

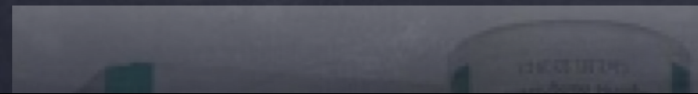
Current Concepts In Concussion

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November 10, 2013

Sports Medicine Update





NDC 50500-530-42

Imodium

Loperamide HCl, 2 mg/Simethicone, 125 mg, Antidiarrheal/Anti-Gas

Multi-Symptom Relief

Diarrhea PLUS

- Cramps & Pressure
- Gas
- Bloating



42 Caplets





Leading Bargain
Brand

Real Fit® Briefs

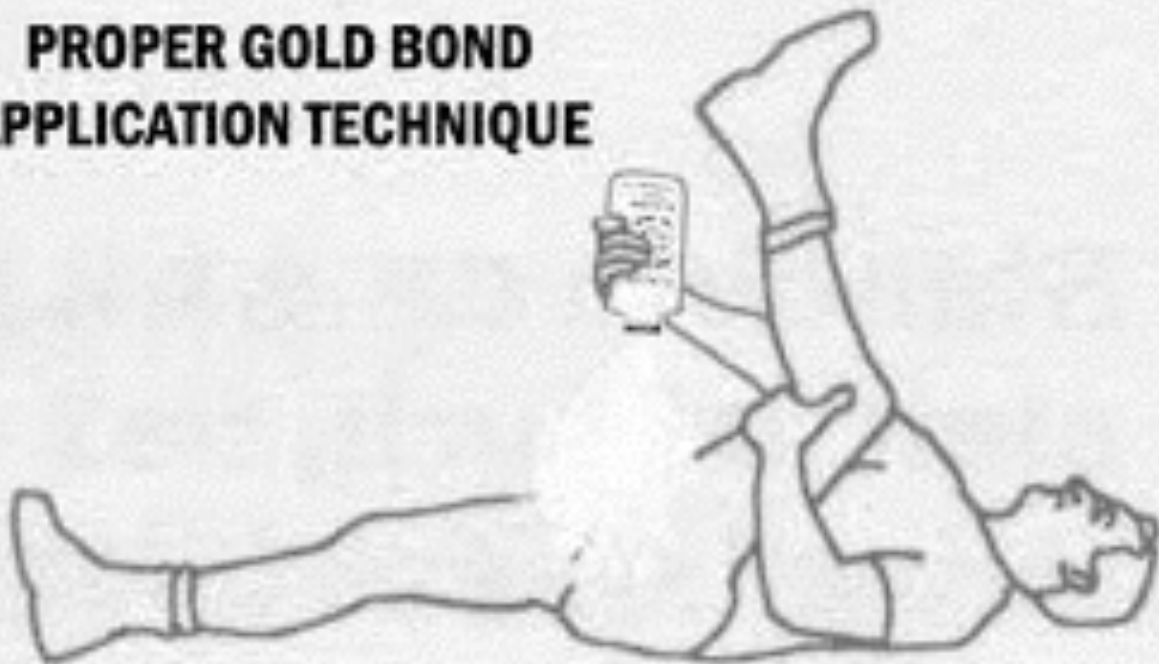
ВІСНОК
ГЕОМІТРИЯ ПІДБИРАЄ

КЕРАМІКА ПІДБИРАЄ

the
POWDER
with the
POWER



**PROPER GOLD BOND
APPLICATION TECHNIQUE**



Objectives

- 👁️ To give most recent definition of concussion
- 👁️ Epidemiology/Pathophysiology of Concussion
- 👁️ To discuss history clues in the office treatment of the concussed athlete
- 👁️ To discuss the physical examination clues in the office treatment of the concussed athlete
- 👁️ To discuss new treatment modalities and return to play criteria

Introduction

- 👁️ Most common head injury in athletics.
- 👁️ 1.4 million ER visits/yr; over \$60 billion
- 👁️ More than 90% of mTBI **do not** result in loss of consciousness.
- 👁️ In the US, 1.7 million suffer mTBI annually
- 👁️ Estimated 250,000 to 2.25 million more cases unidentified each year.

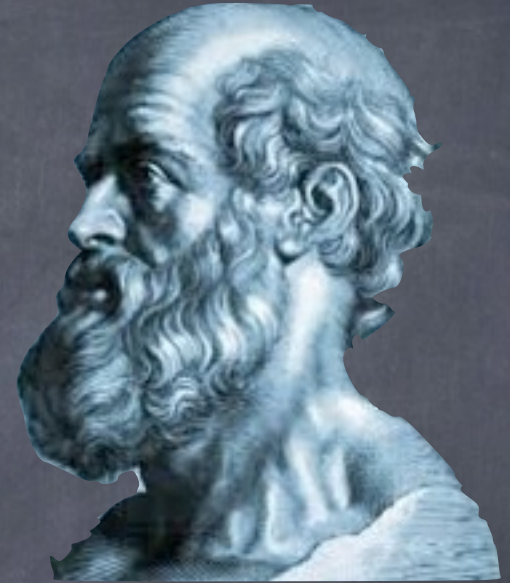
Injury Rate per 1000 athletes exposed

- Football (2.34)
- Men's Ice Hockey (1.47)
- Women's Soccer (1.42)
- Wrestling (1.27)
- Men's Soccer (1.08)
- Women's Lacrosse (0.70)
- Field Hockey (0.57)
- Women's Basketball (0.50)
- Men's Basketball (0.32)
- Softball (0.25)
- Baseball (0.19)

Volleyball (0.15)



History



- First descriptions over 3000 yrs ago
 - Hippocrates:
 - “falls down immediately, loses speech, cannot see or hear.”
- Constellation of symptoms a mystery
- Derived from the latin verb “concutere” meaning “to shake violently” 1400 AD

A glowing, translucent brain is centered in the image, surrounded by a bright, circular aura of light. The background is a dark teal color with a grid of glowing lines, suggesting a digital or scientific theme. The text "What Is A Concussion?" is written in a white, serif font with a slight shadow, positioned over the brain.

What Is A
Concussion?

Definition

- Previous definitions of concussion limited in ability to truly define the symptoms of concussion.
- Previous definitions and grading systems were unable to include minor impact injuries that result in persistent physical and/or cognitive symptoms.



Definition

- ① **Concussion:** a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces. Several common features that incorporate clinical, pathological, and biomechanical injury constructs that may be used to define concussive head injury include the following:
 - ① Caused either by a direct blow to the head, face, neck, or elsewhere on the body with an "impulsive" force transmitted to the head.
 - ① Typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously.

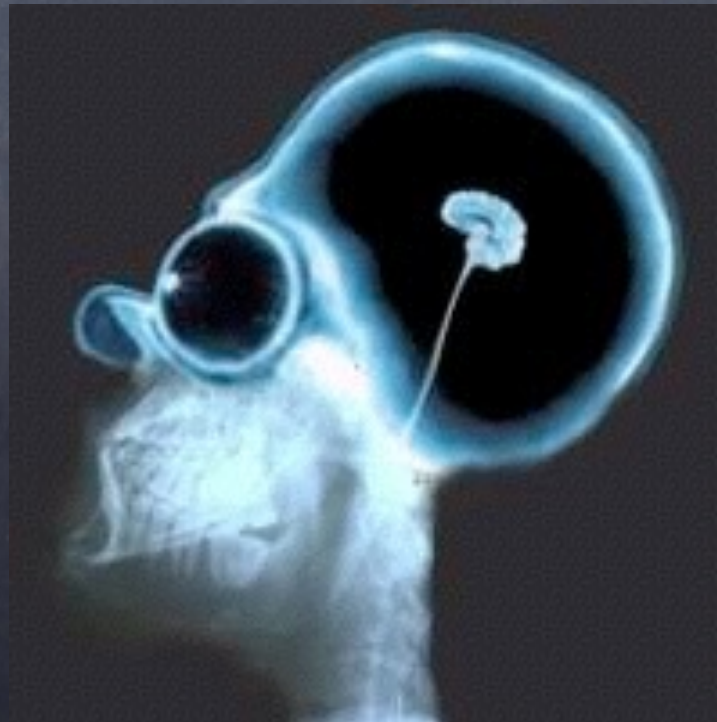
Definition

- May result in neuropathological changes, but the acute clinical symptoms largely reflect a **functional** disturbance rather than structural injury.
- Results in a graded set of clinical symptoms that may or may not involve loss of consciousness.
- Typically associated with grossly normal structural neuroimaging studies.
- Resolution of the clinical and cognitive symptoms typically follows a sequential course that may last from several minutes, to days, weeks, months, or even longer in some cases.
-CDC Physicians Toolkit Collins, et al. 2006



Biomechanics

- due to an abrupt linear and/or rotational acceleration or deceleration of the brain within the skull causing axonal injury



Linear Acceleration

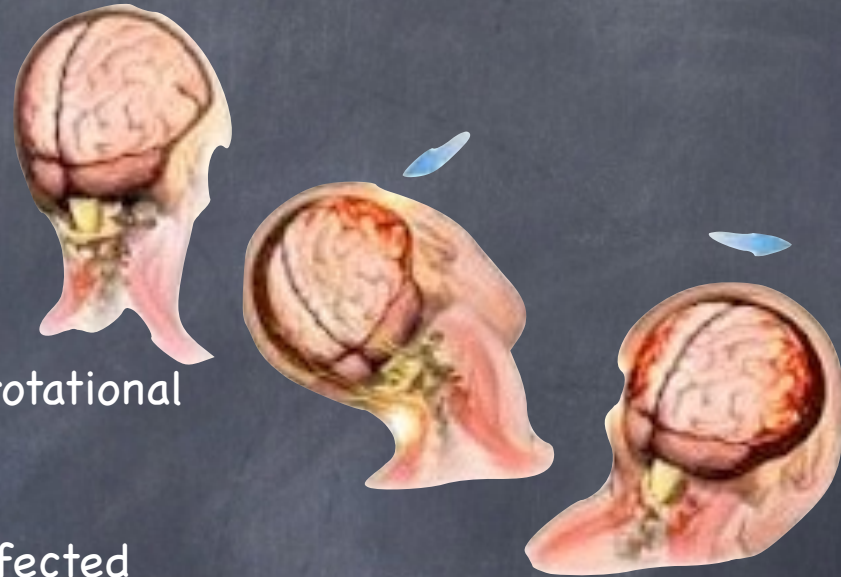
- Caused by sudden change in velocity occurring in a straight line
- Results from a direct hit straight in head's line of center
- causes focused area of damage
- Coup/Contra-coup





NYC 10 DAL 13 2nd 1:17 2nd & 4

Rotational/Angular Acceleration



- Blow that is off-set from midline, causing rotational vector force neck/brain
 - Often greater surface area of brain affected
- Results from hits often not seen
 - More deleterious due to laxity of cervical muscles "pendulum effect"
- If head could spin freely, head would spin up to 916 revolutions/sec every sec at the force needed to sustain concussion

Biomechanics

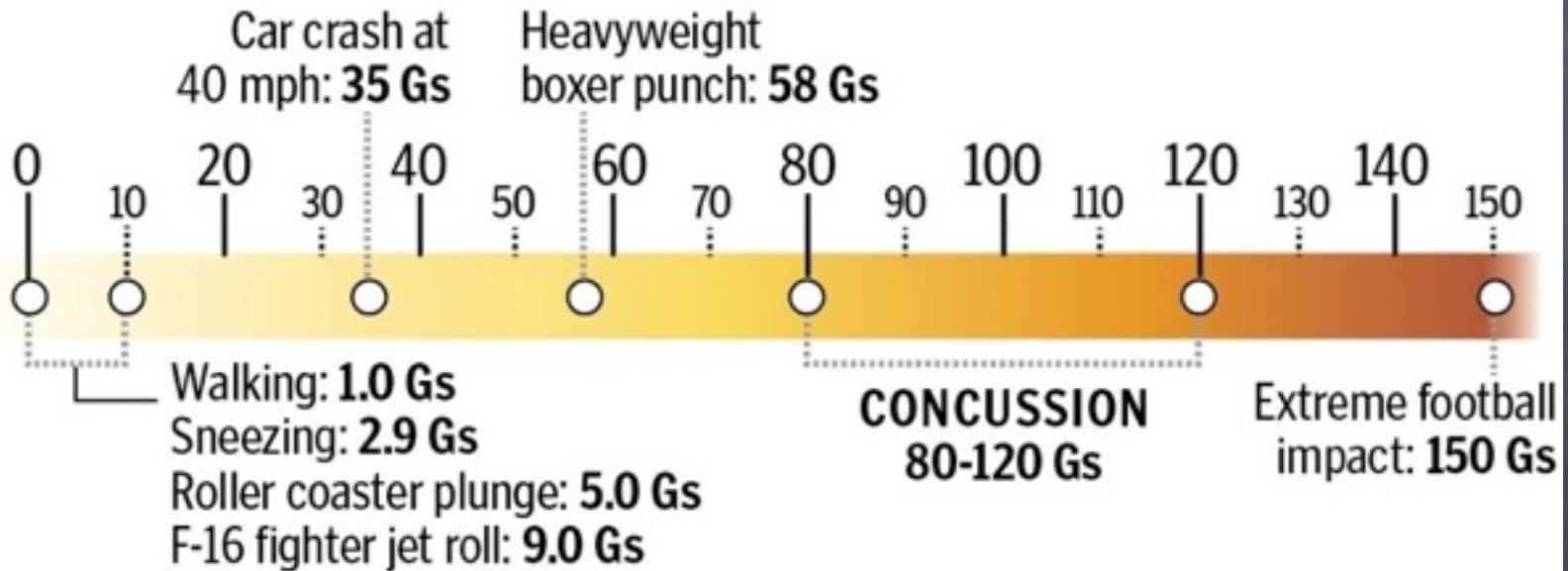
- Broglio, et al. study 2010

- Studied 57,000 impacts HS football players
- range of linear acceleration causing concussion ranged from 74.0g to 146.0g (g=force of gravity), and the angular accelerations ranged from 5,582.6 radians/s² to 9,515.6 rad/s²
- it was determined that an angular acceleration of >5,582 rad/s² and a linear acceleration of >96.1g yielded the highest predictive value of concussion.



Gauging G-force

G-force is the effect of gravity upon anything that is under acceleration.



SOURCE: University of Michigan

The Columbian

- Hockey players can hit 17% harder than football players while having 20% less mass

Biomechanics

- Originally thought cervical muscle strength was a preventative mechanism against concussion
- Now newer thought may be that neck/muscle **stiffness** is better protective mechanism due to decrease angular acceleration of brain
- May be reason why "tackler" rarely gets injured vs. player struck

Biomechanics

- Henlon (2011), Shewchenko (2005)
- Intentional heading scenarios in soccer demonstrate cranial accelerations well below the concussion threshold ranges found in the football studies discussed above.
- For example, a study of girls youth soccer (under age 14) showed a mean linear acceleration of 20.4 g (range 4.5g to 62.9g) and a mean rotational acceleration of 1,940 rad/s² during intentional headers. A separate study concluded that intentional heading scenarios in soccer have low impact accelerations, not exceeding 19.8g.







NFL Have a question during today's games for our NFL officiating guru Mike Pereira? Ask

NFL ON FOX





Pathophysiology Concussion Anyway?

- Due to a reversible neurologic cellular metabolic deficit rather than cell death
- Caused by a VERY complex neurological and biochemical cascade caused by trauma to brain

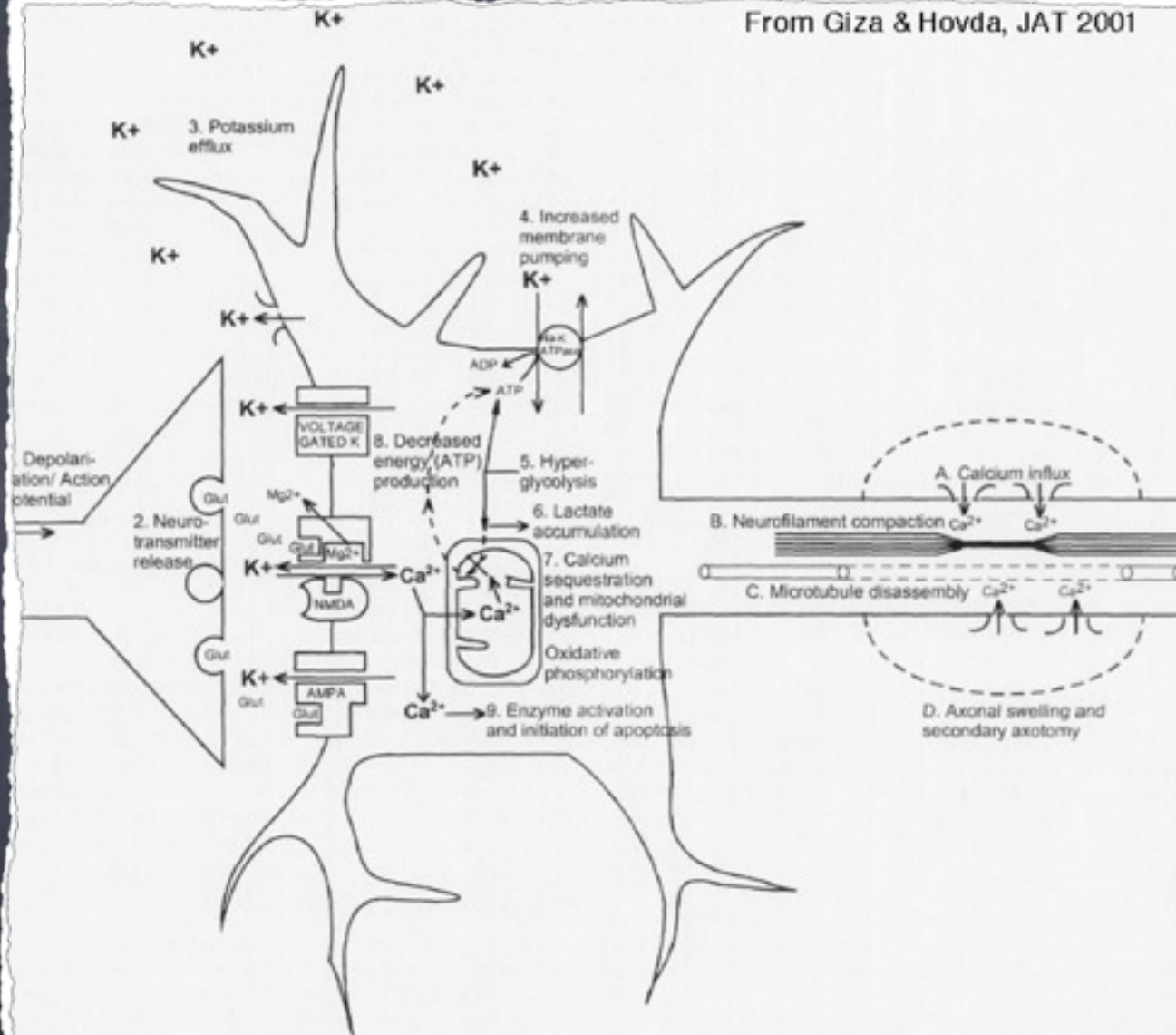
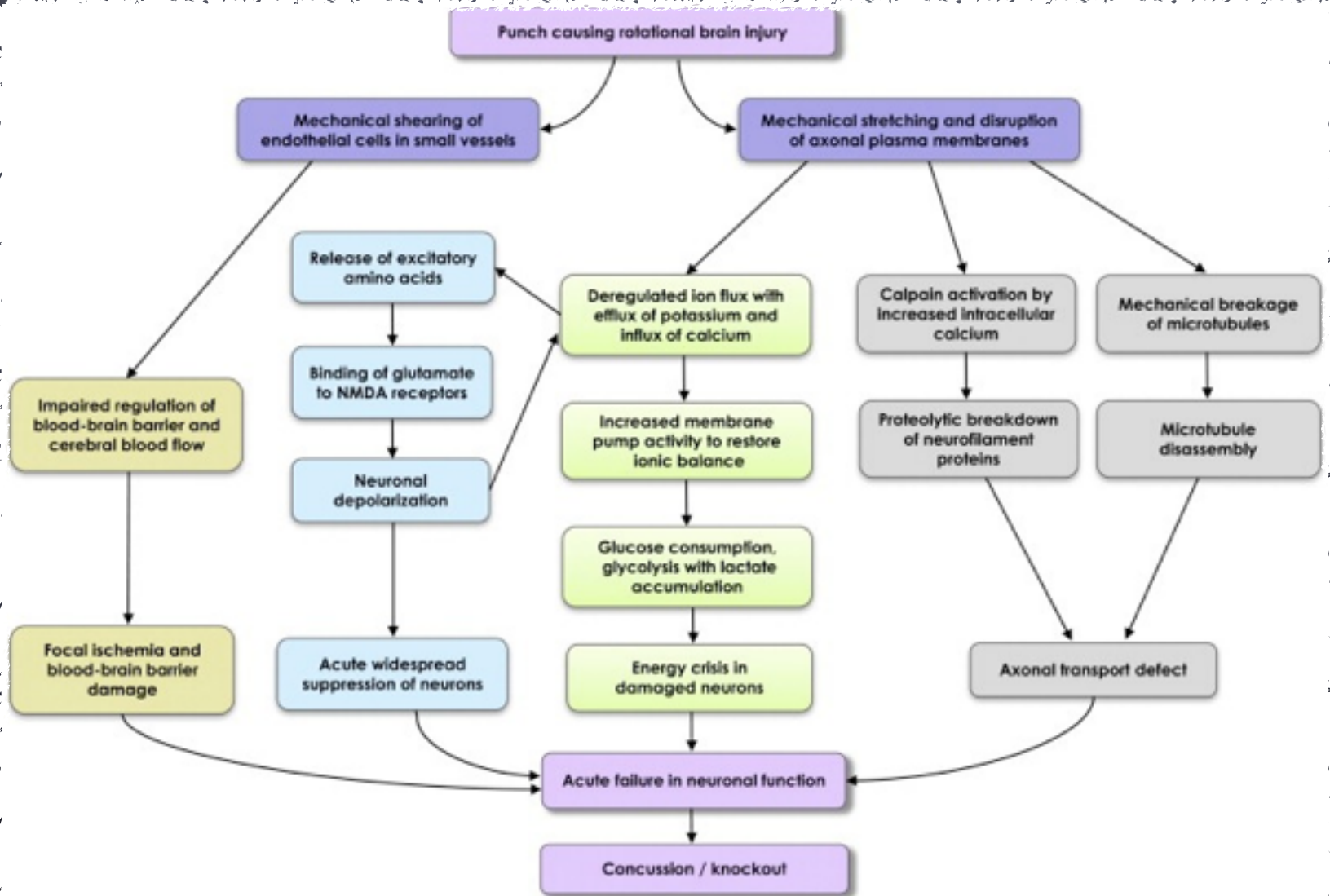
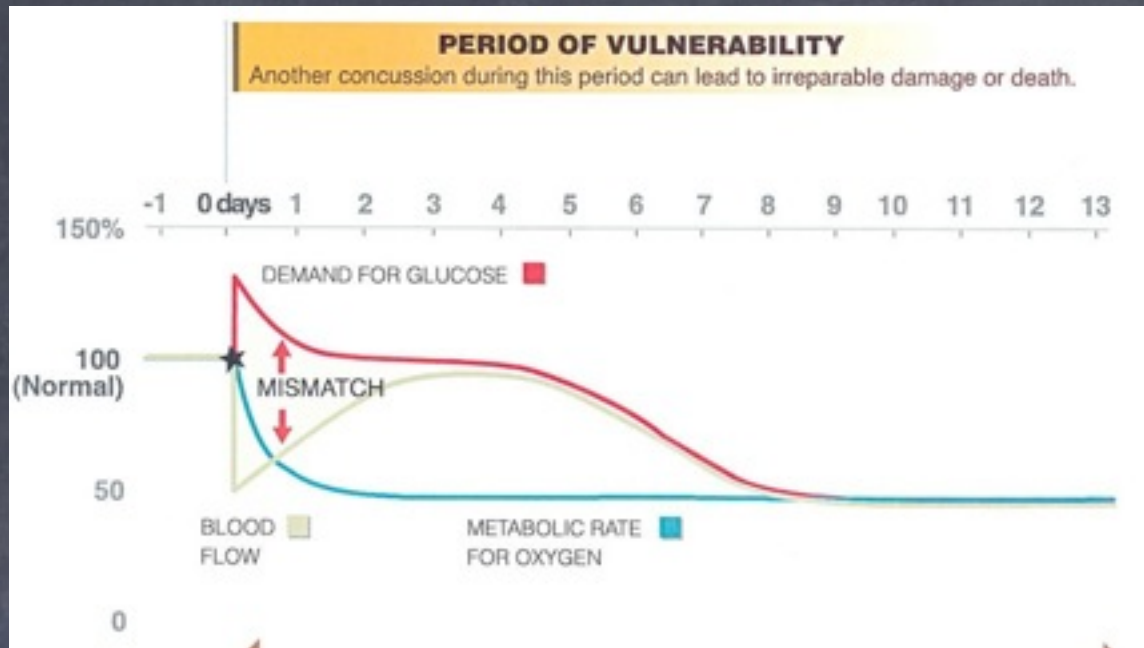


Figure 2. Neurometabolic cascade following traumatic injury. (1) Nonspecific depolarization and initiation of action potentials. (2) Release of excitatory neurotransmitters (EAAs). (3) Massive efflux of potassium. (4) Increased activity of membrane ionic pumps to restore homeostasis. (5) Hyperglycolysis to generate more adenosine triphosphate (ATP). (6) Lactate accumulation. (7) Calcium influx and sequestration in mitochondria leading to impaired oxidative metabolism. (8) Decreased energy (ATP) production. (9) Calpain activation and initiation of apoptosis. A, Axolemmal disruption and calcium influx. B, Neurofilament compaction via phosphorylation or sidearm cleavage. C, Microtubule disassembly and accumulation of axonally transported organelles. D, Axonal swelling and eventual axotomy. K⁺, potassium; Na⁺, sodium; Glut, glutamate; Mg²⁺, magnesium; Ca²⁺, calcium; NMDA, N-methyl-D-aspartate; AMPA, d-amino-3-hydroxy-

Pathophysiology of Concussion

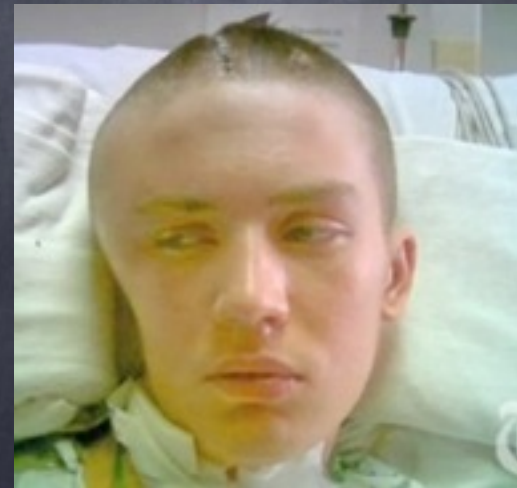




- characteristic ionic fluxes, acute metabolic changes, and cerebral blood flow alterations occur immediately after cerebral trauma
- Extracellular potassium concentration can increase massively in the brain after concussion, followed by hypermetabolism lasting up to ten days or more.
- This makes the brain more vulnerable and susceptible to death after a second trauma insult of even less intensity.
- Fisher and Vaca (2001): study concluded when the patient sustains a “second impact,” the brain loses its ability to auto regulate intracranial and cerebral perfusion pressures.

Second Impact Syndrome

- Emergent intervention needed
- Death can occur within minutes in severe cases
- Management includes emergent craniotomy
- Permanent neurologic deficits can result



Challenges to Management

- No imaging techniques or biomarkers available to diagnose injury
- Variability in management recommendations
- Lack of targeted clinical and treatment pathways
- “Rest” does not cure all concussions
- Lack of well controlled, prospective studies on long-term outcomes
- Media hysteria driving public perception
- “Self-reports” predicting management directive

Challenges

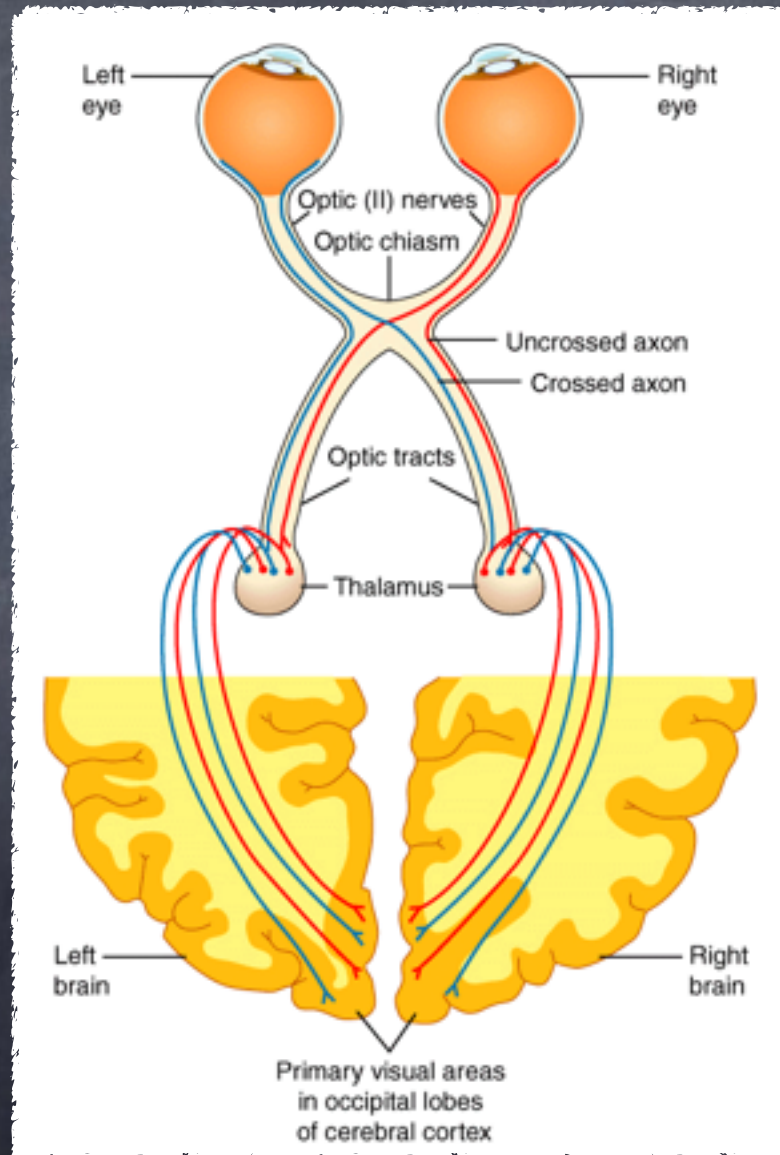
- Each concussion is as unique as the individual
- Factors affecting concussion:
 - Age/sex
 - Increased in females/young age
 - Children up to 40x more sensitive to glutamate
 - Young brain not fully myelinated until 23 yo
 - Hit/Trauma different in each case
 - Skeletal Maturity/Skull Size thickness



Quick Review...

- Visual System
- Vestibular System
- Proprioceptive System

Visual System



Vestibular System

Semicircular canals

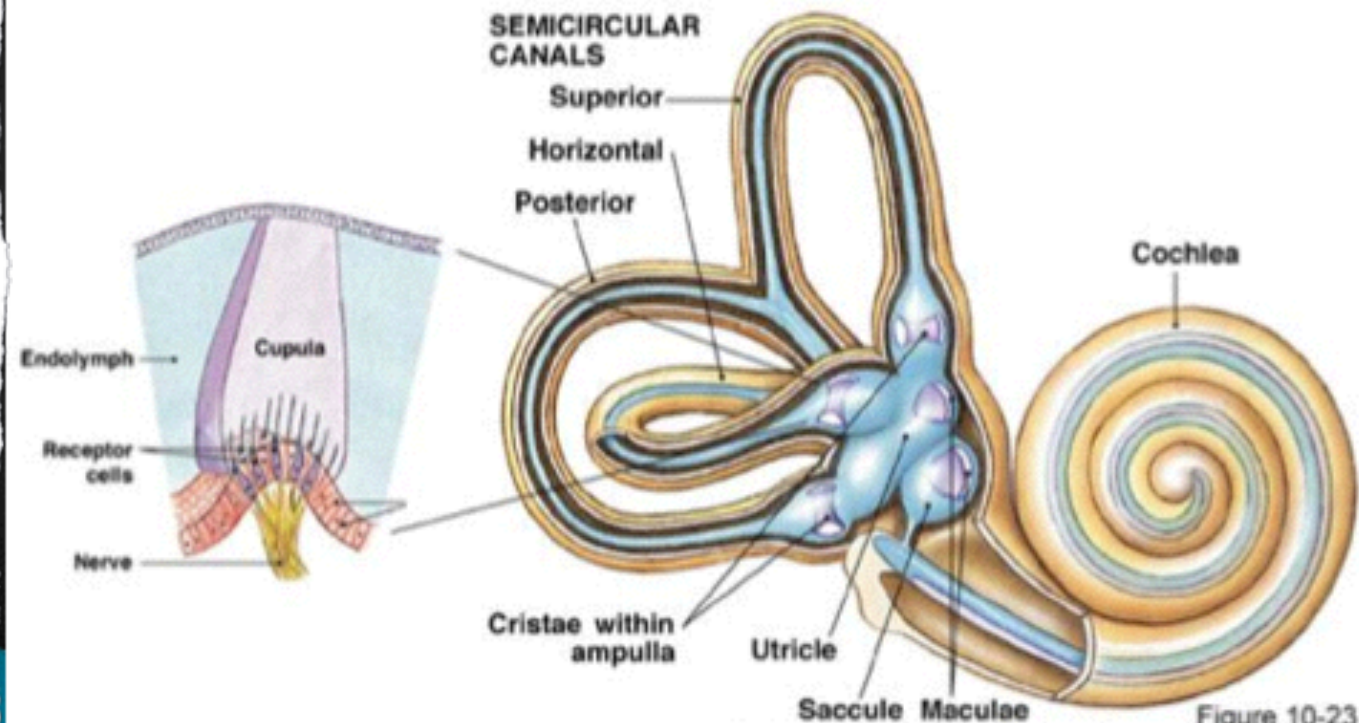
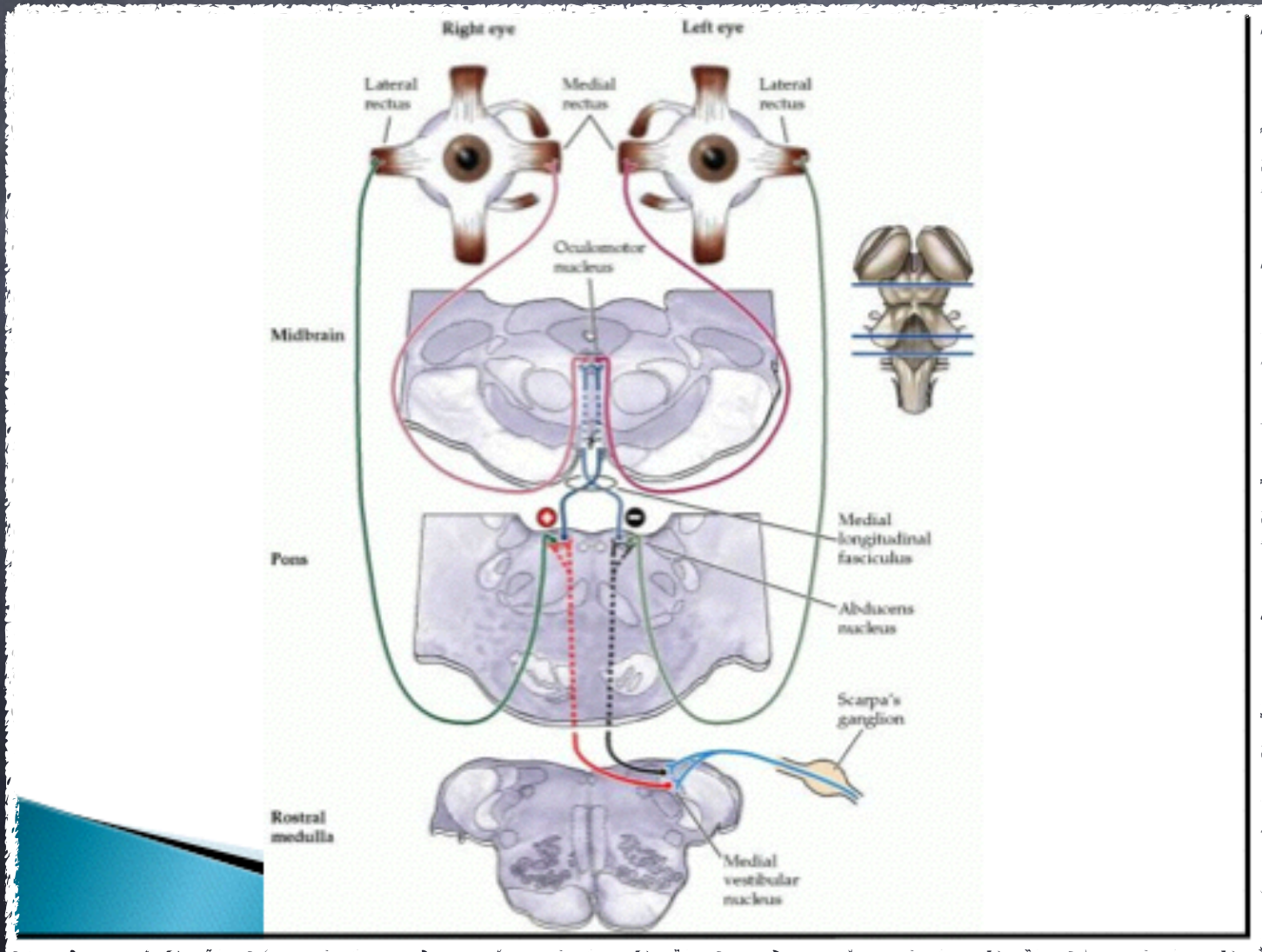


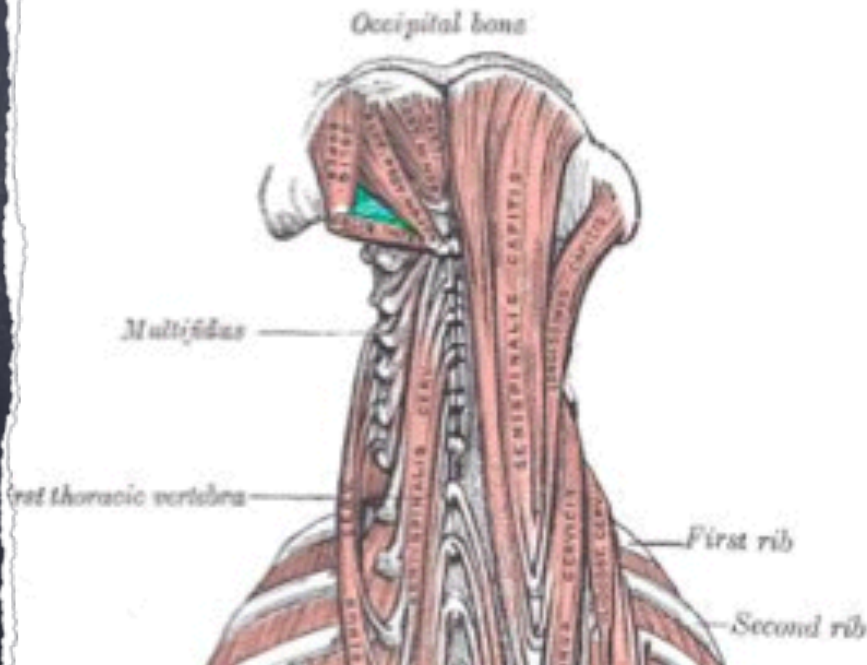
Figure 10-23

Vestibulo-ocular System



Cervical

Proprioceptive System




- 200 muscle spindles per gram

- Relay info to and receive from the CNS

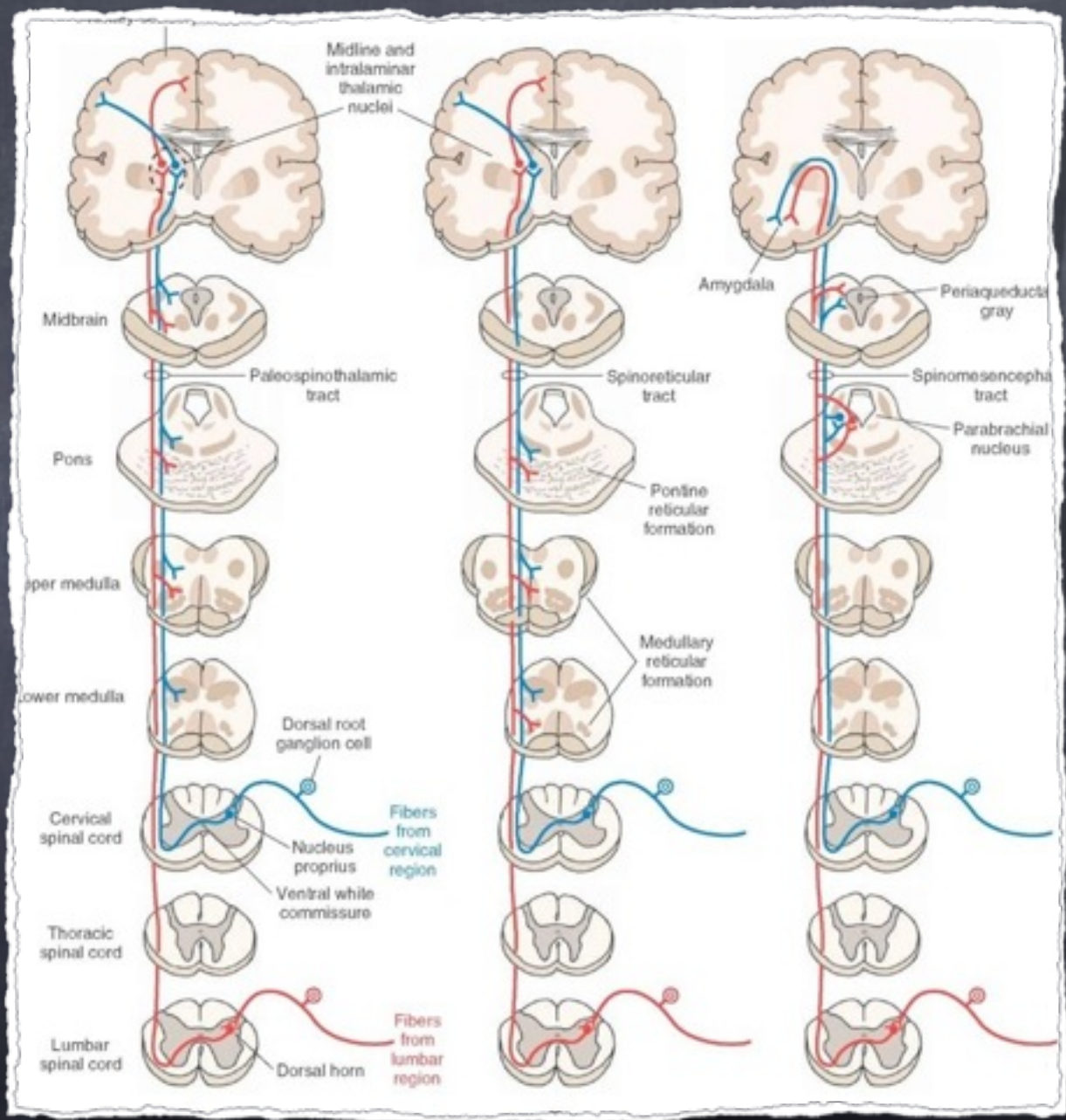
- Specific connections

HEAD Stabilizing Reflexes

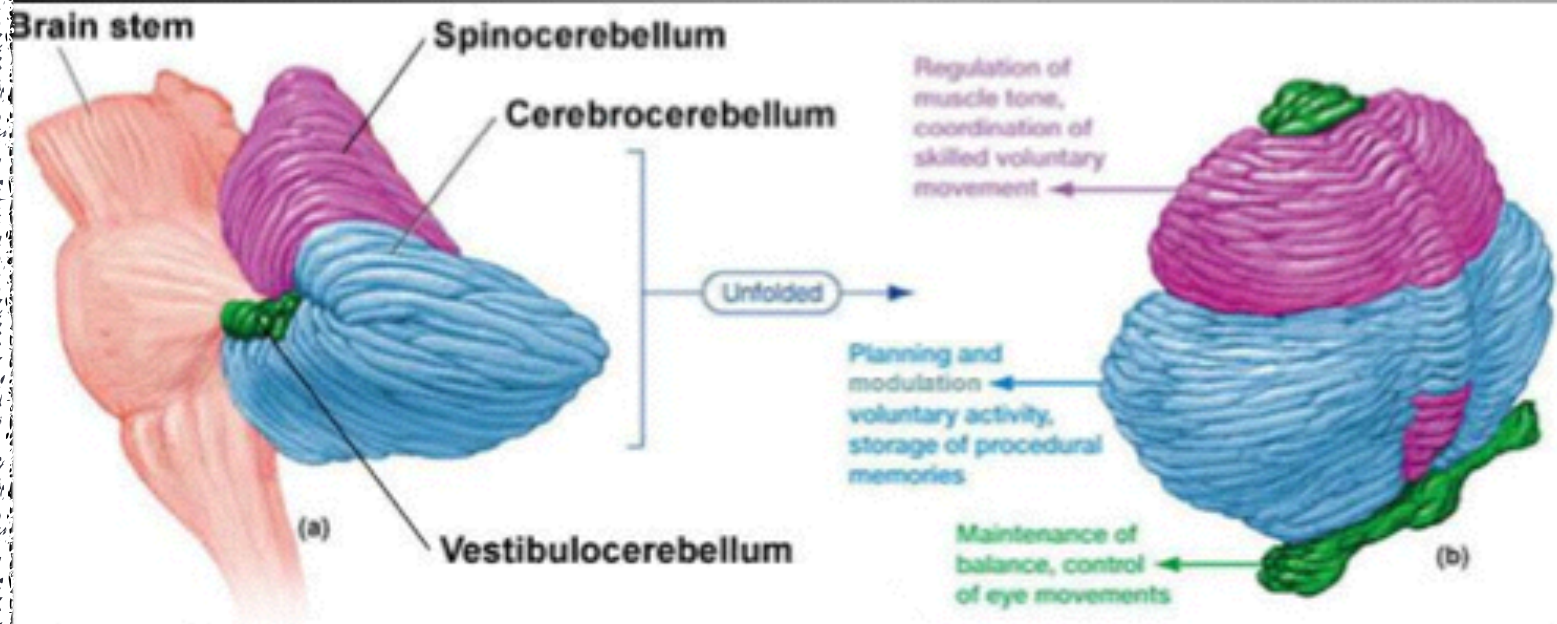
- ▶ Vestibulo-collic reflex (VCR)
 - ▶ Evoked by vestibular stimuli related to movement of head in space
 - ▶ Optokinetic Reflexes (OKR)
 - ▶ Evoked by movements of the visual field in relation to self
 - ▶ Cervico-collic reflexes (CCR)
 - ▶ Evoked by changes in length of neck muscles caused by the movement of the head relative to the body.
- 

EYE Stabilizing Reflexes

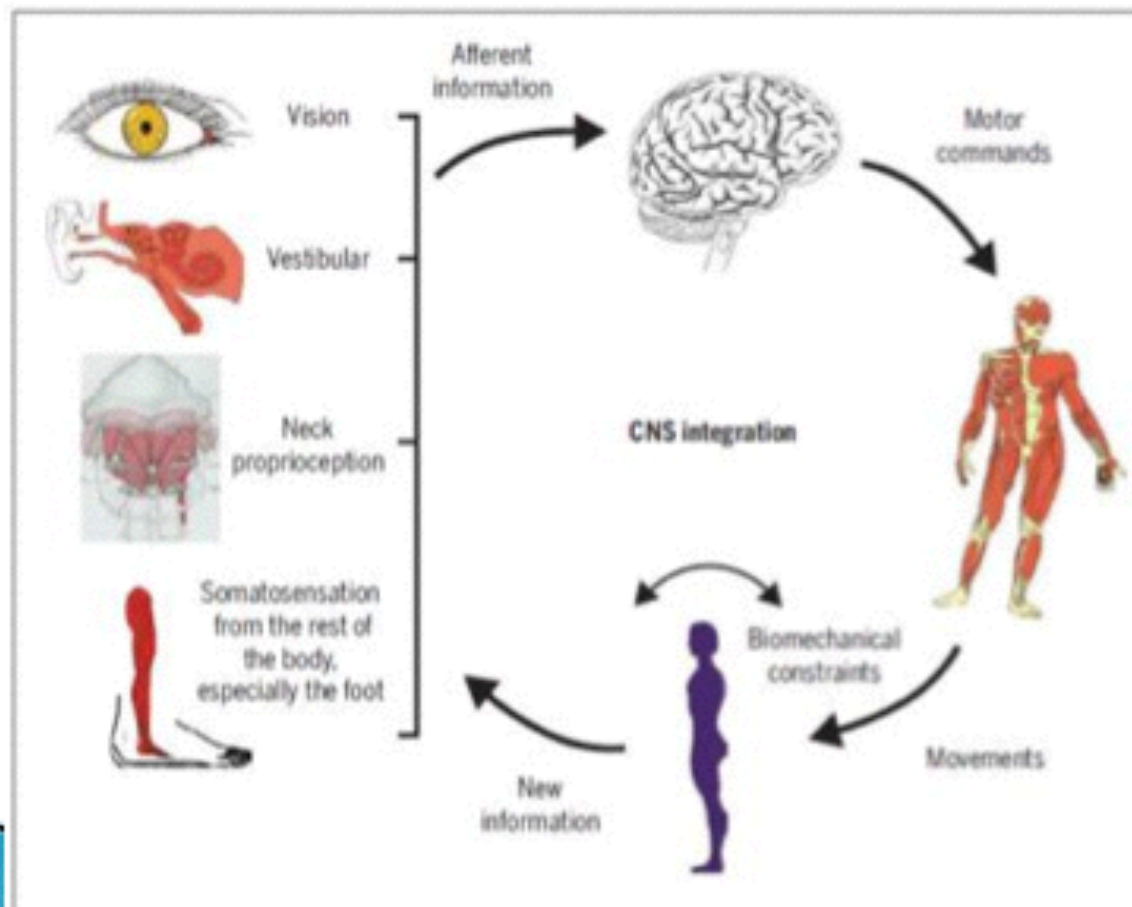
- ▶ Vestibulo-ocular reflex (VOR)
 - ▶ Stabilizes images on the retina during head movement by producing an eye movement in the direction opposite to head movement
- ▶ Optokinetic Reflexes (OKR)
 - ▶ allows the eye to follow objects in motion when the head remains stationary
- ▶ Cervical Ocular Reflexes (COR)
 - ▶ Assists clear vision with movement

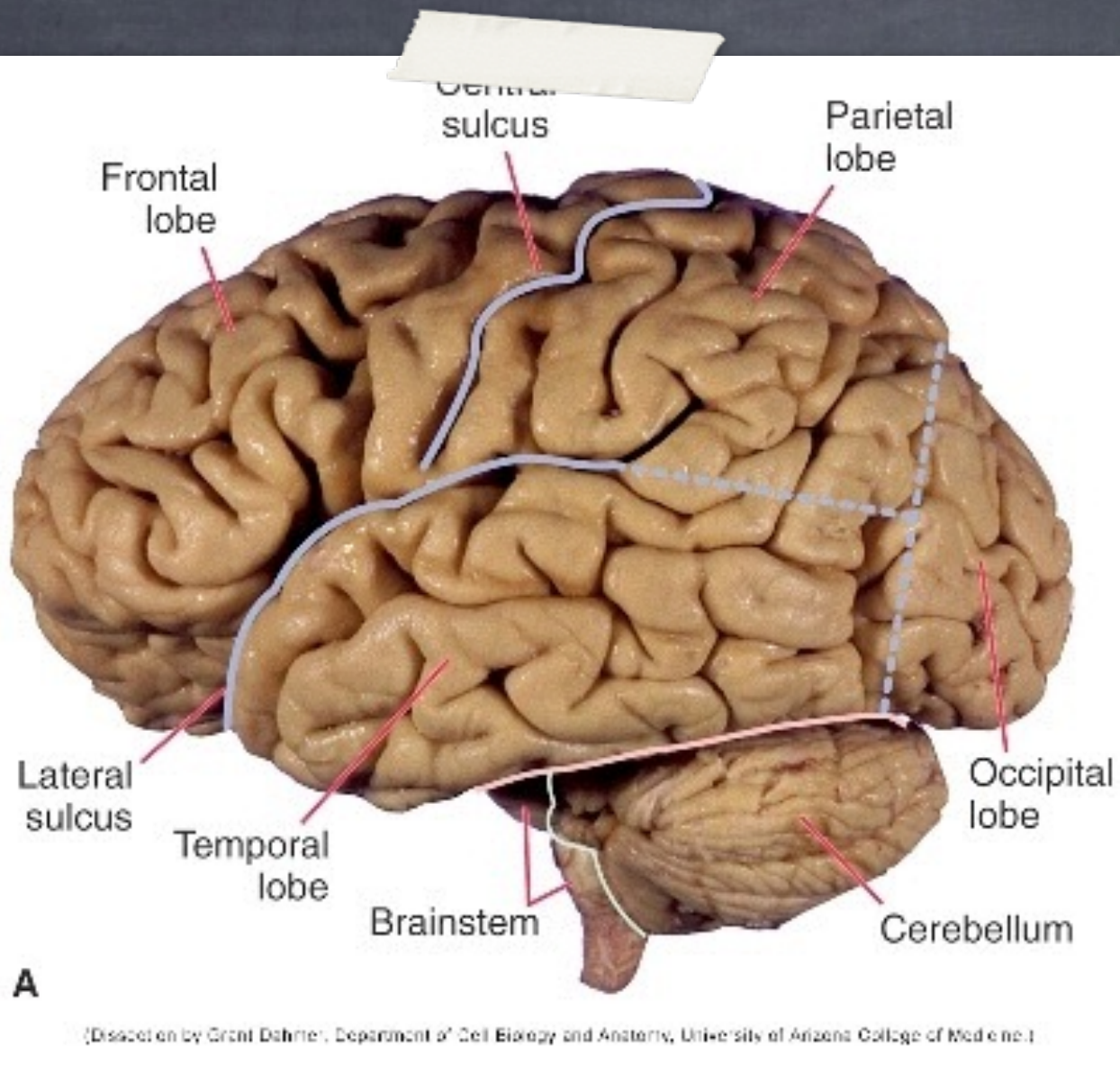


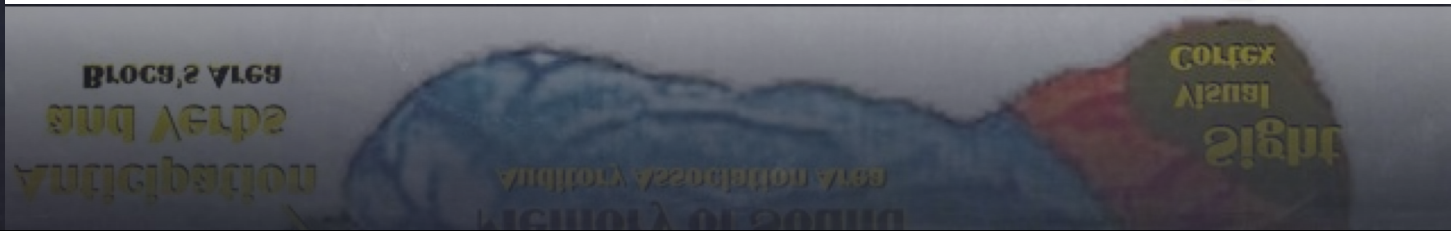
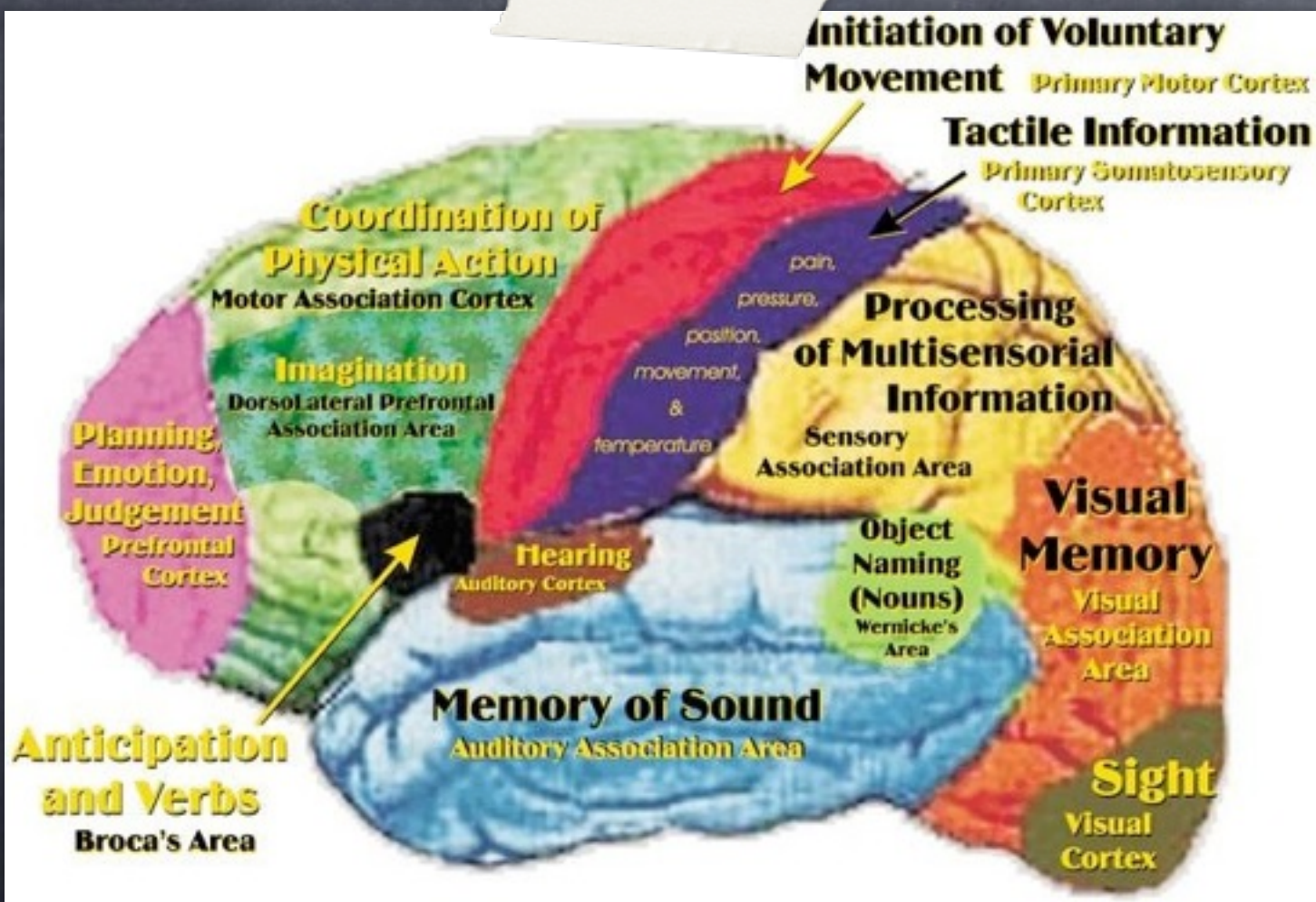
Cerebellum



Put it all together....







What Does This All Look Like?



Most Commonly Reported Symptoms

1-7 Days following concussion

- 👁️ Headache (75%)
- 👁️ Difficulty Concentrating (57%)
- 👁️ Fatigue (52%)
- 👁️ Drowsiness (51%)
- 👁️ Dizziness (49%)
- 👁️ Foggy (47%)
- 👁️ Feeling Slowed Down (46%)
- 👁️ Light Sensitivity (45%)
- 👁️ Balance Problems (39%)
- 👁️ Memory Difficulty (38%)

Physical Signs

- ⑥ LOC/impaired conscious state
- ⑥ Poor coordination or balance
- ⑥ Concussive convulsion/impact seizure
- ⑥ Gait disturbance
- ⑥ Nausea/vomiting
- ⑥ Vacant stare/glassy eyed
- ⑥ Slurred speech
- ⑥ Significantly decreased playing ability

@gifdsports

1:23 PM

FOX



1:22:56

2:00

WEEK 3

vs

D. McFadden: 5 career rush TD vs Broncos (most vs any ts

FLUORIDE



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Behavioral Changes

- ① Displaying unusual or inappropriate emotions
- ① Personality changes
- ① Inappropriate playing behavior



Cognitive Impairment

- ① Unaware of period, opposition, or game score
- ① Confusion
- ① LOC
- ① Unaware of time, date, or place
- ① Slow to answer questions or follow directions
- ① Easily distracted or poor concentration
- ① Slow reaction time

Cognitive Impairment

👁️ Amnesia

- 👁️ 10x more predictive value than LOC in predicting severity of concussion
- 👁️ Antegrade worse than Retrograde
- 👁️ Post-traumatic amnesia had been one of biggest keys in measuring severity
- 👁️ Now it is the total number of concurrent symptoms with "fogginess" being the symptom of critical concern

Symptom Presentation

Migraine

Neuropsychiatric

More Emotional
Sadness
Nervousness
Irritability

Somatic Complaints

Headaches
Visual Disturbances
Dizziness
Noise/Light Sensitivity
Nausea/Vomiting

Cognitive Symptoms

Attention Difficulties
Memory Dysfunction
"Fogginess"
Cognitive Slowing/Fatigue

Cervical

Sleep Disturbance

Difficulty Falling Asleep
Difficulty Staying Asleep
Hypersomnia/Hyposomnia

Concussions Play Drrrrrrty...

- Concussions “exploit” and “amplify” previous pathology
 - Must ascertain pre-morbid conditions
 - Migraines
 - Motion Sickness
 - Visual deficiencies
 - Depression/Anxiety/Mood Disorders

Before Exam Begins

- ① Watch athlete walk to exam room
- ② CT Scan/Radiographic data if done
- ③ Computerized Neurocognitive Test Baseline and any post-tests
- ④ Thorough history of athlete with complete concussion history



Where Is The Noise Coming
From???

Key Historical Points

- ① Number of symptoms has been associated with worse prognostic recovery
- ① Headache is most often reported symptom
 - ① HA with nausea as well as +/-light sensitivity: pt is **7x more likely** to take >1 mth to recover
- ① The adolescent brain recovers slower than the adult brain
- ① If an athlete has had a concussion, they are 4-6 times more likely to have a second

Key Historical Points

- ① Subsequent hits, although lesser in nature, may produce worse symptoms
- ② Thus, a complete history of past concussions, with emphasis on LOC and type of amnesia is critical
- ③ Athletes with co-morbid migraine headache history or associated ADHD/learning disabilities may need special consideration

Key Historical Questions

- 👁️ How many head injuries has the patient had in the past?
- 👁️ How did they occur?
- 👁️ What type of symptoms did they have?
- 👁️ How long did the symptoms last?
- 👁️ Were they associated with LOC or amnesia, and what type?

Key Historical Questions

- 👁️ Do they have a pressure HA and does it get worse with school, reading, note taking, exertion?
 - 👁️ Where is the HA? Similar to previous migraines?
- 👁️ Do they get dizzy with movement/car rides/crowded places (malls, supermarkets)?
- 👁️ Do they get fatigued at a certain point in the day?
- 👁️ Are they more sensitive to light/noise?
- 👁️ Are they more distracted?
- 👁️ Are they have trouble falling/staying asleep?
- 👁️ Are they more moody/irritable?

Key Historical Questions

- 👁️ Do they feel “foggy”?
- 👁️ How many practices/competitions did they miss?
- 👁️ Did the symptoms affect classes and their grades?
- 👁️ How long did it take them to “feel themselves”?
- 👁️ Did they have any “dings” or hits to chest, neck, or face that radiated to head that were unreported as concussion?

Physical Examination

Vitals

Speech

Gait analysis

DTRs

MS UE and LE b/l (always include cervical exam)

Sensation UE and LE b/l

Cranial Nerve Examination

Physical Examination

Romberg Test (Balance and Motor
Coordination)

Pronator Drift Test (Upper Motor Neuron
Testing)

Tandem Walk (Coordination)

Heel to Shin (Balance and Coordination)

Finger to Nose (Point to Point Coordination)

Physical Exam

- Cognitive Testing
 - 4 Object Recall (Immediate/Distant)
 - Days/Months Backwards
 - Serial 7's
 - Number Recall

Physical Examination

Vestibular/Ocular Testing

Extraocular Muscle Testing: "H" pattern with convergence (cock-eyed)

Saccades: vertical and horizontal (10-15 sec@180bpm): measures smooth pursuit/oculomotor/vestibular integration

Vestibular Ocular Reflex: vertical/horizontal for 10-15 sec@180bpm

Optokinetic Hypersensitivity (Space/Motion Discomfort):
perform for 10-15 sec@180bpm

Physical Examination

Visual Testing

Accommodation/Convergence Dysfunction Test



Accommodation: nl is 15cm or less

Convergence: nl is 6cm or less





SWAY
BALANCE



- 1 Remove your shoes
- 2 Read instructions and tap the "Begin Test" button
- 3 Hold the device against your chest until the test is complete

Ok, Let's Begin!



1/5



Place feet together with eyes closed

Begin Test



2/5

Put left foot
in front of
right with
eyes closed



Begin Test



3/5



Put right
foot in front
of left with
eyes closed

Begin Test



4/5



Balance on right foot



Lift left foot and close eyes

Begin Test



5/5



Lift right foot and close eyes



Balance on left foot

Begin Test



Profile



OVERALL
9/7/13 - 9/29/13



Latest Score

99.4

Feet Together

97.0

Tandem Stance (right)

99.9

Tandem Stance (left)

99.9

Single Foot (right)

99.9

Single Foot (left)

100.0



Overall Score

71.3

Treatment Goals

- ① Prevent Second Impact Syndrome
- ① Prevent cumulative effects of concussion
- ① Prevent Post Concussion Syndrome
- ① Alleviate symptoms

First Line Overall Treatment

👁️ Athlete should be placed at complete mental and physical rest

👁️ Includes:

👁️ NO PE

👁️ NO tests/quizzes/projects

👁️ No video games

👁️ No texting

👁️ Limited computer

👁️ No concerts

👁️ No loud indoor events

👁️ No long TV watching or reading

Long Term Care

- Grandma Talk
 - Proper Sleep
 - Proper Hydration
 - Proper Diet
 - Exercise
 - Reduce Stress



Nutriceutical Support for Concussion

- Fish Oil (DHE/EPA): 3-4 gm qd
- Magnesium 500mg qd
- Vitamin D3: 5-10,000 IU qd
- Extra Virgin Coconut Oil: 1 cap/1-2 tsp qd
- Curcumin 500mg bid
- Resveratrol 250mg bid
- Green Tea 500mg qd
- Vit B2(Riboflavin): 200-400mg qd
- CoQ10: 300mg qd
- Alpha Lipoic Acid: 400-600mg qd

Prescription Med Support

- **Cognitive Slowing**

- Amantadine
- Neurostimulants (ADD meds)

- **Sleep Dysfunction**

- Melatonin/
Antihistamines/Trazadone
- Hypnotics

- **Vestibular/Vertiginous symptoms**

- Klonopin

- **Mood Disorder**

- TCA's
- SSRI's

- **Migraine**

- CCB/B blockers/Triptans

Vestibular Therapy

- 🌀 Helps with dizziness, vertigo and imbalance associated with concussion
- 🌀 Uses current PT and OT maneuvers
- 🌀 May be used alone or as adjunct therapy

Vestibular Therapy

👁️ Maneuvers

👁️ Epley Maneuver

👁️ Treats positional vertigo

👁️ Oculomotor Exercises

👁️ Increases coordination between eyes, brain and vestibular system

👁️ Balance Retraining

👁️ Improves balance by having brain use all systems affecting balance

👁️ Motion Tolerance Exercises

👁️ Retrains brain to adapt to specific movements without dizziness

Psychological Treatment

- ① May have application in concussion.
- ① May have benefit to treat affective symptoms such as depression often associated with concussion.

Cognitive Therapy

- ① Written as last part of neuropsychological assessment
- ① Can be done in out-patient or school setting
- ① Breaks cognition into component parts and uses cues and retraining to assist and reteach learning
- ① May assist in shaping IEP or 504 plans

Ophthalmologic Treatment

- 👁️ May need assistance from Ophthalmology to distinguish gaze vs. convergence dysfunction
- 👁️ Treatment may be intra-office or via home computer retraining

Ophthalmologic Treatment


Ophthalmologic Issues


Convergence Insufficiency


 Important for reading

 Inability to use two eyes together as a team

Oculomotor Dysfunction

 Permits accurate visual scanning and exploration




 Important for reading and copying from board

 Inability for eyes to together track a moving target
and switch fixation from one target to another

Ophthalmologic Treatment

Ophthalmologic Issues




Accommodative Infacility

-  Important for academic efficiency and comfort to focus on an object – i.e. copy from blackboard
-  Inability to allow rapid and accurate shifts of attention from one distance to another with instantaneous clarity
-  Inability to allow student to maintain focus at reading distance

Ophthalmologic Treatment

Ophthalmologic Issues

Visual Intake-Visual Memory

-  Allows for optimal academic and athletic performance as affects proficiency in reading comprehension and spelling
-  Inability to obtain maximum visual information in the shortest possible time
-  Inability to retain this information over an adequate period of time

Educational Component

- 👁️ No or adaptive PE as conditions warrant
- 👁️ Education assistance
 - 👁️ Extra Help
 - 👁️ Extra Time
 - 👁️ 504 Plans/IEP
 - 👁️ Change in class difficulty level
 - 👁️ Alternative testing
 - 👁️ Important to differentiate comprehensive vs. computational dysfunction (i.e. inability to focus or converge vs. true cognitive dysfunction)

Return to Play


- 👁️ Never return player who still has concussive symptoms.
- 👁️ Patient requires physical and cognitive rest
- 👁️ This includes activities that require concentration and attention
 - 👁️ School Work
 - 👁️ Video Games
 - 👁️ Text Messaging
- 👁️ If symptoms have resolved with rest, test patient with exertion.


Return to Play (Zurich Protocol)

- ① Player should proceed stepwise.
- ② If post-concussive symptoms recur, the athlete should drop back to previous asymptomatic level and attempt progression again in 24 hours.
- ③ Should not be taking any pharmacological agents that may effect or change symptoms of concussion.
- ④ Should have neuropsychological testing return to baseline


Return to Play

STAGE 1

 No activity

 Complete rest

 Recovery Phase

 Once asymptomatic for 24 hours, proceed to stage 2

Return to Play

👁️ STAGE 2

👁️ Light aerobic exercise

👁️ Walking

👁️ Swimming

👁️ Stationary Cycling

👁️ All Less Than 70 % M_{PHR}

👁️ No Resistance Training

👁️ - Increase HR

Return to Play

👁️ STAGE 3

- 👁️ Sport-specific training
 - 👁️ Skating drills in ice hockey
 - 👁️ Running in soccer
- 👁️ No head impact activities
- 👁️ Add movement

Return to Play

👁️ STAGE 4

👁️ Noncontact training drills

👁️ Progression to more complex training drills

👁️ Passing drills in football




👁️ Passing drills in hockey

👁️ May begin progressive resistance training

👁️ Exercise, coordination, and cognitive load

Return to Play

STAGE 5

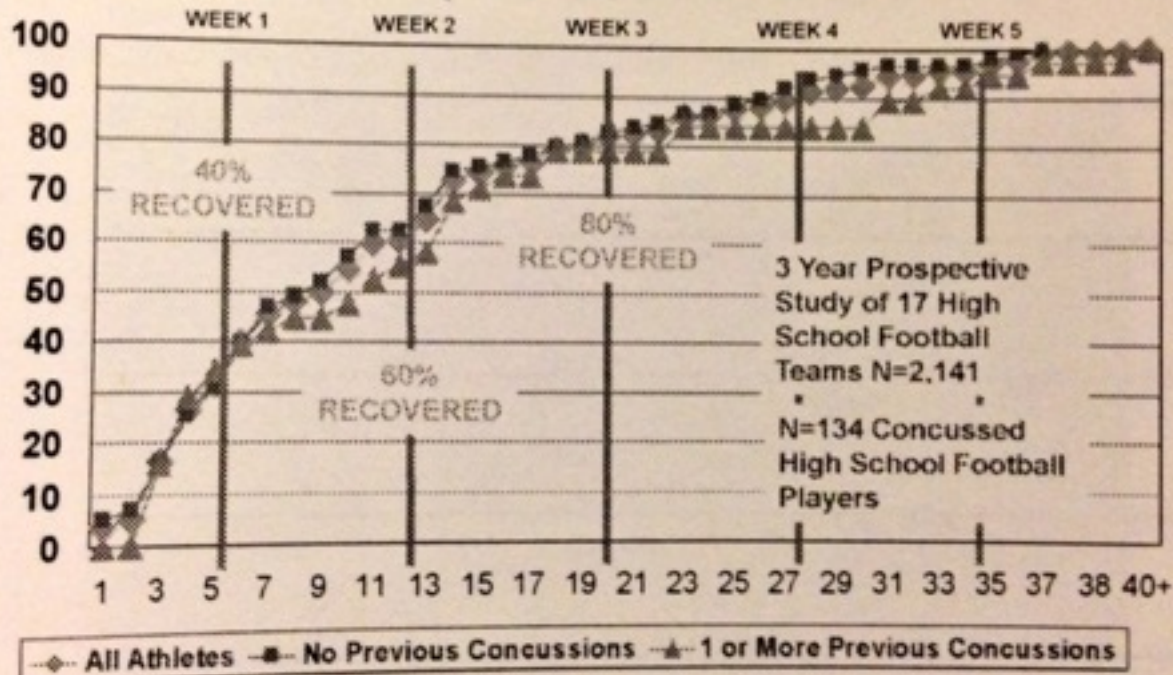
-  Full-contact training after medical clearance
-  Restore confidence and assess functional skills by coaching staff
-  Return to game play

Return To Play

- MUST SATISFY THREE CRITERIA:
 - **Symptom-free** at rest
 - **Symptom free** with cognitive/physical exertion
 - Normalized neurocognitive testing scores (ie: ImPACT) **AND** objective evaluation

How Long?

Individual Recovery From Football-Related mTBI: How Long Does it Take?



Collins et al., 2006, Neurosurgery

Top 11 Symptom Predictors of Protracted Recovery

- Fogginess
- Difficulty Concentrating
- Vomiting
- Dizziness
- Nausea
- Headache
- Slowness
- Balance
- Light Sensitivity
- Noise Sensitivity
- Numbness

Modifiers of Concussion Management

- Loss of Consciousness
 - LOC of greater than one minute is a factor that may modify management
 - Less than one minute of LOC not noted as a measure of concussion severity
- Amnesia
 - Post-traumatic rather than retrograde amnesia greater modifier of concussion management

Modifiers of Concussion Management

- 👁️ Motor and Convulsive Phenomena
 - 👁️ Generally benign and require no specific management
- 👁️ Depression
 - 👁️ May be long term consequence of sports related concussion
 - 👁️ May reflect abnormality with limbic–frontal model of depression and may need concurrent treatment

Education

- ① Imperative that coaches, players and parents understand the medical issues involved in concussion.
- ① Athletes must know of consequences of premature return of play.
- ① Athletes must also know that not every concussion results in automatic removal from sports.

Heads Up Concussion Kits

[http://www.cdc.gov/ncipc/tbi/
Coaches_Tool_Kit.htm](http://www.cdc.gov/ncipc/tbi/Coaches_Tool_Kit.htm)



CDC Concussion Tool Kit


Education



 <http://www.thinkfirst.ca>

 <http://www.bianj.org>

 <http://impacttest.com>

 Good sites for athletes to check for understanding of concussion.

Imaging

- 👁 Zurich International Concussion Conference (2012) recognized that conventional neuroimaging is usually normal and unwarranted.
- 👁 Encouraged to utilize in cases where there is suspicion of cerebral bleed, prolonged disturbance of conscious state, focal neurological deficit, seizure activity or persistent clinical or cognitive symptoms.
- 👁 CT is gold standard (R/O bleed, etc)



Imaging

Additional Neuroimaging Considerations

MRI

- Use of gradient echo, perfusion and diffusion weighted images better choice to distinguish structural brain abnormalities

PET Scan/Functional MRI

- Used often in concussion research but not yet standard of care

Diffusion tensor imaging

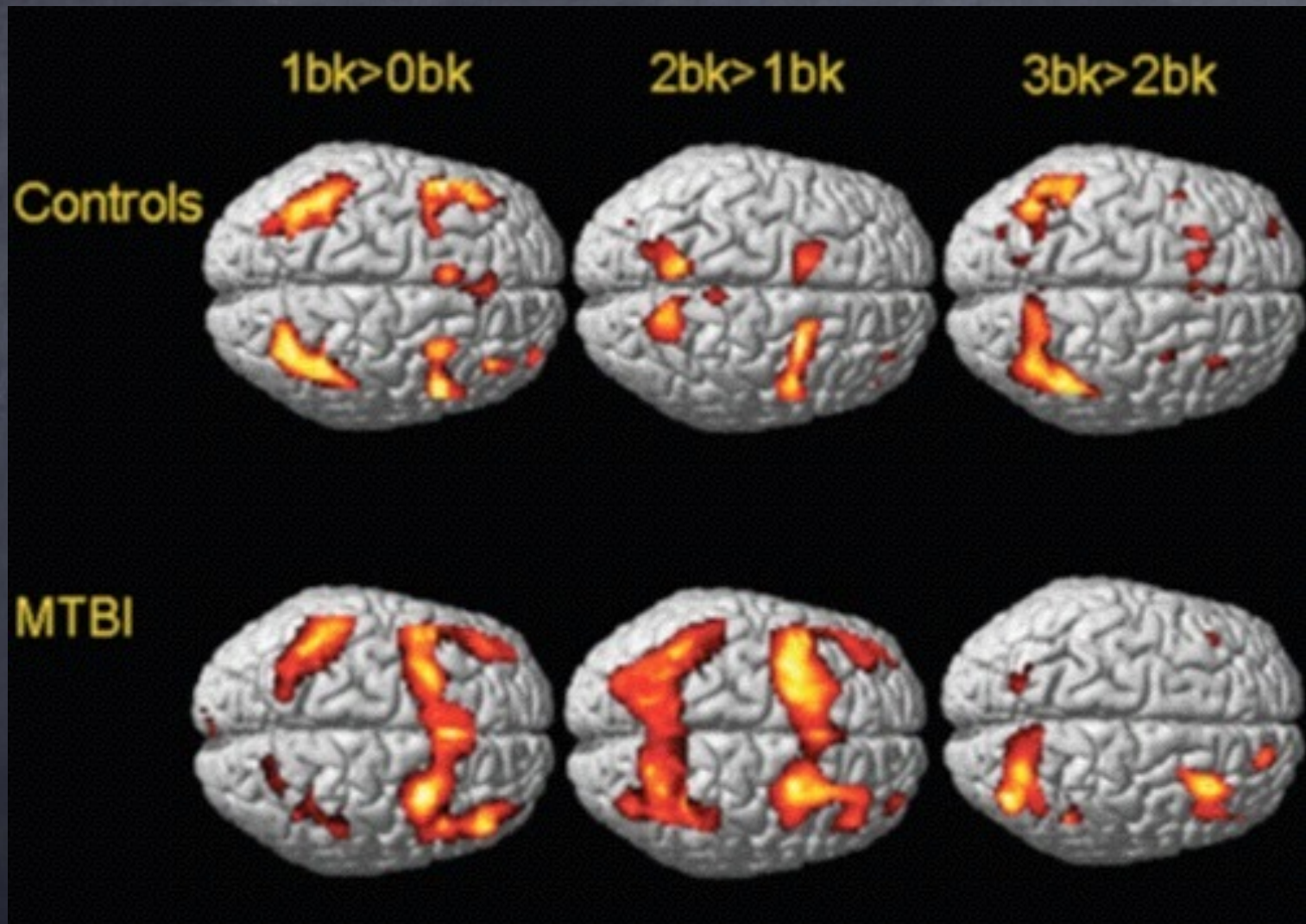
Magnetic resonance spectroscopy

Functional connectivity

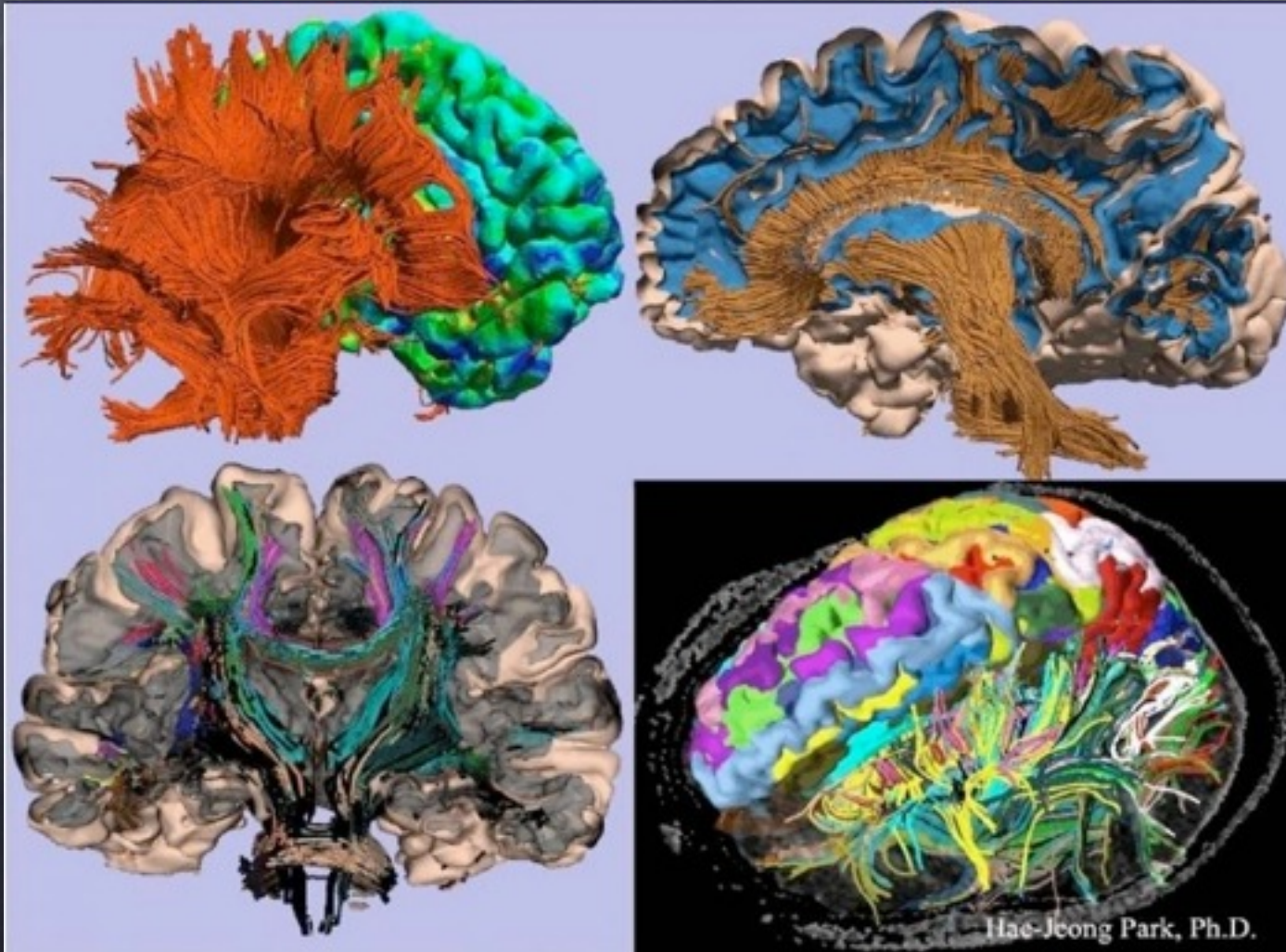
Imaging

👁️ fMRI

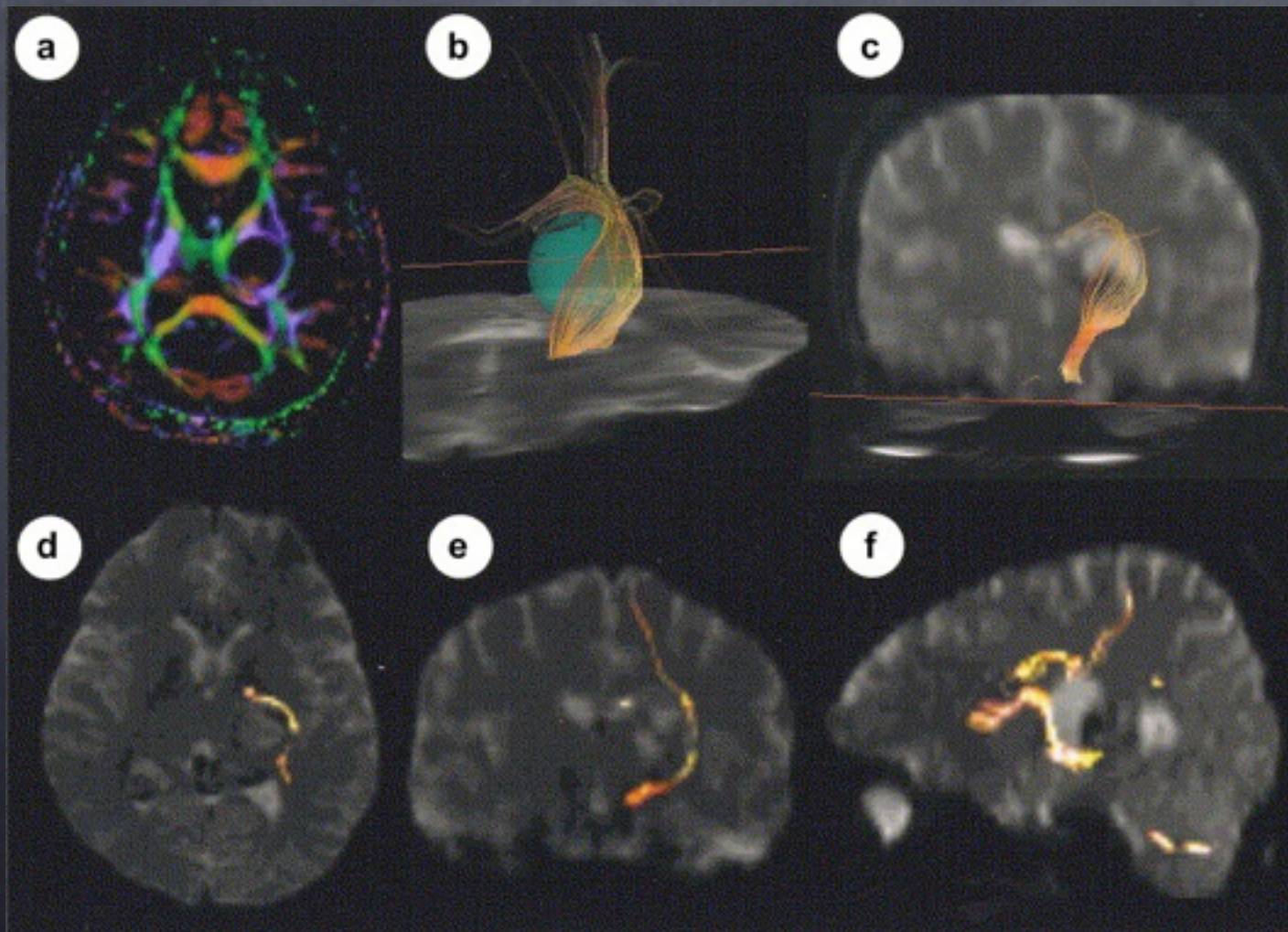
- 👁️ Administration of MRI while patient undergoes cognitive challenge
- 👁️ Measures brain activity by changes in blood flow
- 👁️ See signaling in dorsolateral pre-frontal cortex corresponding to memory centers of brain
- 👁️ These areas often correspond with areas with altered brain metabolism seen with concussion research studies

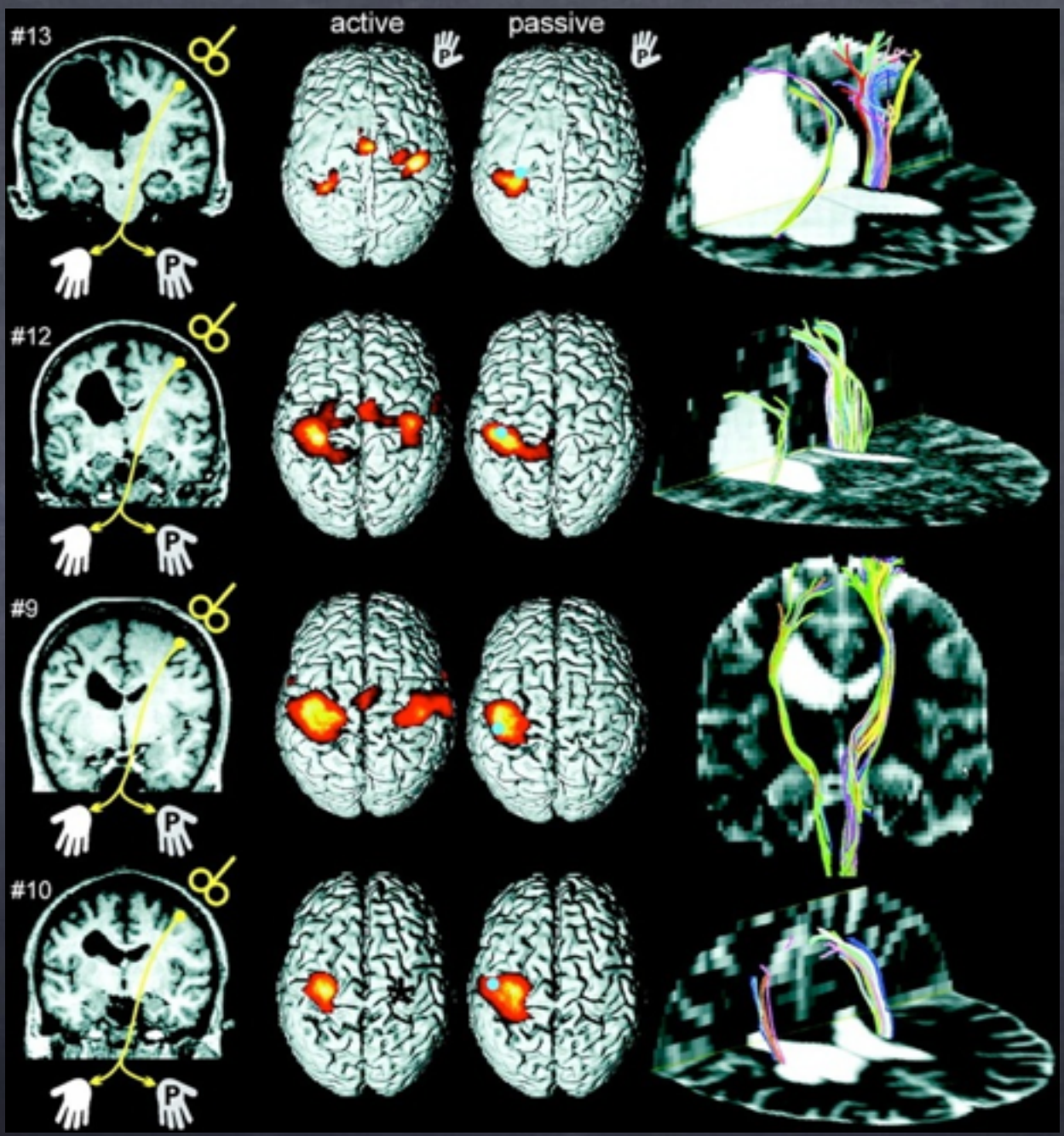


High Definition Fiber Tracking



High Definition Fiber Tracking





Summary

- Concussion is an incredibly complex injury that encompasses cognitive, visual, and vestibular aspects of the brain as well as alter mood and sleeping patterns.
- It is indeed a traumatic injury to the brain causing an energy/metabolic crisis.
- It involves more than "rest": multi-faceted approach is the key to effective treatment.
- Newer advances are emerging in treatment.

Thank You!

