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 the 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

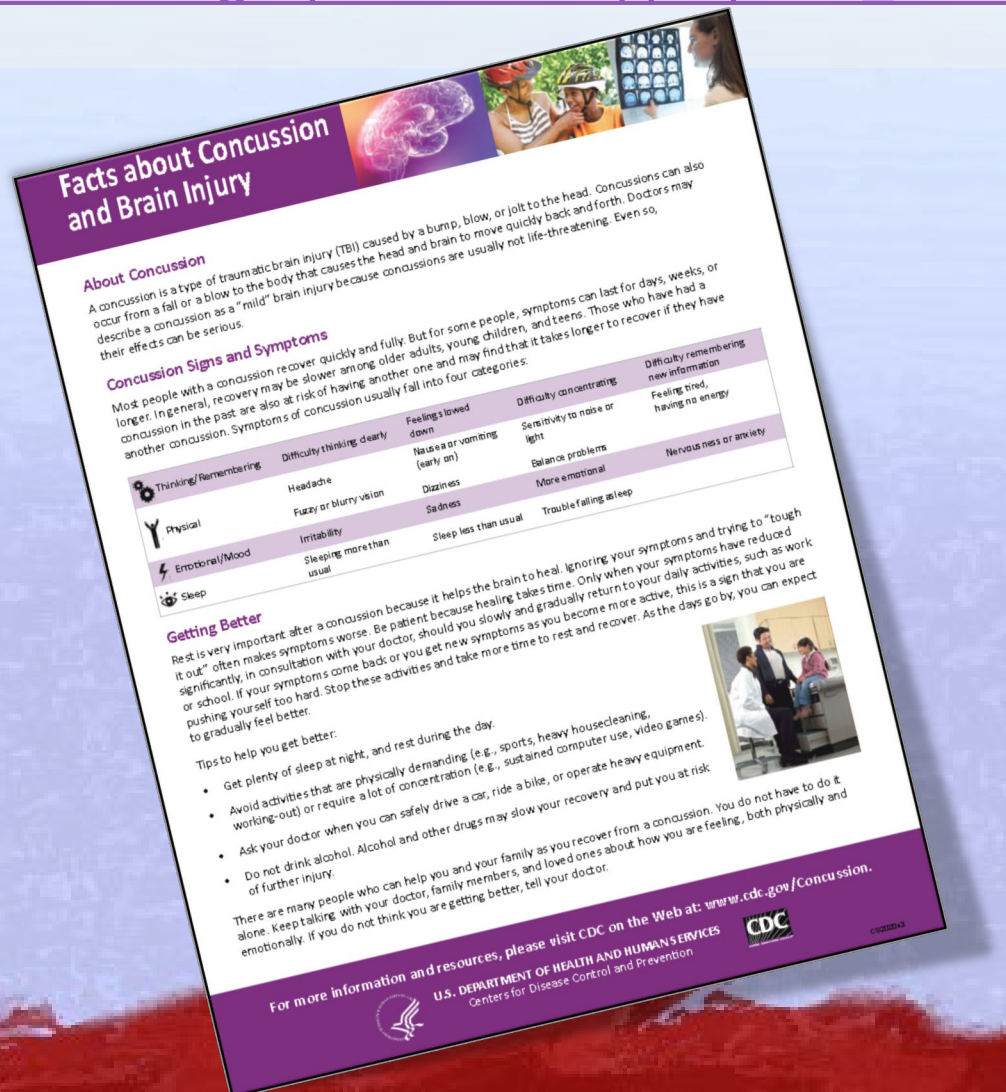
Consequences:

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

www.CDC.gov

Get the Facts…

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 slowed down	Difficulty concentrating	Difficulty remembering new information
Physical	Headache	Nausea or vomiting (early on)	Sensitivity to noise or light	Feeling tired, having no energy
Emotional/Mood	Fuzzy or blurry vision	Dizziness	Balance problems	
Sleep	Irritability	Sadness	More emotional	Nervousness or anxiety
	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.

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

CDC

TBI is caused by a bump, blow or jolt to the head or a penetrating head injury the 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.[1]
- According to jail and prison studies, 25-87% of inmates report having experienced a head injury or TBI [2-4] as compared to 8.5% in a general population reporting a history of TBI.[5]
- Prisoners who have had head injuries may also experience mental health problems such as severe depression and anxiety,[3] substance use disorders,[6-8] difficulty controlling anger,[6] or suicidal thoughts and/or attempts.[6,9]

http://www.cdc.gov/traumaticbraininjury/pdf/Prisoner_TBI_Prof-a.pdf

How damaging is it?

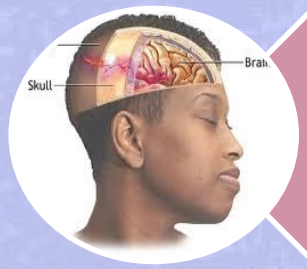
- Minor knocks can be damaging
- 1.7 million cases of TBI/year
- 8.5% of US population
- 60% of prisoners have TBI

www.cdc.gov/TraumaticBrainInjury/

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

www.CDC.gov

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

http://www.cdc.gov/traumaticbraininjury/severe.html

A-Head Check

IMMEDIATE HEAD INJURY EVALUATION

BTF BRAIN TRAUMA FOUNDATION

CDC CENTERS FOR DISEASE CONTROL AND PREVENTION

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:

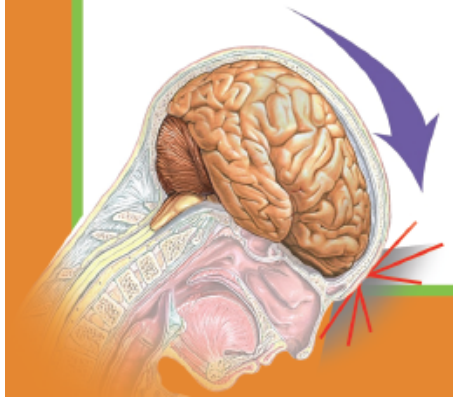
- Do you have a severe headache?
- Do you feel like you may vomit?
- Do you have difficulty staying awake?

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** or **www.cdc.gov/Concussion**.

A part of CDC's Heads Up Series

http://www.cdc.gov/concussion/pdf/Concussion_A-Must_Read_for_Young_Athletes.pdf

Sports Related Head Injuries

Don't hide it,
Report it.

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.

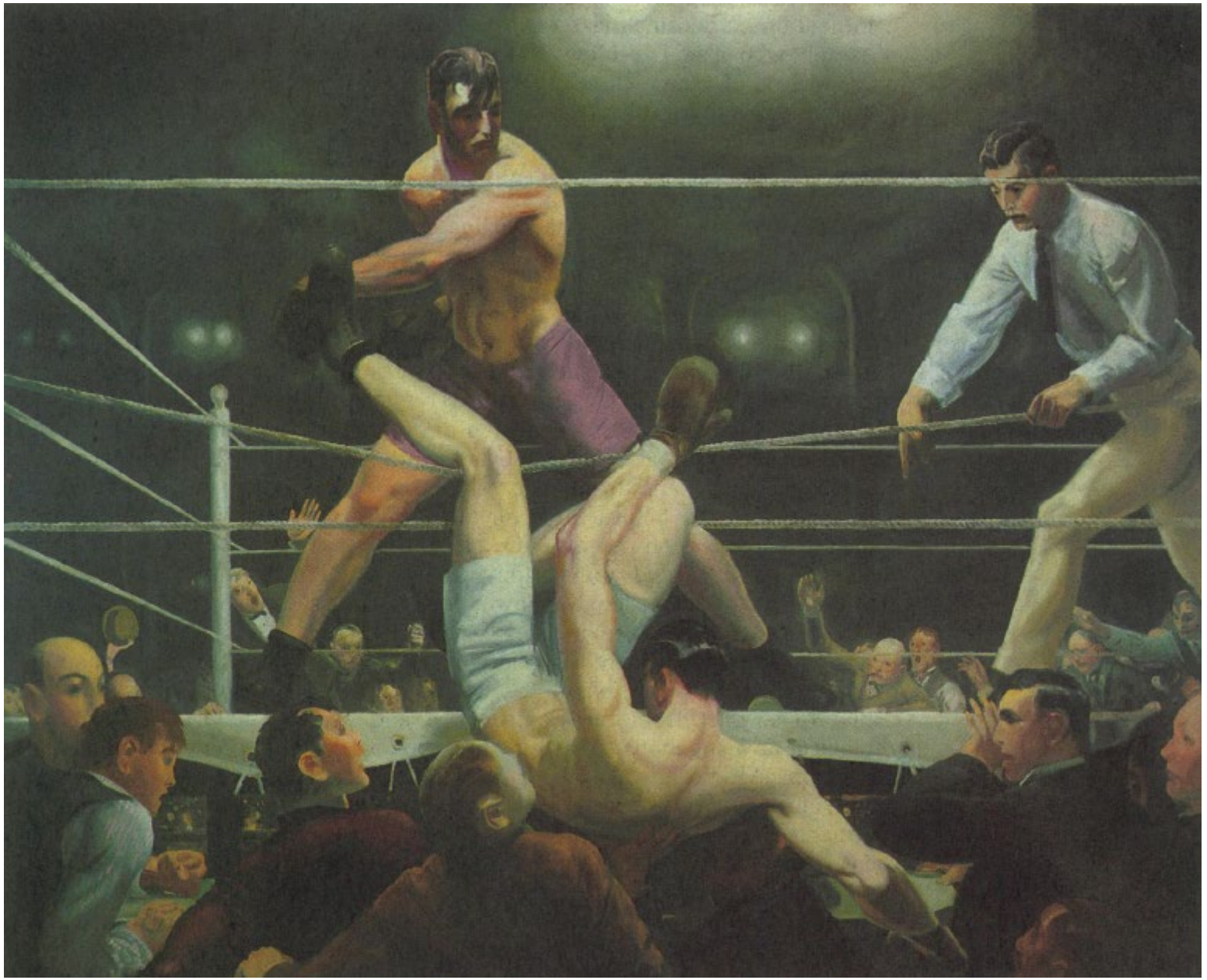
Cantu Evidence-Based Grading System for Concussion

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 Pugilisitica
- 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).

Cantu, R. C. Neurosurgery 61:223–225

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

Cantu, R. C. Neurosurgery 61:223–225

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

Corsellis JA, Bruton CJ, Freeman-Browne D: The aftermath of boxing. **Psychol Med** 3:270–303, 1973.

Often years after retirement…

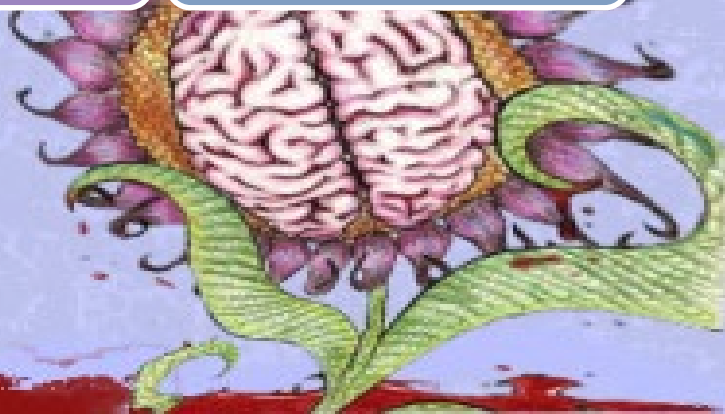
Behavioral
- Angry
- Irritable
- Suicidal

Cognitive
- Impaired decision making

Memory
- Cannot form new memories

Movement
- Parkinson's

Speech
- Dysarthria (unclear speech articulation)
- Dysphagia (trouble with swallowing)



Gross atrophy of:

Cortex

Basal ganglia

Brainstem

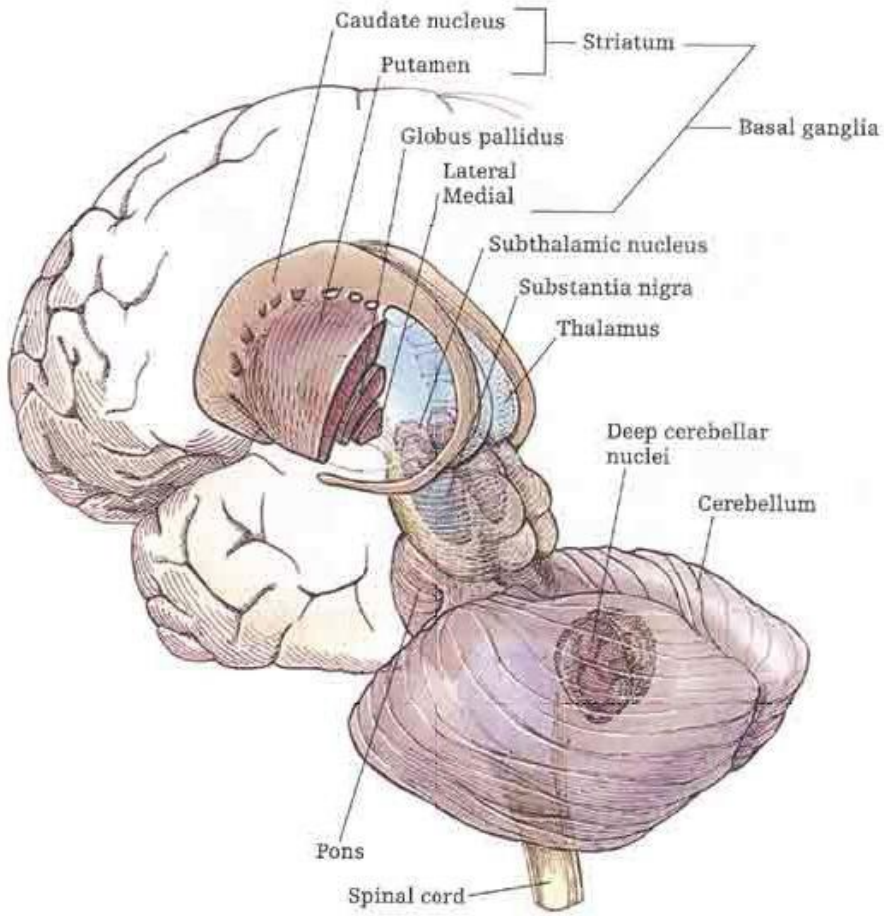
Cerebellum

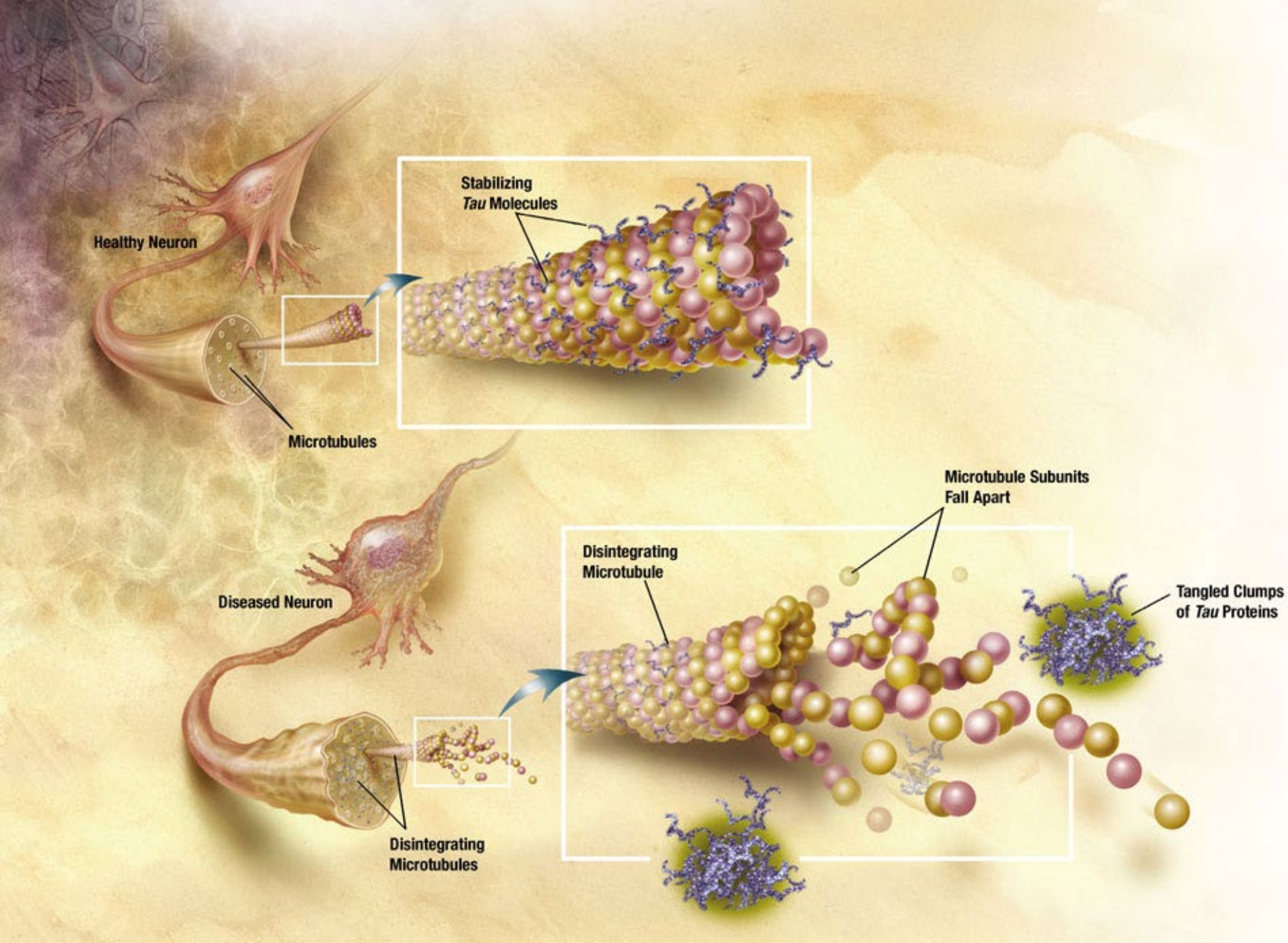
Diecephalon

Hippocapmus

Substantia nigra

Mammillary bodies




Healthy Neuron
Stabilizing
Tau Molecules
Microtubules
Diseased Neuron
Microtubule Subunits
Fall Apart
Disintegrating
Microtubule
Tangled Clumps
of *Tau* Proteins
Disintegrating
Microtubules

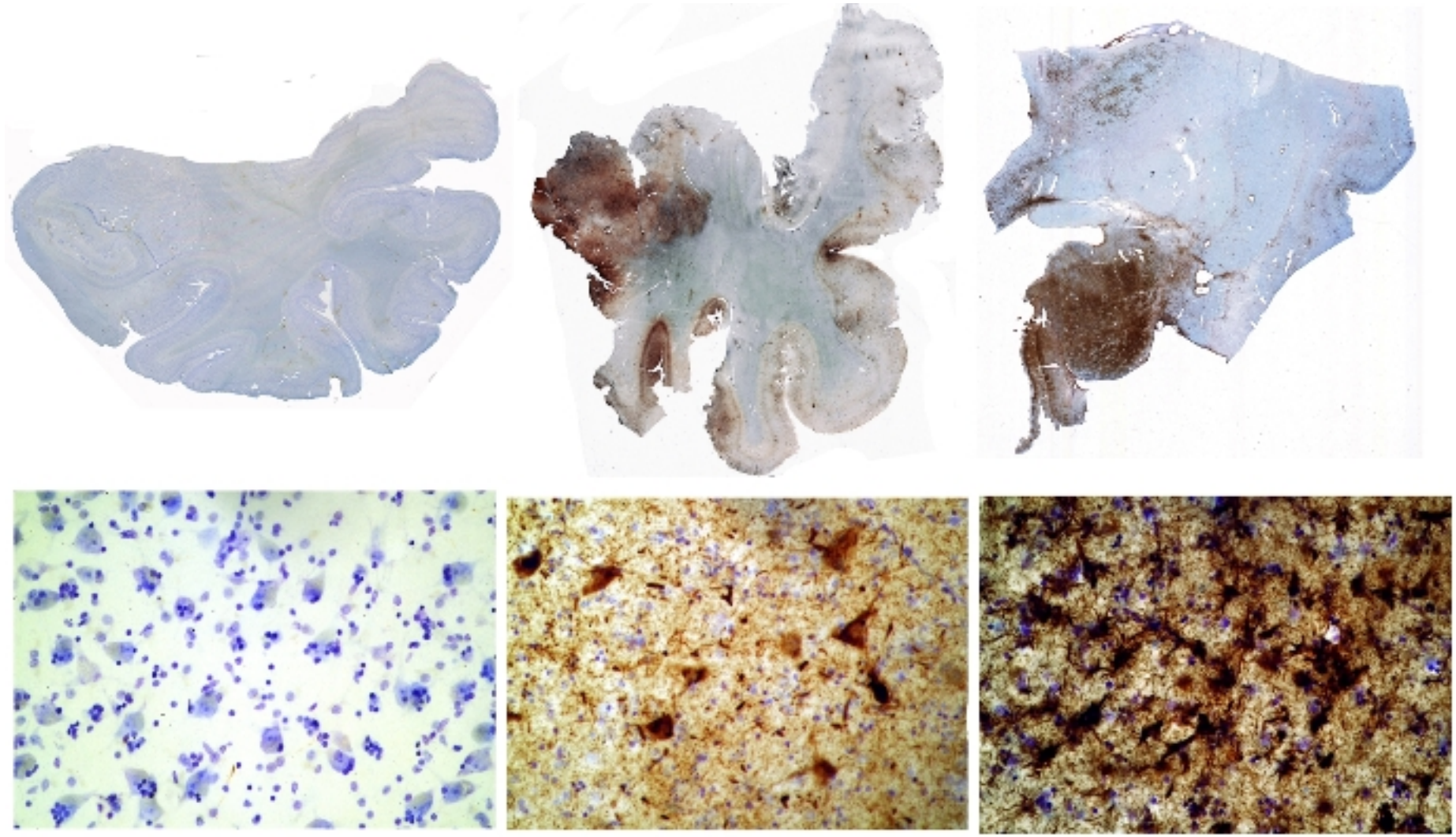
Neuropathology:

Tau proteins

Neurofibrillary tangles & inclusions

Neuropil threads

Glial tangles



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

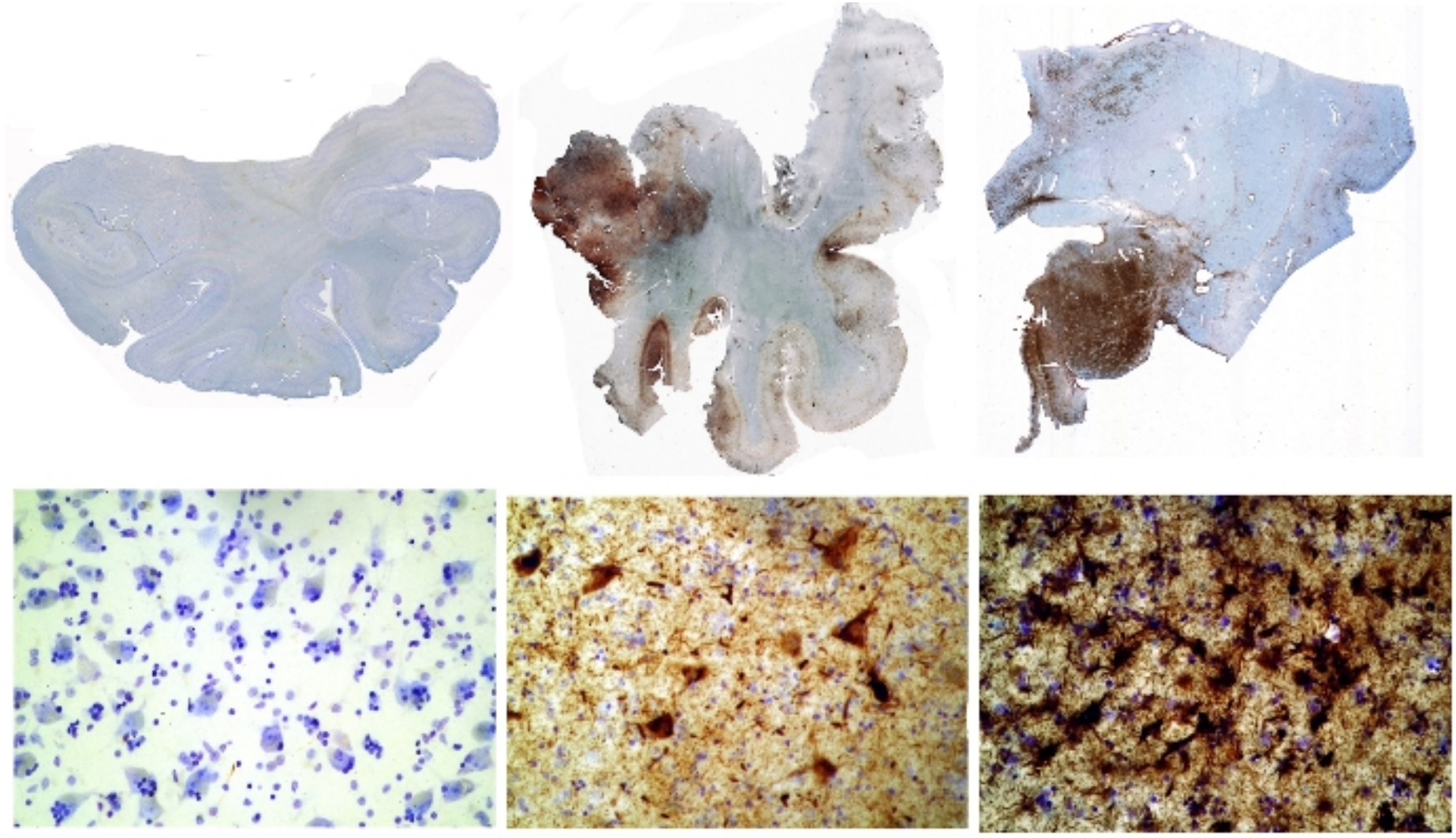
(l-to-r) 65-year old control, Football player , 73-year old boxer [Ann McKee]

CTE progresses for decades

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

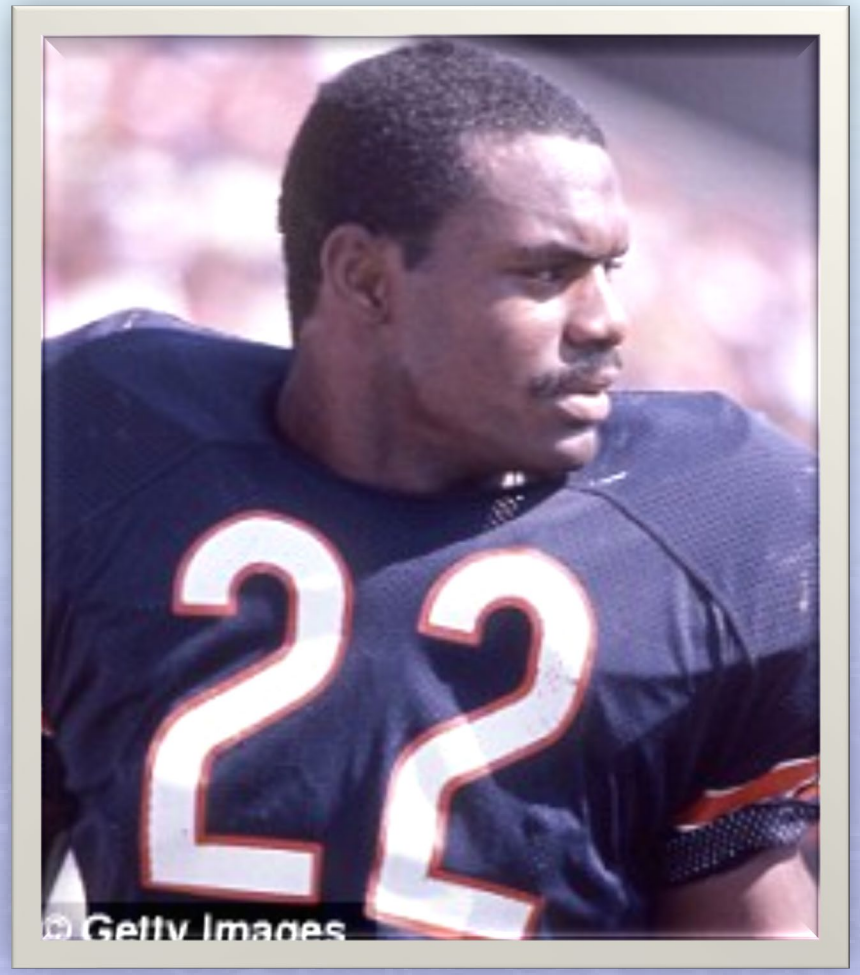
John Grimsley

- 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

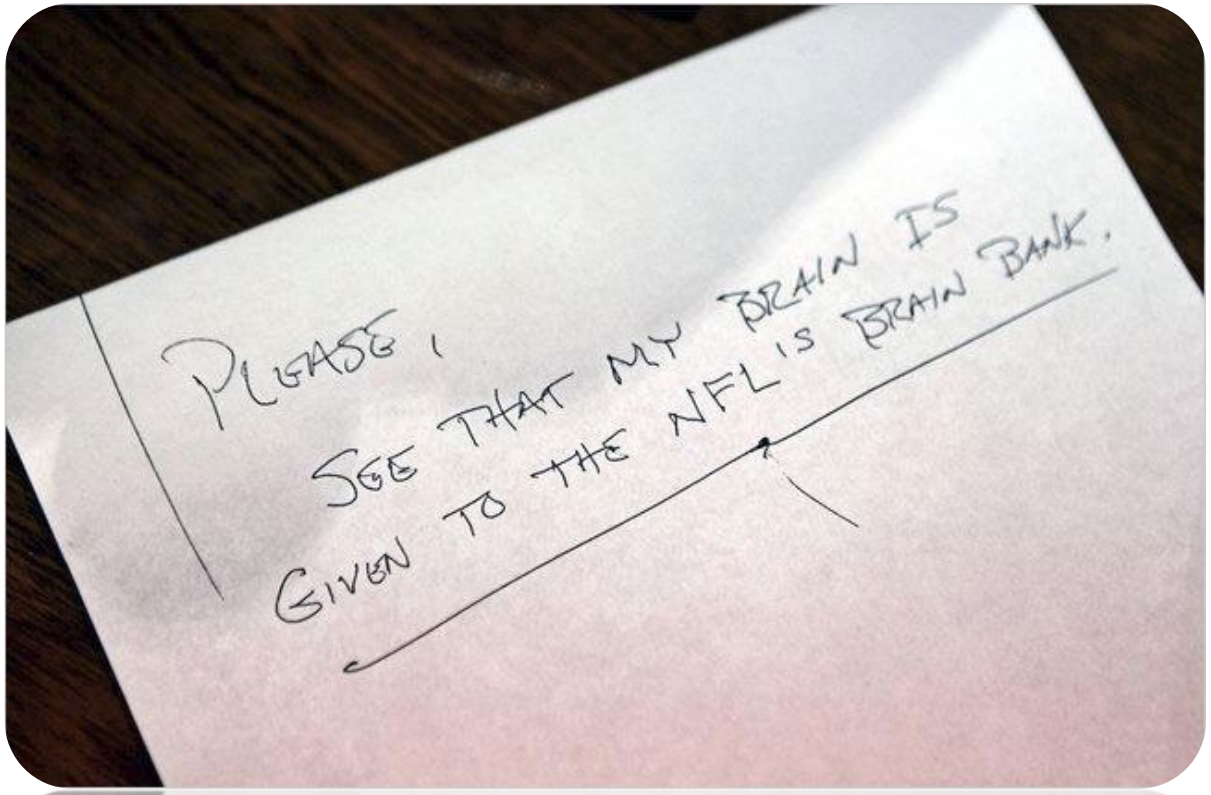
- Notre Dame
  Chicago Bears
- All-American
  11 years in NFL
- Family: at least 10 concussions- never treated
- Successful business man in food industry

bankruptcy
Business failed

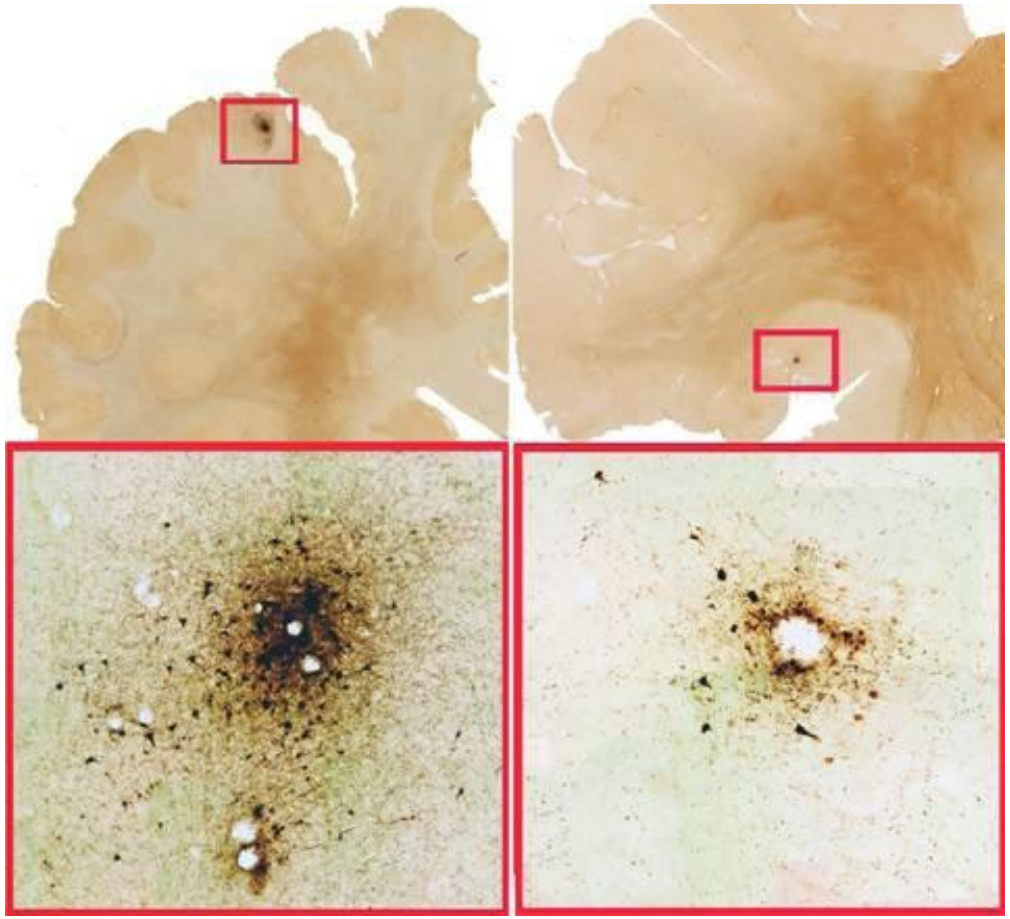
Personal life
Failed marriage
Abusive behavior

Brain damage
Memory loss
Impulse control

Suicide
CTE diagnosis confirmed at autopsy



Signs of damage start early



Center for the Study of Traumatic Encephalopathy

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

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

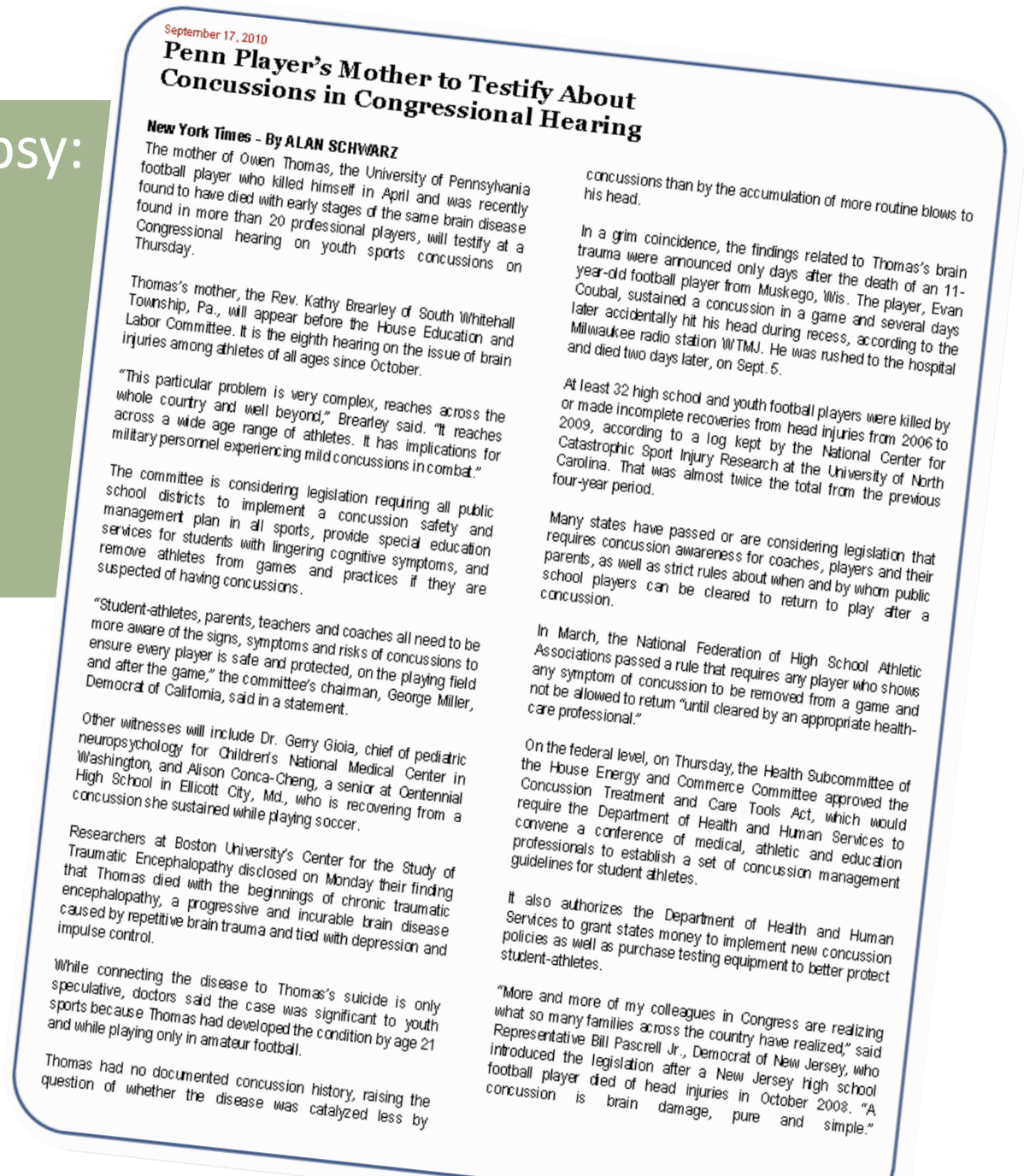
No known concussions in football career

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.

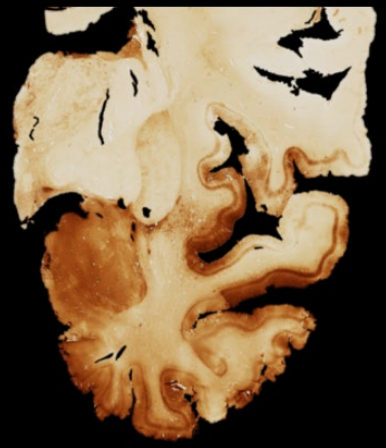
Many states have passed or are considering legislation that requires concussion awareness for coaches, players and their parents, as well as strict rules about when and by whom public school players can be cleared to return to play after a concussion.

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."



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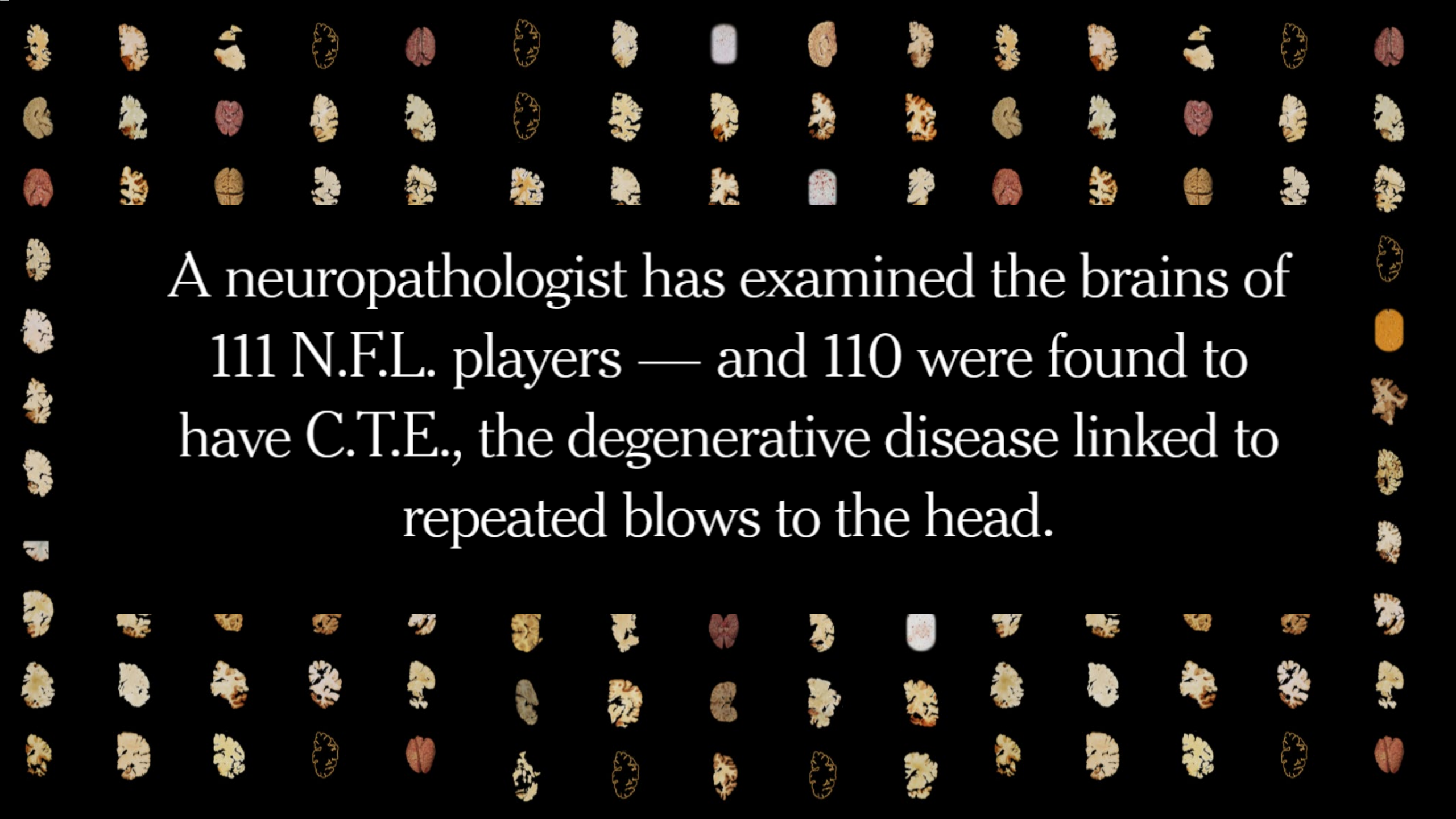
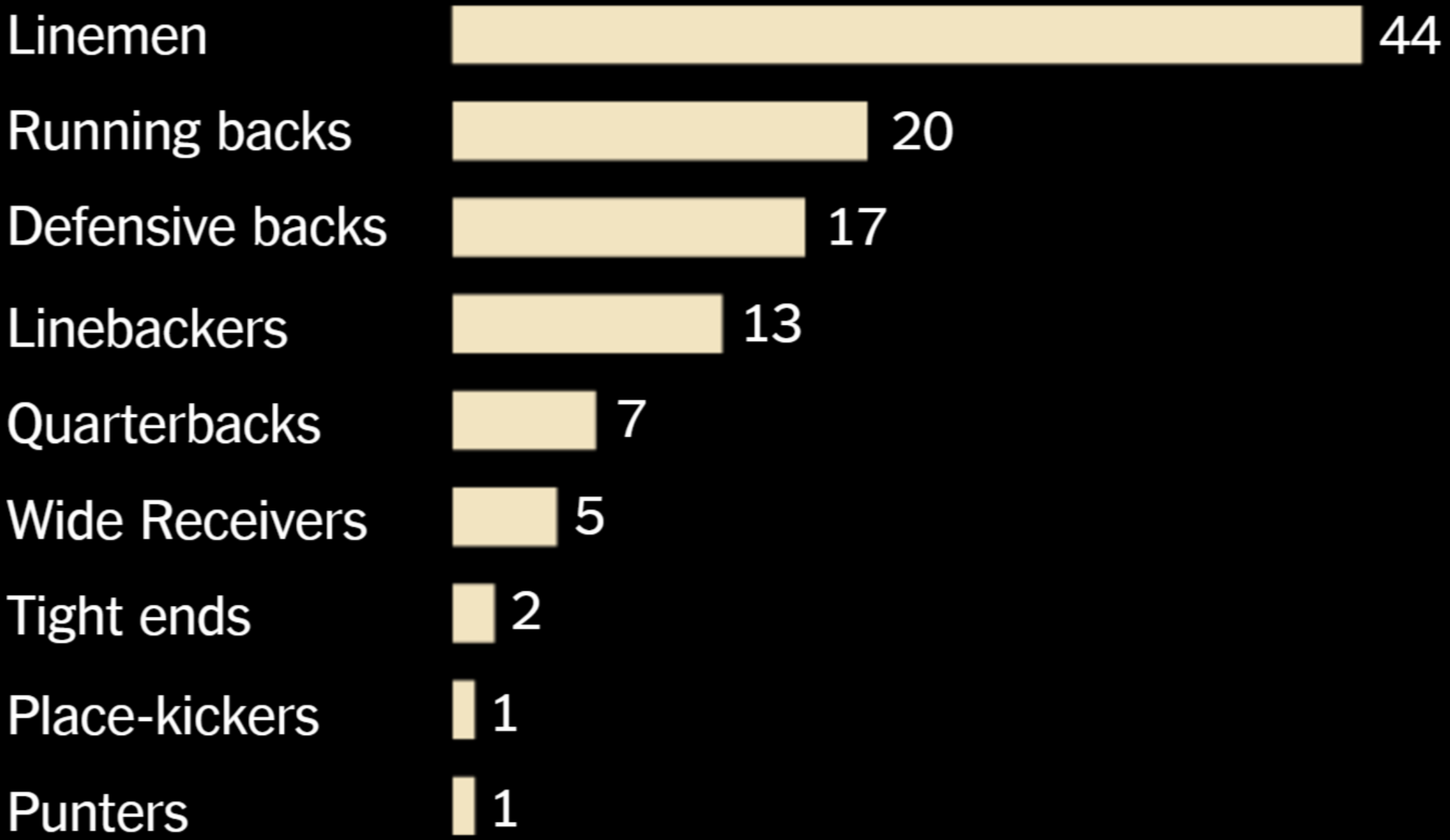
N.F.L. Brains


A neuropathologist has examined the brains of 111 N.F.L. players — and 110 were found to have C.T.E., the degenerative disease linked to repeated blows to the head.


Linemen
44
Running backs
20
Defensive backs
17
Linebackers
13
Quarterbacks
7
Wide Receivers
5
Tight ends
2
Place-kickers
1
Punters
1

44

Linemen

Daniel Colchico

Pete Duranko

Tom Keating

Tom Mchale

Mike Pyle

Gerry Huth

Joe O'Malley

John Wilbur