey



Bob Probert  
Hockey



## With Focus on Youth Safety, a Sport Considers Changes



David Duprey/Associated Press

The Sabres' Jason Pominville was concussed after a blindside hit against the glass on Oct. 11. A Mayo Clinic conference will discuss steps to prevent such injuries.

By JEFF Z. KLEIN

Published: October 17, 2010

<http://www.nytimes.com/2010/10/18/sports/hockey/18hockey.html>

# PET Scan May Reveal C.T.E. Signs, Study Says

The New York Times

By Ken Belson

Published: January 22, 2013

For years, researchers have had to use tissue obtained posthumously to diagnose chronic traumatic encephalopathy, or C.T.E., the degenerative brain disease that has bedeviled athletes, soldiers and others who have sustained repeated head hits and concussions.

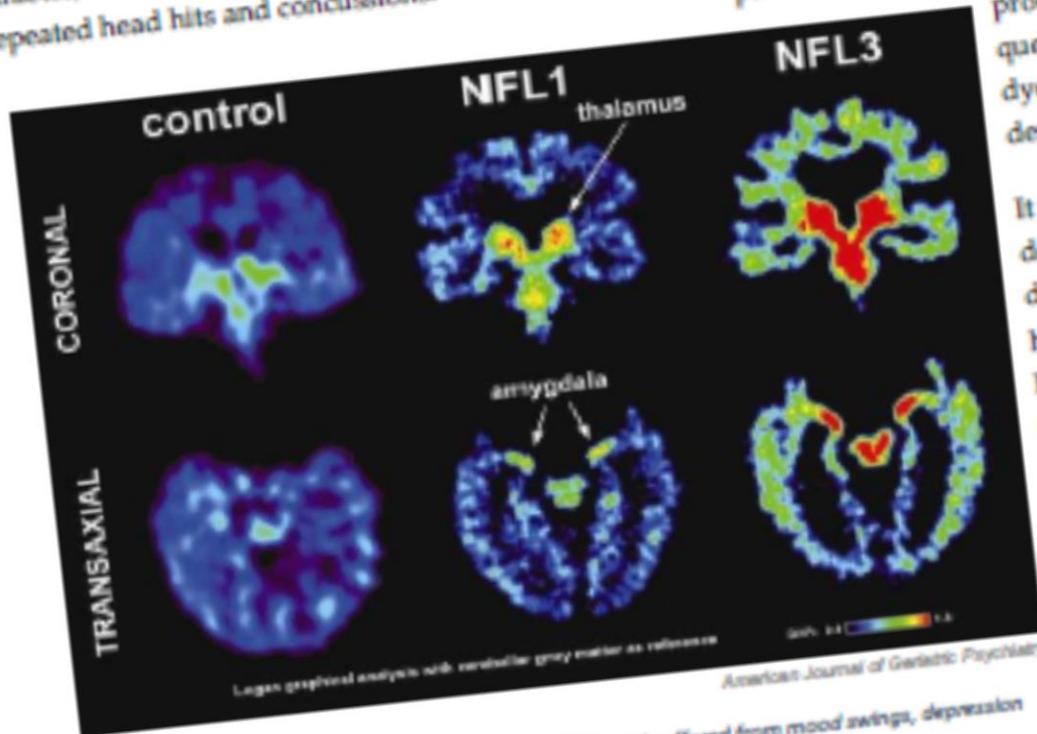
retired players was consistent with those found in the autopsies of players who had C.T.E.

But the size of the group was tiny. Far larger and more in-depth studies will be needed before PET scans may be used to identify the tau pathology in patients who are not already experiencing cognitive

problems. Some doctors also questioned the accuracy of the dye used to identify tau deposits in the brain.

It may take years and perhaps decades for doctors to determine how much of a role head hits and brain trauma have in patients with C.T.E., as opposed to genetic predisposition and health maladies like heart disease.

But the study is a first step toward the possibility of using PET scans to develop strategies to prevent the onset of the disease and provide treatment



Five retired N.F.L. players who were 45 years and older and suffered from mood swings, depression and other symptoms also had PET, or positron emission tomography, scans.

# what about one season of contact sports in college?

## Cognitive effects of one season of head impacts in a cohort of collegiate contact sport athletes

T.W. McAllister, MD  
L.A. Flashman, PhD  
A. Maerlender, PhD  
R.M. Greenwald, PhD  
J.G. Beckwith, MS  
T.D. Tosteson, ScD  
J.J. Crisco, PhD  
P.G. Brolinson, DO  
S.M. Duma, PhD  
A.-C. Duhaime, MD  
M.R. Grove, MS  
J.H. Turco, MD

### Conclusion:

Repetitive head impacts over the course of a single season may negatively impact learning in some collegiate athletes. Further work is needed to assess whether such effects are short term or persistent.

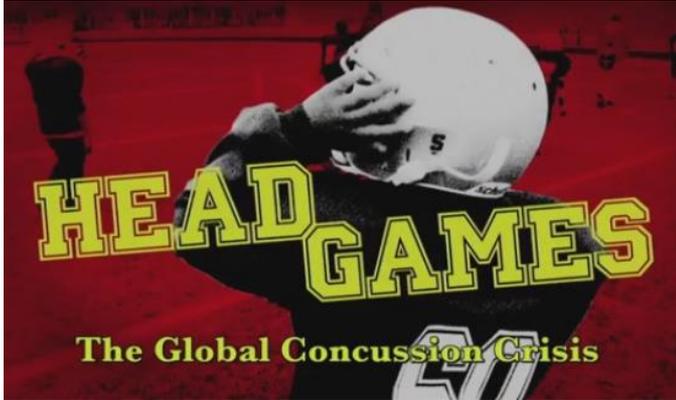
Neurology 2012;78:1777–1784

HEAD GAMES:  
THE GLOBAL  
CONCUSSION CRISIS



HEAD  
GAMES

The Global Concussion Crisis



# This Is Your Brain on Football

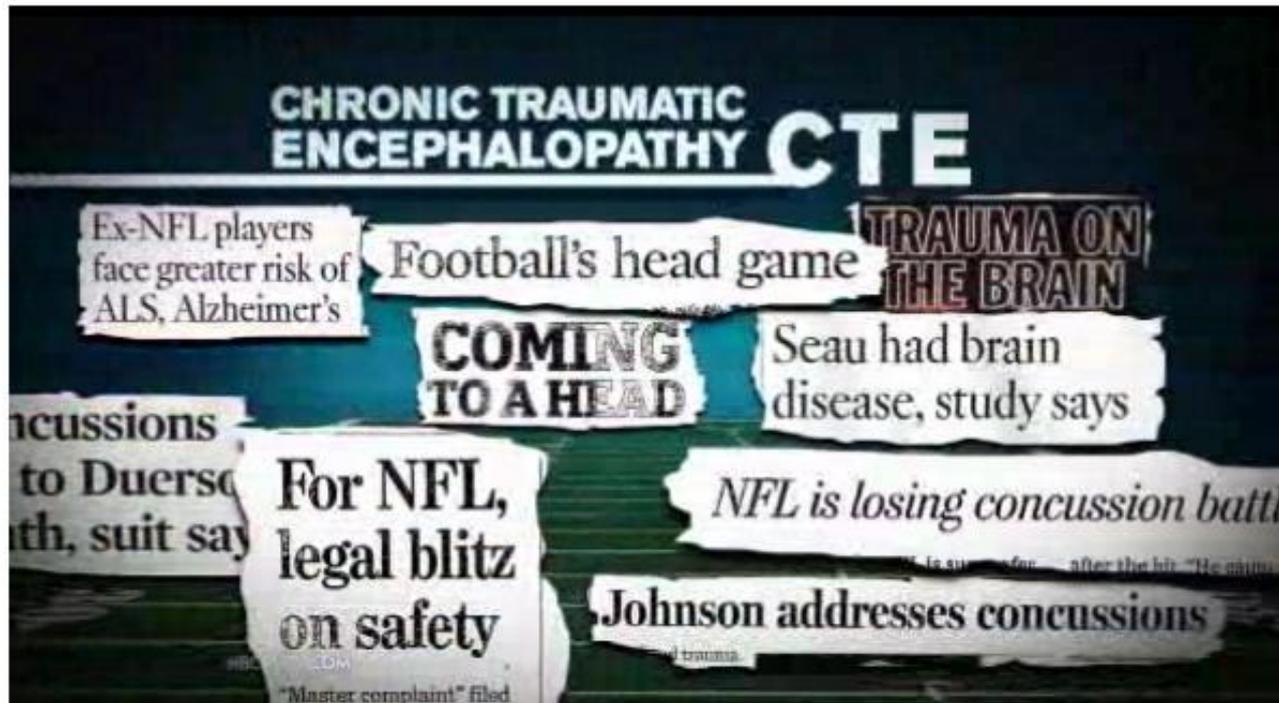
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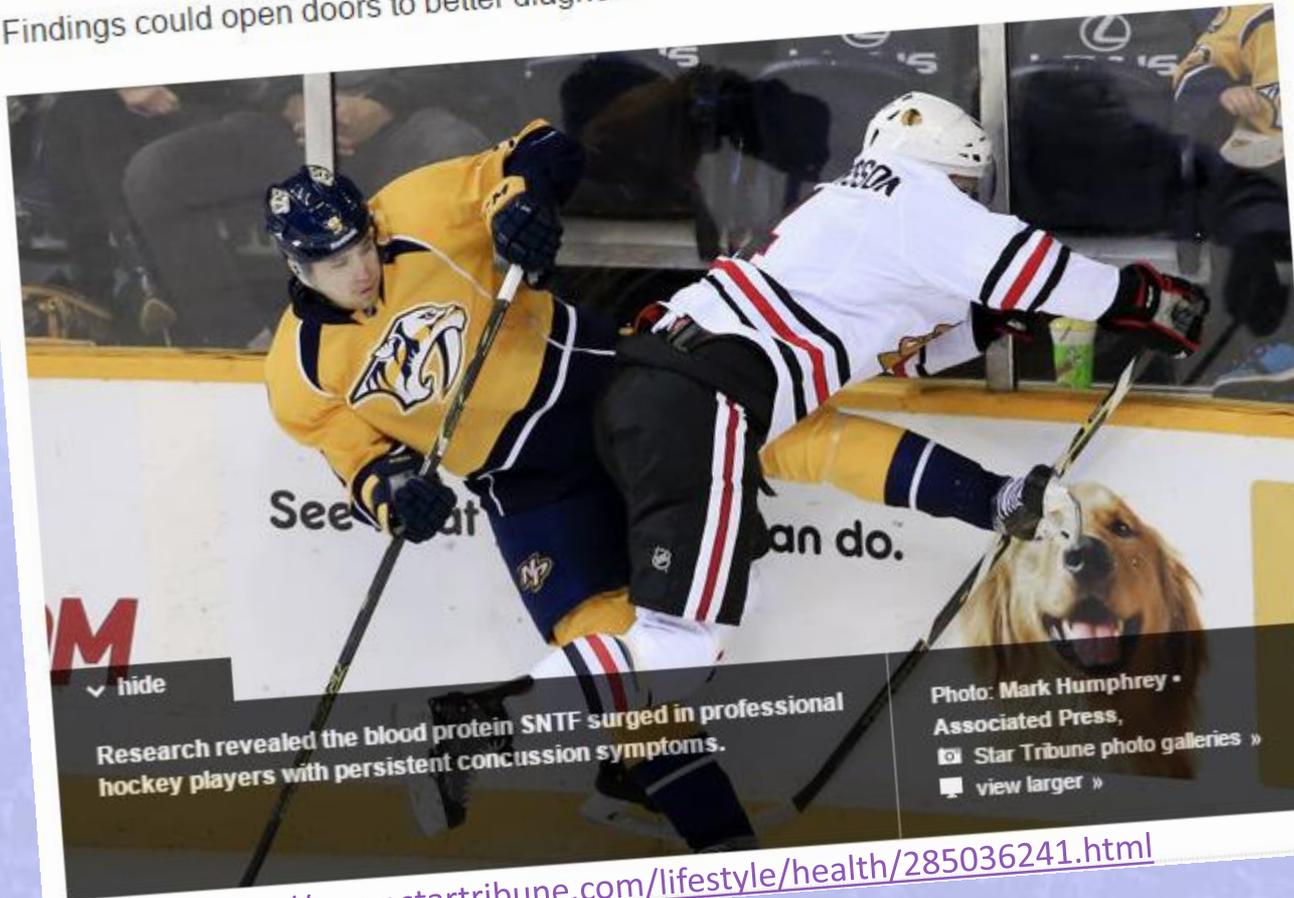
## Game change: Brain scans offer new view of NFL concussions



# Blood test shows promise in diagnosing concussions

Article by: MARIE MCCULLOUGH, Philadelphia Inquirer | Updated: December 7, 2014 - 8:19 PM

Findings could open doors to better diagnoses.



hide

Research revealed the blood protein SNTF surged in professional hockey players with persistent concussion symptoms.

Photo: Mark Humphrey - Associated Press,  
Star Tribune photo galleries »  
view larger »

<http://www.startribune.com/lifestyle/health/285036241.html>



# Blood Test for Concussion Symptoms?

## **Serum SNTF Increases in Concussed Professional Ice Hockey Players And Relates to the Severity of Post-Concussion Symptoms**

Robert Siman, PhD, Pashtun Shahim, MD\*, Yelverton Tegner, MD\*\*, Kaj Blennow, MD PhD\*,  
Henrik Zetterberg, MD PhD\*#, Douglas H. Smith, MD



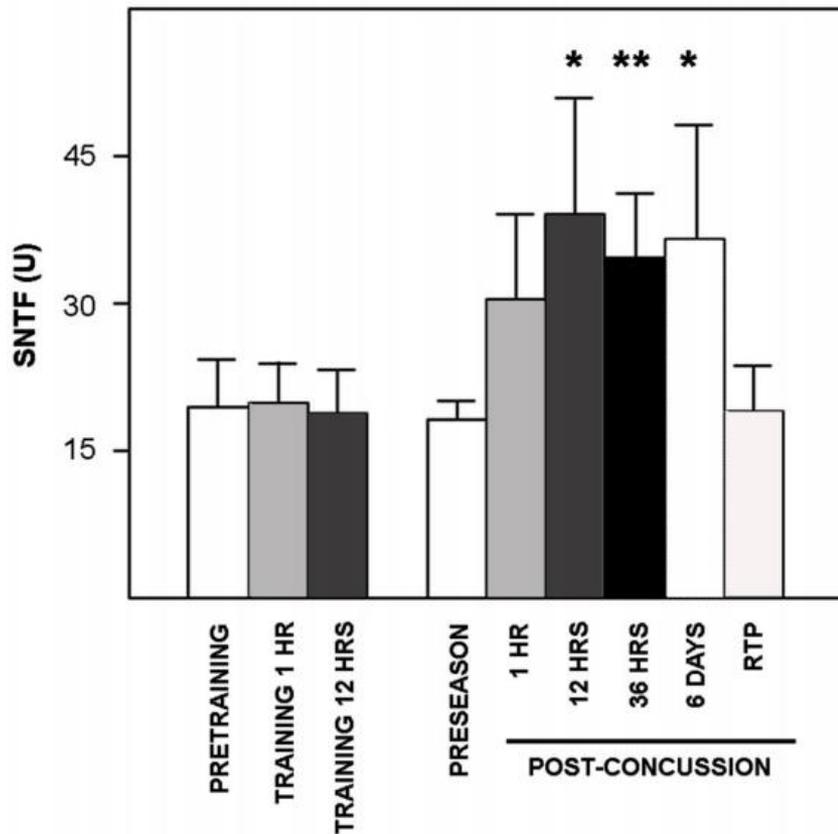


Figure 1. Sustained increase in serum SNTF concentrations in professional ice hockey players after concussion but not concussion-free training. SNTF levels were measured in serum during the preseason (n=45) or serially after an in game concussion (n=28), or before and after a training game (n=17). The mean serum SNTF levels (+/- S.E.M.) were elevated at 1,12,36, and 144 hours post-concussion compared with the mean preseason baseline concentration, and the increases at the latter three time points were statistically significant (two-tailed t-test; \*p<0.03; \*\*p<0.002). At the time of return to play (RTP) after a period of rest, SNTF levels returned to their preseason baseline. In contrast to the pronounced effects of concussion, SNTF was unchanged 1 or 12 hours after concussion-free training (p>0.87).



## Evidence that the blood biomarker SNTF predicts brain imaging changes and persistent cognitive dysfunction in mild TBI patients

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Although mild traumatic brain injury (mTBI), or concussion, is not typically associated with abnormalities on computed tomography (CT), it nevertheless causes persistent cognitive dysfunction for many patients. Consequently, new prognostic methods for mTBI are needed to identify at risk cases, especially at an early and potentially treatable stage. Here, we quantified plasma levels of the neurodegeneration biomarker calpain-cleaved  $\alpha$ -spectrin N-terminal fragment (SNTF) from 38 participants with CT-negative mTBI, orthopedic injury (OI), and normal uninjured controls (UCs) (age range 12–30 years), and compared them with findings from diffusion tensor imaging (DTI) and long-term cognitive assessment. SNTF levels were at least twice the lower limit of detection in 7 of 17 mTBI cases and in 3 of 13 OI cases, but in none of the UCs. An elevation in plasma SNTF corresponded with significant differences in fractional anisotropy and the apparent diffusion coefficient in the corpus callosum and uncinate fasciculus measured by DTI. Furthermore, increased plasma SNTF on the day of injury correlated significantly with cognitive impairment that persisted for at least 3 months, both across all study participants and also among the mTBI cases by themselves. The elevation in plasma SNTF in the subset of OI cases, accompanied by corresponding white matter and cognitive abnormalities, raises the possibility of identifying undiagnosed cases of mTBI. These data suggest that the blood level of SNTF on the day of a CT-negative mTBI may identify a subset of patients at risk of white matter damage and persistent disability. SNTF could have prognostic and diagnostic utilities in the assessment and treatment of mTBI.

**Keywords:** surrogate marker, concussion, calpain, DTI, spectrin, diffuse axonal injury, prognostic marker, cognitive impairment





# Concussion Coach

**There's an App  
For That**