

Reframing Concussion Care: Science, Strategy, and Support for the Injured Brain

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Disclosure

- “I, Daniel Scura, have no financial relationships with commercial interests, or relationships otherwise to disclose.”



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Objectives

- Understand updated concussion pathophysiology and relevant anatomy.
- Provide perspective for concussion symptoms.
- Explain why concussions remain misunderstood despite increased awareness.
- Understand various treatment options and modalities.

Case Study

- HPI: 15 year old female soccer player presents with mom with eye pain, dizziness, recurrent headaches, and neck pain following a collision during a soccer game about 5 weeks ago. Denied LOC. Relative rest since then with only minimal improvement. Worked with school trainer using visual spot cards. Denies prior concussions.
- PMHx: “Undiagnosed” ADHD, Anxiety and depression on Sertraline
- Past Family Hx: Mom with migraines.
- Average grades in school: A/B+
- Sports since then: No
- Takes a daily multivitamin, birth control.
- Last physical with PMD 8 months ago.

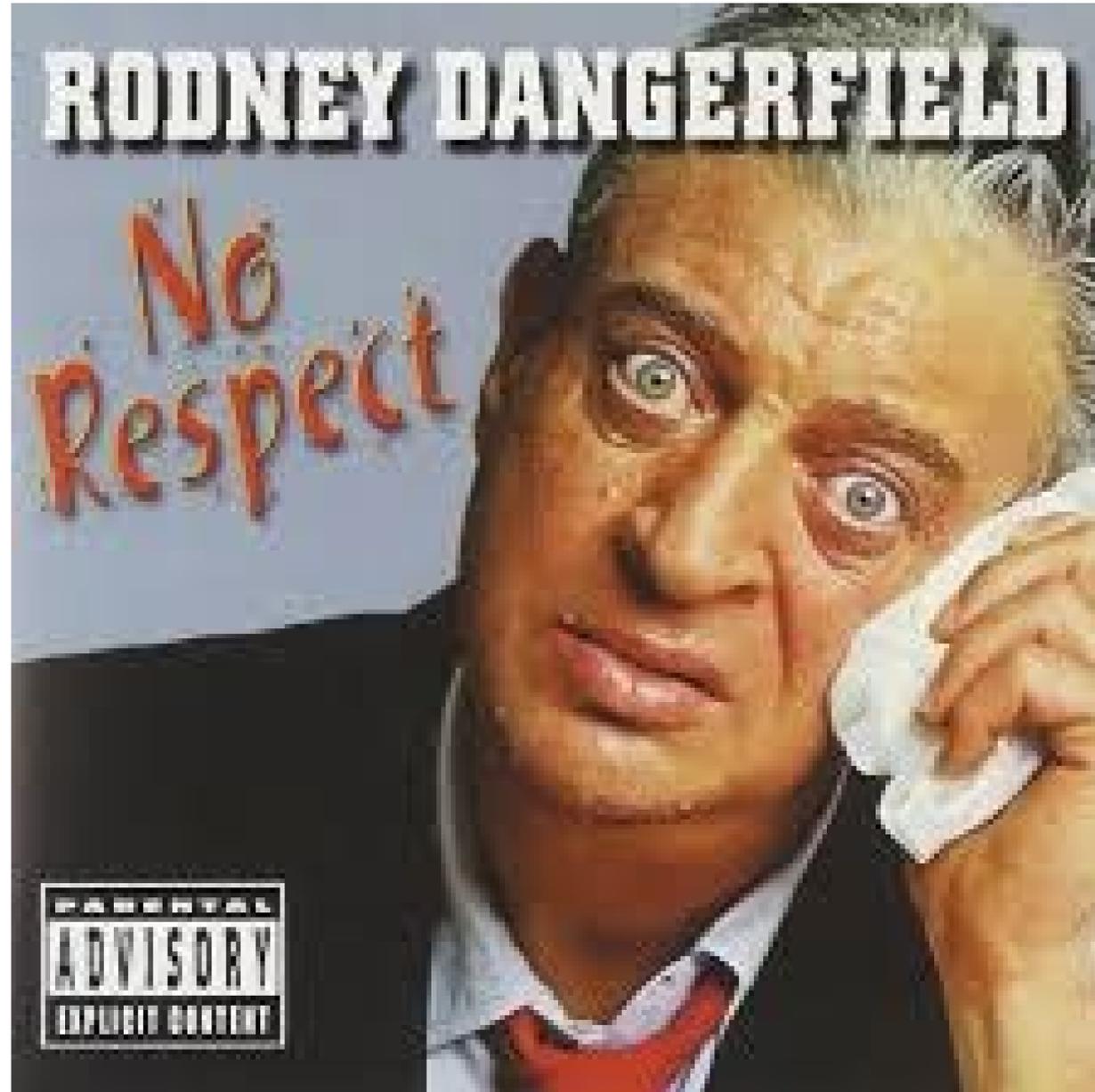


Perspective

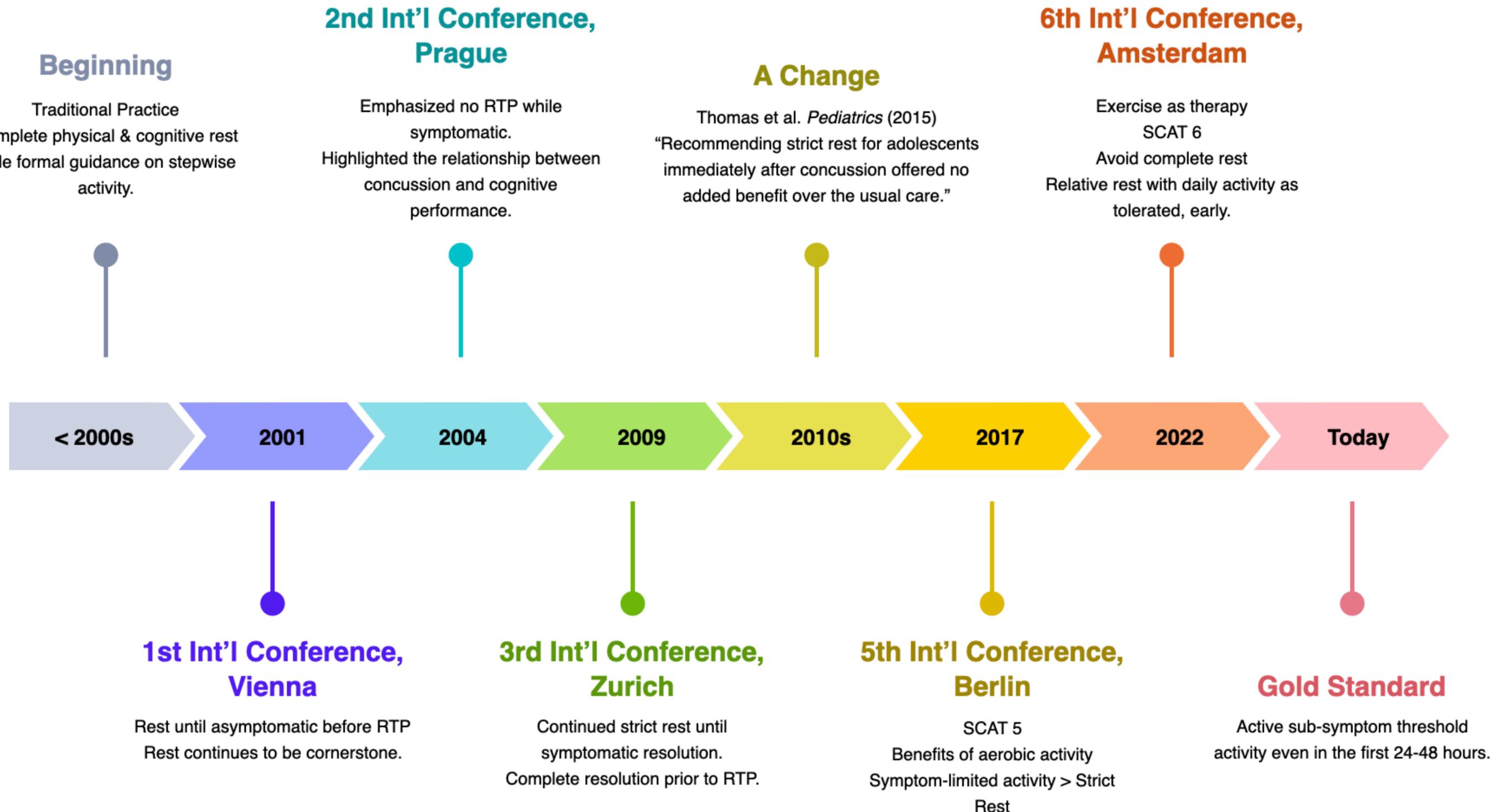
- The brain contains an estimated 86 billion neurons.
- Each neuron is connected to thousands of others (Goriely, 2025).
- Estimated 100 - 1,000 Trillion neuronal connections
- Stars in the Milky Way Galaxy? 100-400 billion
- Each part of the brain has its own separate but connected function



The respect it deserves, and needs.



Evolution of Management



Fundamentals

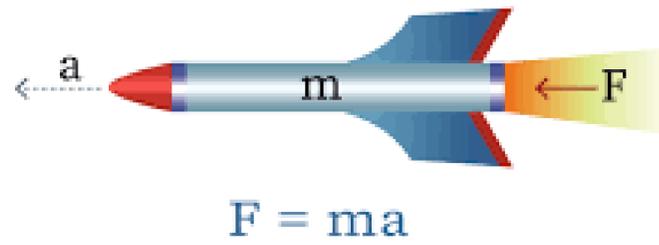
Physics!

1st Law: Inertia!



2nd Law: Force!

NEWTON'S SECOND LAW OF MOTION



$$F = ma$$

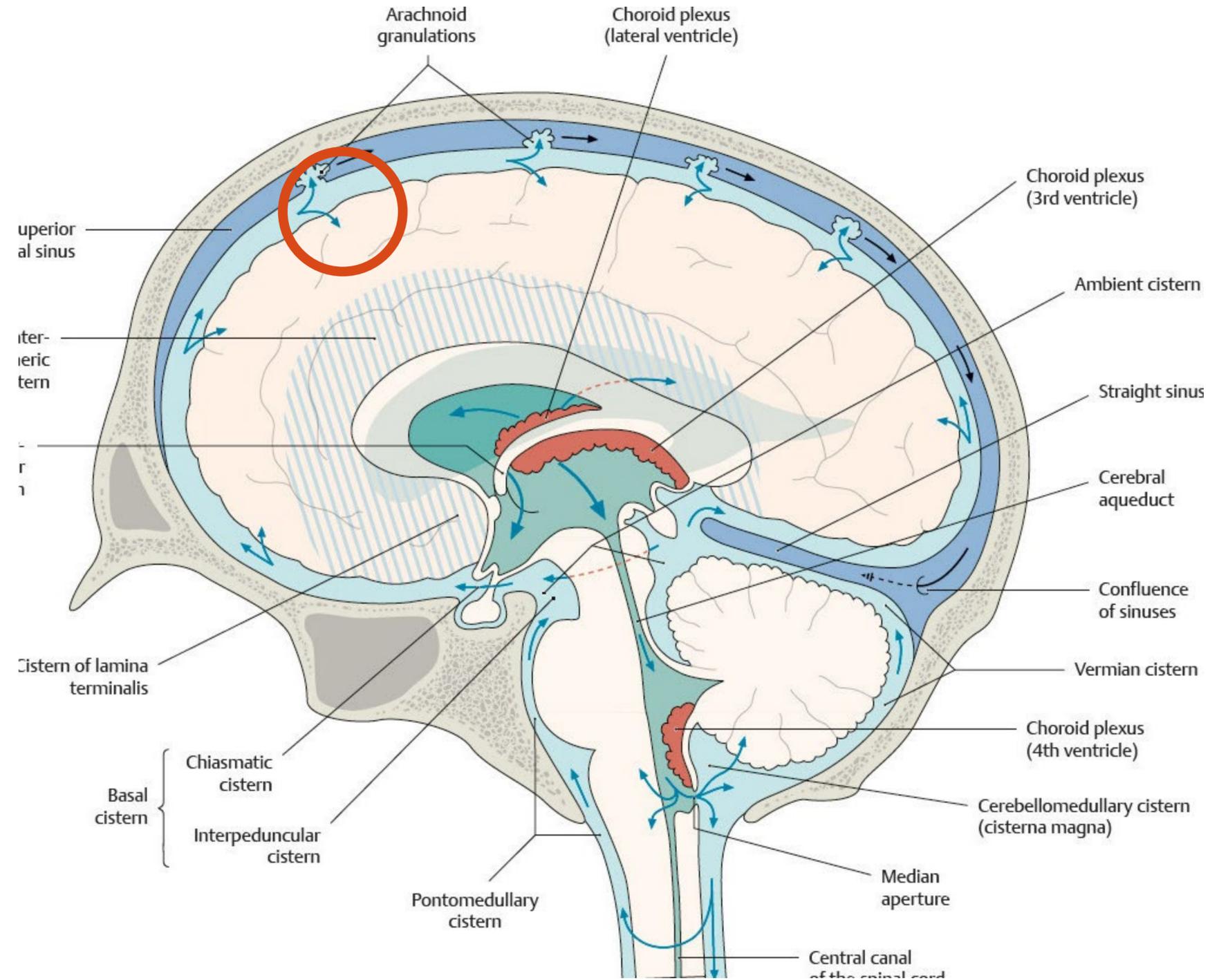
Where F - force
m - mass of the body
a - acceleration of the body

3rd Law: Action = Reaction!



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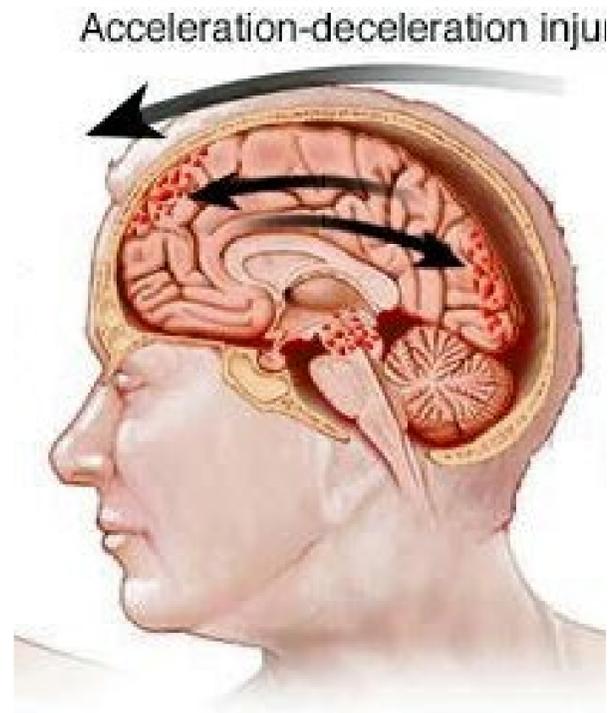




Source: [Ventricles & CSF Spaces](#). In: [Gilroy A](#), [MacPherson B](#), [Schünke M](#), [Schulte E](#), [Schumacher U](#), [Voll M](#), [Wesker K](#), ed. [Atlas of Anatomy](#). 3rd Edition. New York: Thieme; 2016. doi:10.1055/b-005-148856

Applied Physics!

1st Law: Inertia!



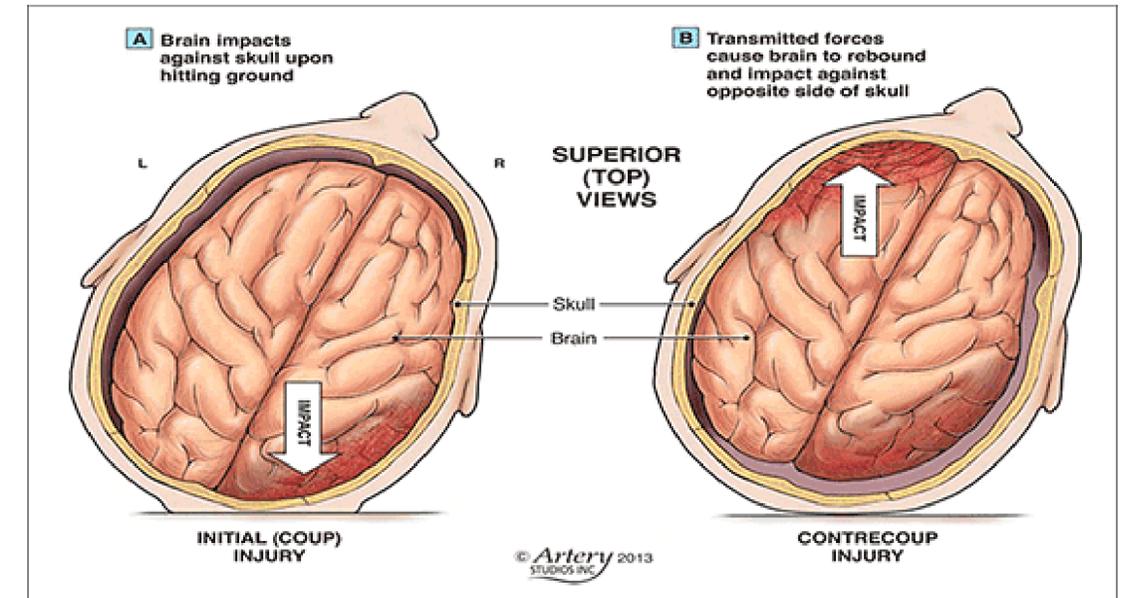
ION AND RESEARCH. ALL RIGHTS RESERVED.

Mayo Foundation For Medical Education and Research

2nd Law: Force!

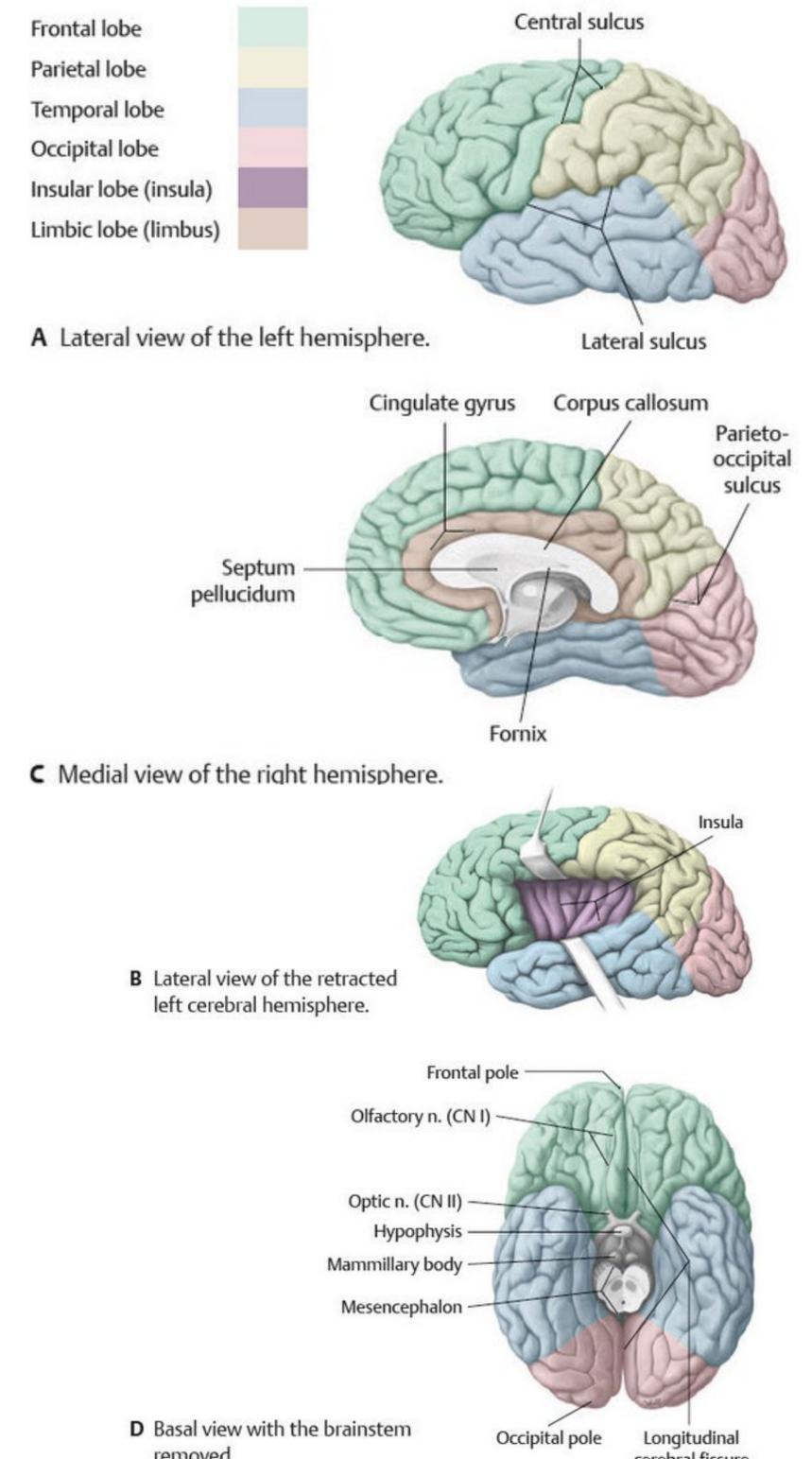


3rd Law: Action = Reaction!



Does the angle or impact influence the symptoms?

- Sometimes but not precisely predictable.
- Functional MRI (fMRI) revealed greater abnormalities in superior frontal and temporal regions of the brain in athletes with a higher symptom severity score (Churchill, et al.).
- Network disruptions.
- The thalamus also revealed abnormalities (motor-sensory relay) (Woodrow RE 2023).
- Thalamocortical connectivity has been the focus of research in post-concussion syndrome.



Whose who?

Anatomic focus not necessarily related to symptoms, why?

BRAIN

[Article Navigation](#)

JOURNAL ARTICLE

Acute thalamic connectivity precedes chronic post-concussive symptoms in mild traumatic brain injury

Rebecca E Woodrow , Stefan Winzeck, Andrea I Luppi, Isaac R Kelleher-Unger, Lennart R B Spindler, J T Lindsay Wilson, Virginia F J Newcombe, Jonathan P Coles, CENTER-TBI MRI Substudy Participants and Investigators, David K Menon ... [Show more](#)

[Author Notes](#)

Brain, Volume 146, Issue 8, August 2023, Pages 3484–3499,

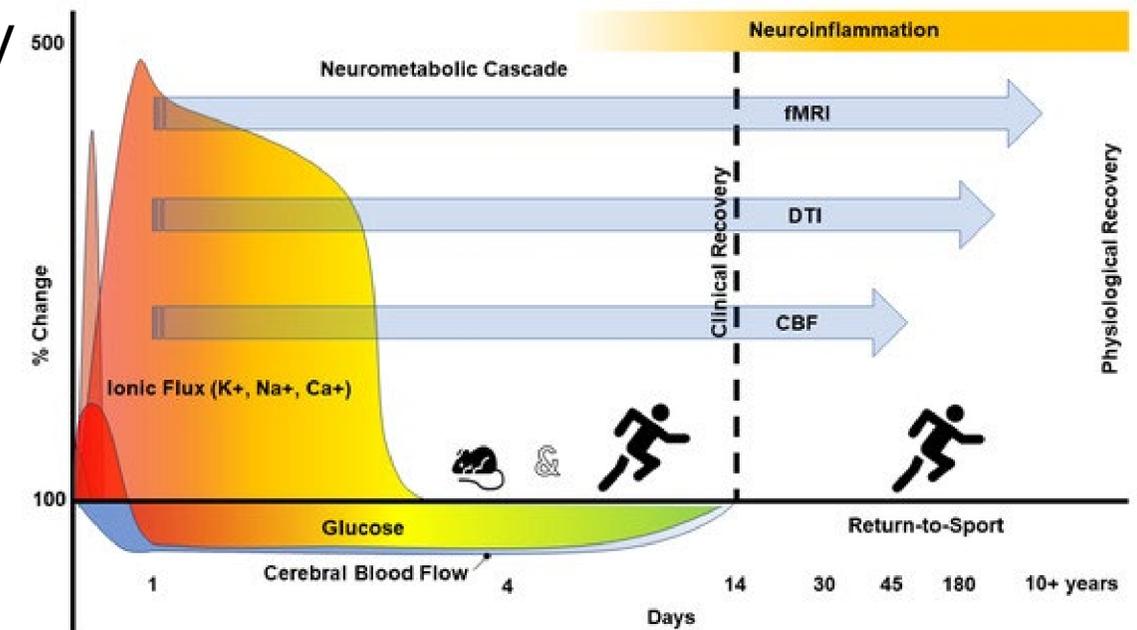
<https://doi.org/10.1093/brain/awad056>

Published: 22 February 2023 **Article history** ▼

- 50% of patients are symptomatic at 6 months despite adequate therapy.
- The thalamus plays a pivotal role in the communication between motor and sensory regions of the brain.
- Implications for headache, sleep disturbances, fatigue, cognition.
- No structural damage but shows persistent histopathological changes.

Does clinical recovery align with physiological recovery?

- Clinical recovery is resolution of symptoms and return to sport.
- Physiologically:
 - Neurometabolic cascade, metabolic energy crisis, neuroinflammatory response.
 - Axonal strain → Glutamate excitotoxicity → Glutamate: NMDA-r → intracellular/extracellular potassium or sodium flux.
 - Cerebral perfusion changes.
- fMRI shows persistent microglial activation after clinical recovery suggesting a neuroinflammatory response in the support of neuronal healing.



Cells. 2023 Aug 22;12(17):2128. doi: [10.3390/cells12172128](https://doi.org/10.3390/cells12172128)

Energy Crisis

Minutes - to - Days

- Increased demand for energy to restore the ATP requiring membrane ionic pumps.
- Animal models reveal impaired glucose metabolism for 7-10 days post injury.
- Axonal shear, cytoskeletal damage and axonal dysfunction.
- Generally little cell death but functional impairment is evident.
 - Unless, repeated injury which leads to prolonged metabolic disturbances that result in cell apoptosis.



The New Neurometabolic Cascade of Concussion

Giza, Christopher C. MD^{*,‡,§}; Hovda, David A. PhD^{‡,§,¶}

Editor(s): Rosseau, Gail MD; Bailes, Julian MD; Maroon, Joseph MD

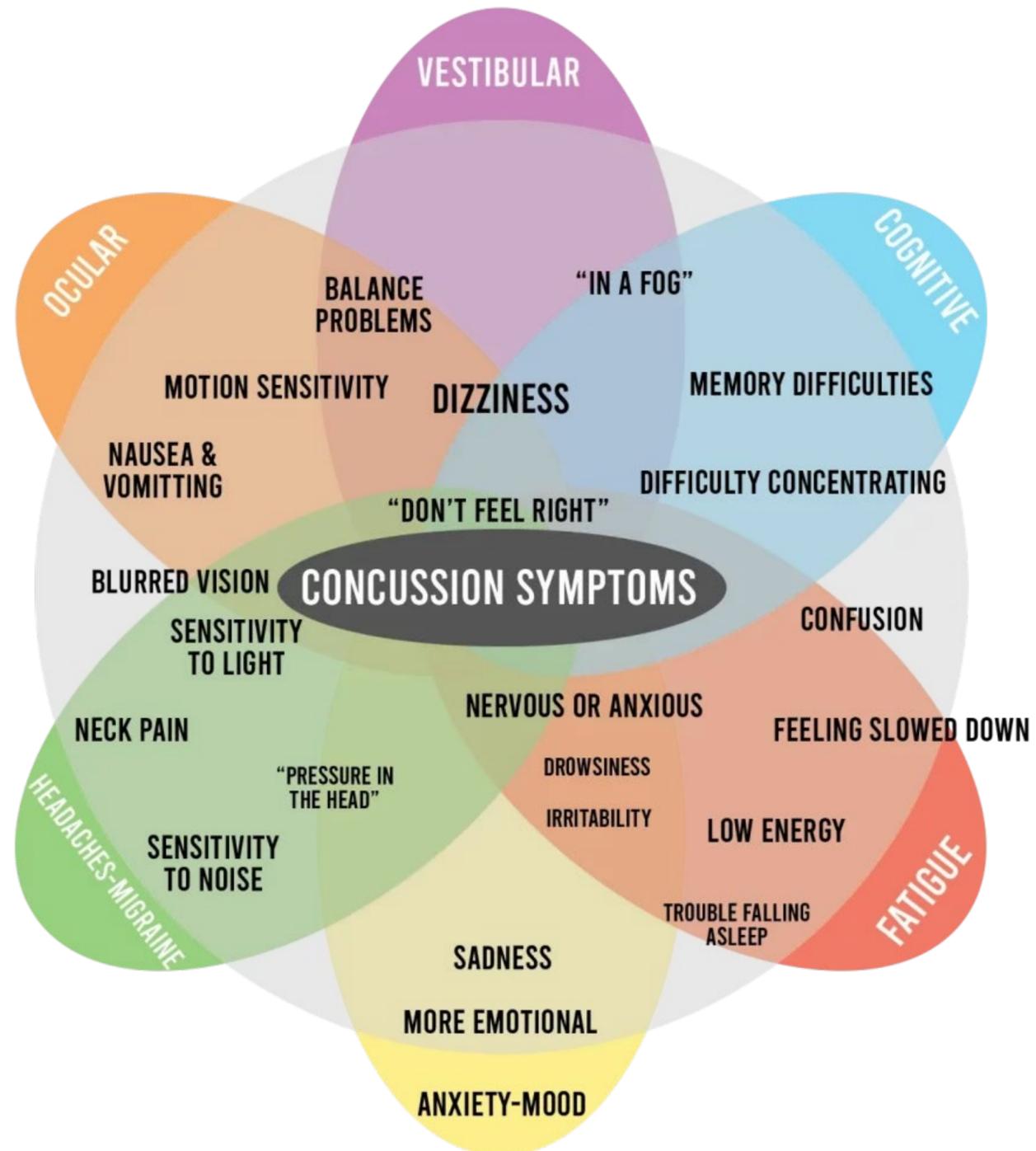
[Author Information](#)

Neurosurgery 75():p S24-S33, October 2014. | DOI: 10.1227/NEU.0000000000000505

Post-TBI pathophysiology	Acute symptom / clinical correlate
Ionic flux	Migraine headache, photophobia, phonophobia
Energy crisis	Vulnerability to second injury
Axonal injury	Impaired cognition, slowed processing, slowed reaction time
Impaired neurotransmission	Impaired cognition, slowed processing, slowed reaction time
Protease activation, altered cytoskeletal proteins, cell death	Chronic atrophy, development of persistent impairments

Cerebral Domains

“Clinical Phyentyping”



=

Step 2: Symptom Evaluation

Baseline: Suspected/Post-injury: Time elapsed since suspected injury: mins/hours/days

The athlete will complete the symptom scale (below) after you provide instructions. Please note that the instructions are different for baseline versus suspected/post-injury evaluations.

Baseline: Say *“Please rate your symptoms below based on how you typically feel with “1” representing a very mild symptom and “6” representing a severe symptom.”*

Suspected/Post-injury: Say *“Please rate your symptoms below based on how you feel now with “1” representing a very mild symptom and “6” representing a severe symptom.”*

PLEASE HAND THE FORM TO THE ATHLETE

Symptom	Rating
Headaches	0 1 2 3 4 5 6
Pressure in head	0 1 2 3 4 5 6
Neck pain	0 1 2 3 4 5 6
Nausea or vomiting	0 1 2 3 4 5 6
Dizziness	0 1 2 3 4 5 6
Blurred vision	0 1 2 3 4 5 6
Balance problems	0 1 2 3 4 5 6
Sensitivity to light	0 1 2 3 4 5 6
Sensitivity to noise	0 1 2 3 4 5 6
Feeling slowed down	0 1 2 3 4 5 6
Feeling like “in a fog”	0 1 2 3 4 5 6
“Don’t feel right”	0 1 2 3 4 5 6
Difficulty concentrating	0 1 2 3 4 5 6
Difficulty remembering	0 1 2 3 4 5 6
Fatigue or low energy	0 1 2 3 4 5 6
Confusion	0 1 2 3 4 5 6
Drowsiness	0 1 2 3 4 5 6
More emotional	0 1 2 3 4 5 6
Irritability	0 1 2 3 4 5 6
Sadness	0 1 2 3 4 5 6
Nervous or anxious	0 1 2 3 4 5 6
Trouble falling asleep (if applicable)	0 1 2 3 4 5 6

Do your symptoms get worse with physical activity? Y N

Do your symptoms get worse with mental activity? Y N

If 100% is feeling perfectly normal, what percent of normal do you feel?

If not 100%, why?

PLEASE HAND THE FORM BACK TO THE EXAMINER

Once the athlete has completed answering all symptom items, it may be useful for the clinician to revisit items that were endorsed positively to gather more detail about each symptom.

Total number of symptoms: of 22

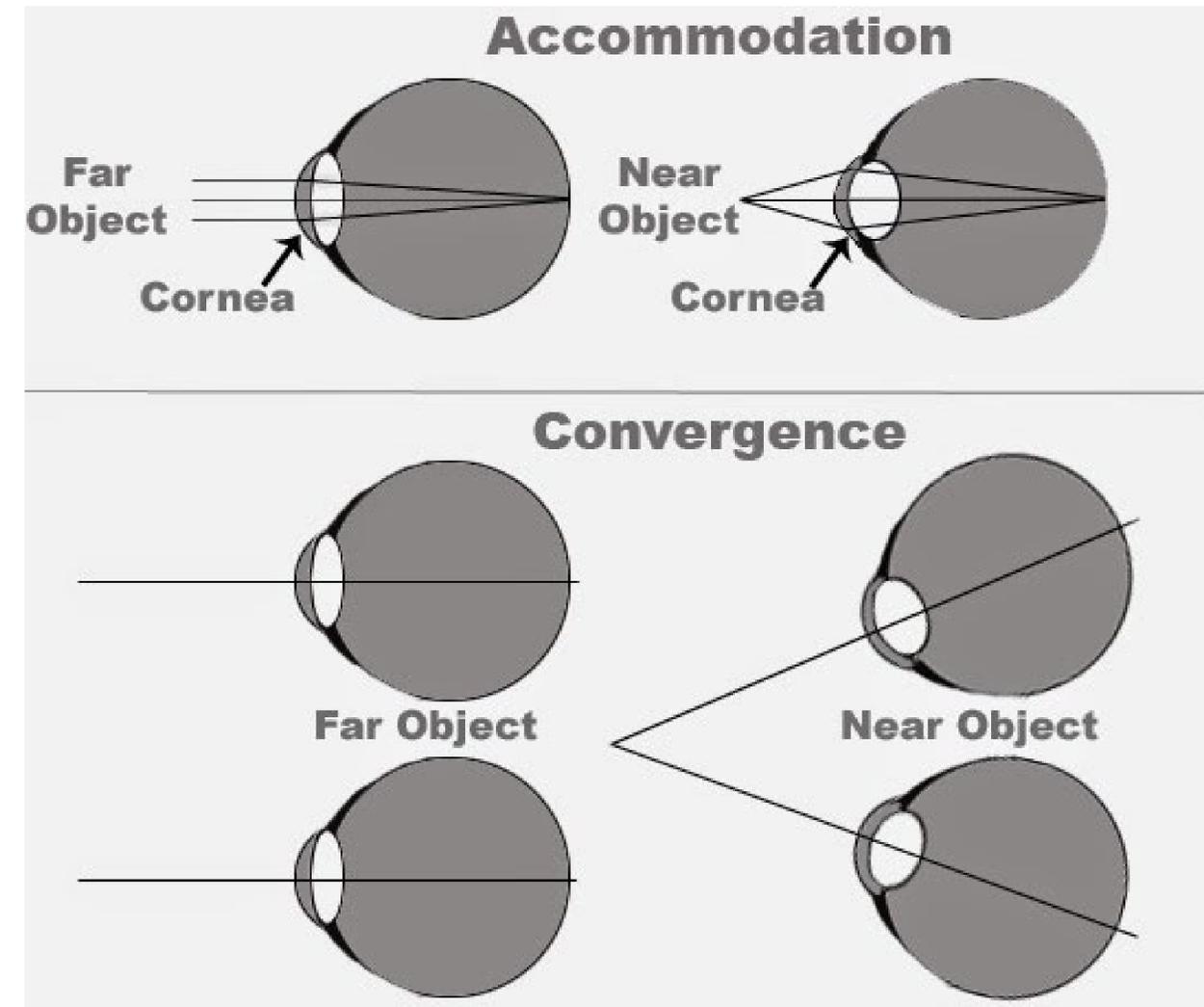
Symptom severity score: of 132

Cognitive Function

- Memory impairment, decreased attention, impaired concentration, slow mental processing, other executive dysfunctions.
- SCAT6 and ImPACT/Cogsport applications.
- Confounding factors from HPI.
 - Mood disorders, ADHD/ADD/Dyslexia, headache, pain, fatigue.
- Reduced cognitive performance may persist for 1.5-2 years in adolescents. Large population study including adults suggests that 88% of adults may experience symptoms for up to 8 years (Taylor 2014).
- Concussions during time of rapid development can have greater consequences on cognition than either earlier or later.

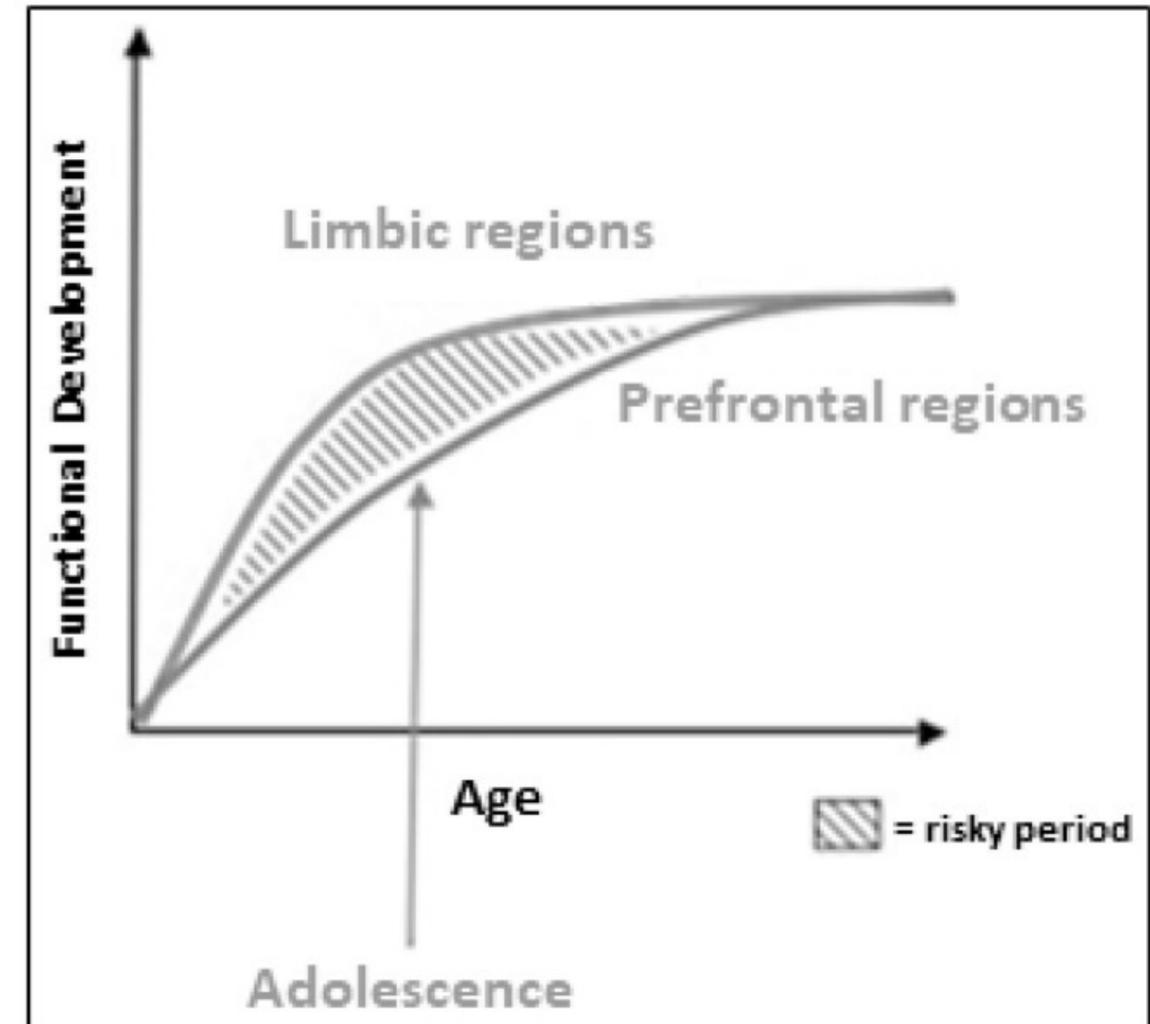
Oculomotor Manifestations

- 61% of patients with symptoms on initial evaluation.
- Near-point convergence, saccadic eye movements, visual pursuit, photophobia.
- Convergence deficits in 60% of patients. Associated with blurred vision, difficulty focusing, and headaches (Wu 2025).
 - Poor prognostic indicator.
- Accommodation deficits present in 76% of patients.
- Deficits typically persist beyond clinical resolution (Fenner 2025).



Affective Disturbances

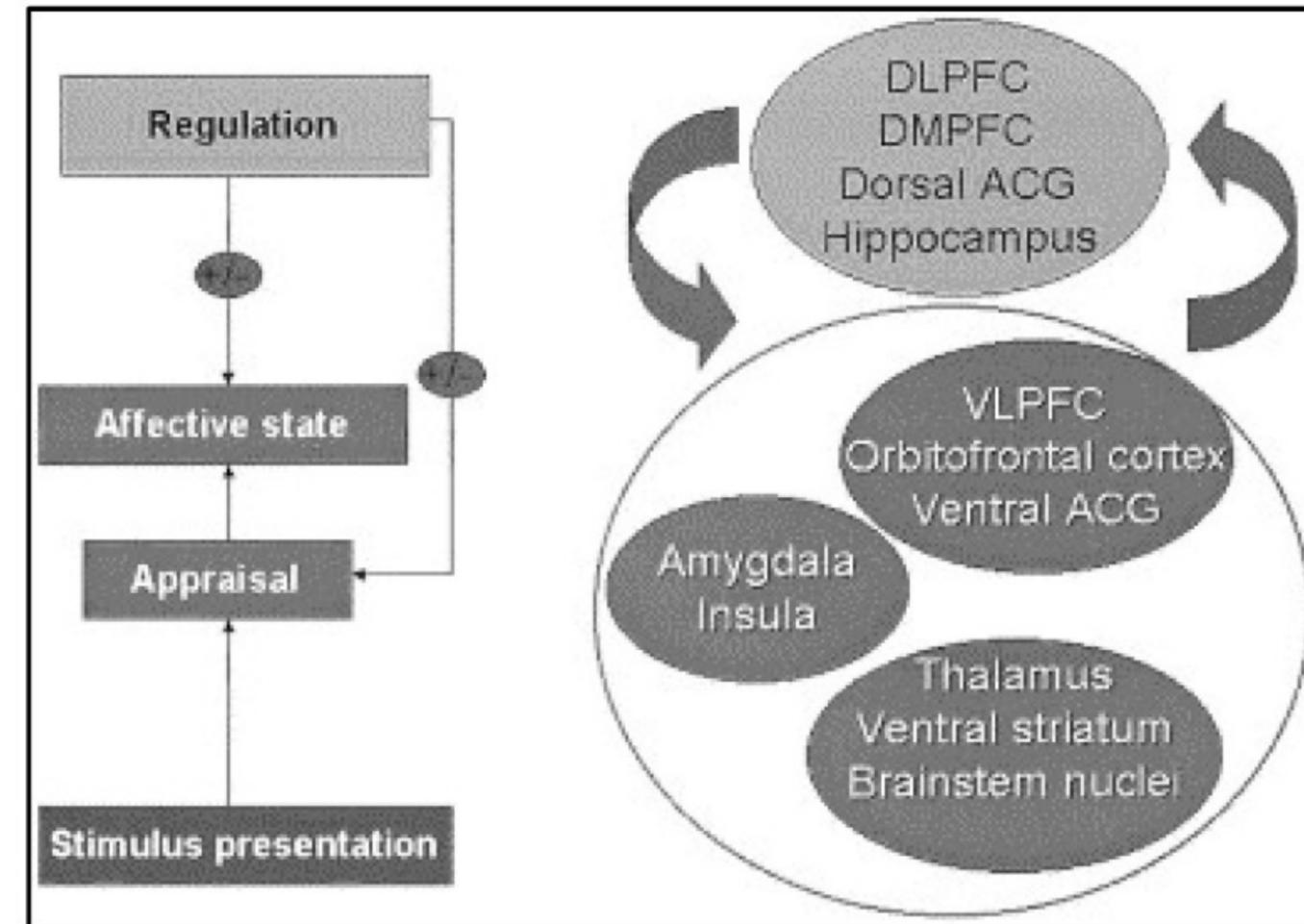
- Affective disturbances are a risk factor and also potential consequence.
- Fatigue, sadness, irritability, trouble sleeping, difficulty concentrating, increased emotional state, anxiety.
- Psychological factors play role in delayed recovery.
- Adolescents are more sensitive than children or adults due to the rapid development of the limbic system and development of the prefrontal cortex.
 - Brain plasticity is positive but increases vulnerability.
- Importance for screening for post-concussive affective disorders (PHQ-9).



Int J Environ Res Public Health. 2023 Jul 1;20(13):6274. doi: [10.3390/ijerph20136274](https://doi.org/10.3390/ijerph20136274)

Affective disorders, continued.

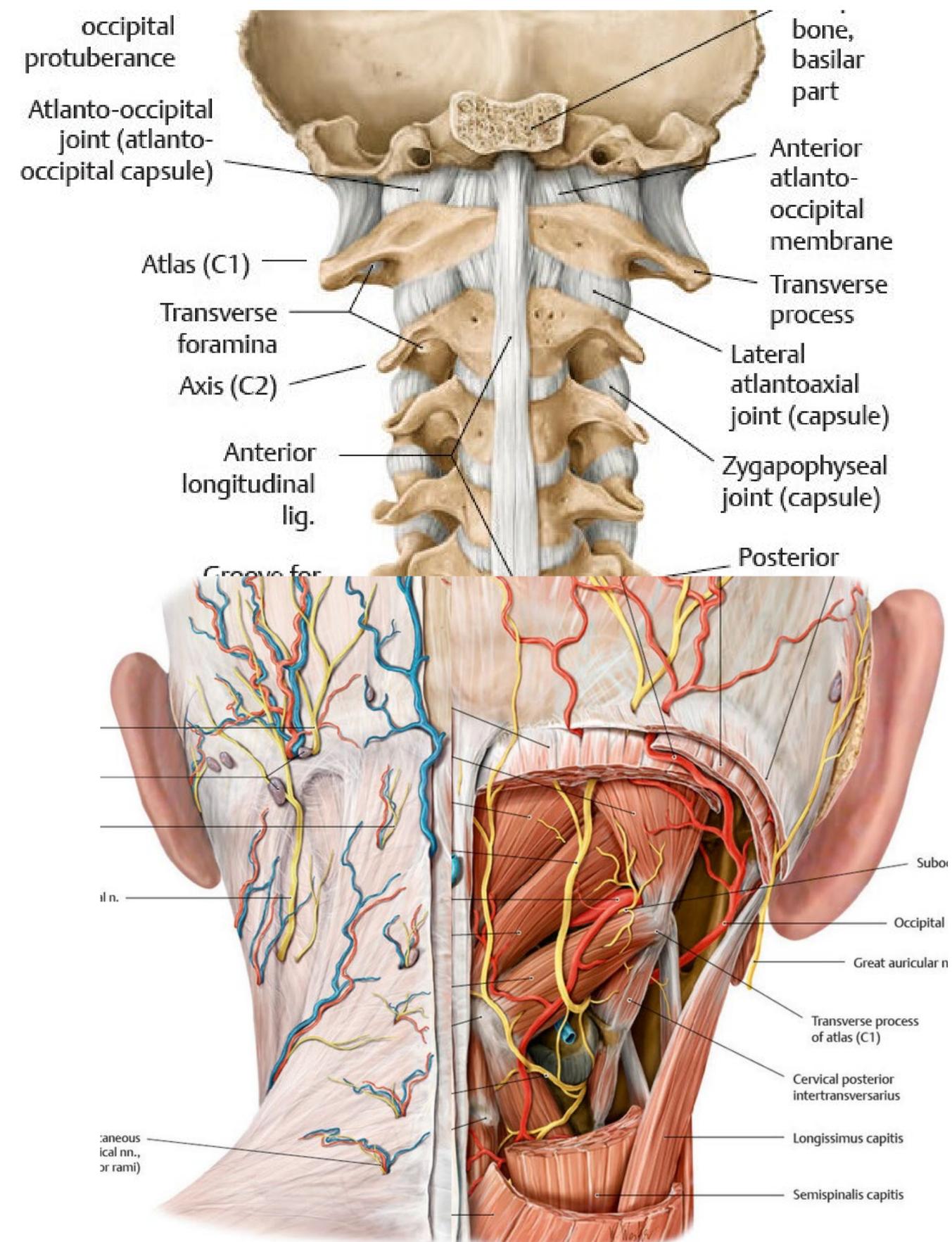
- It is complex!
- Controversial among researchers is whether concussed patients develop emotional dysregulation symptoms as
 - A direct result of injury to brain regions involved in emotional regulation circuits
 - Secondary effect of frustrations and/or uncertainty associated with their injury, or withdrawal from sports participation,
 - Or because of a preexisting vulnerability.



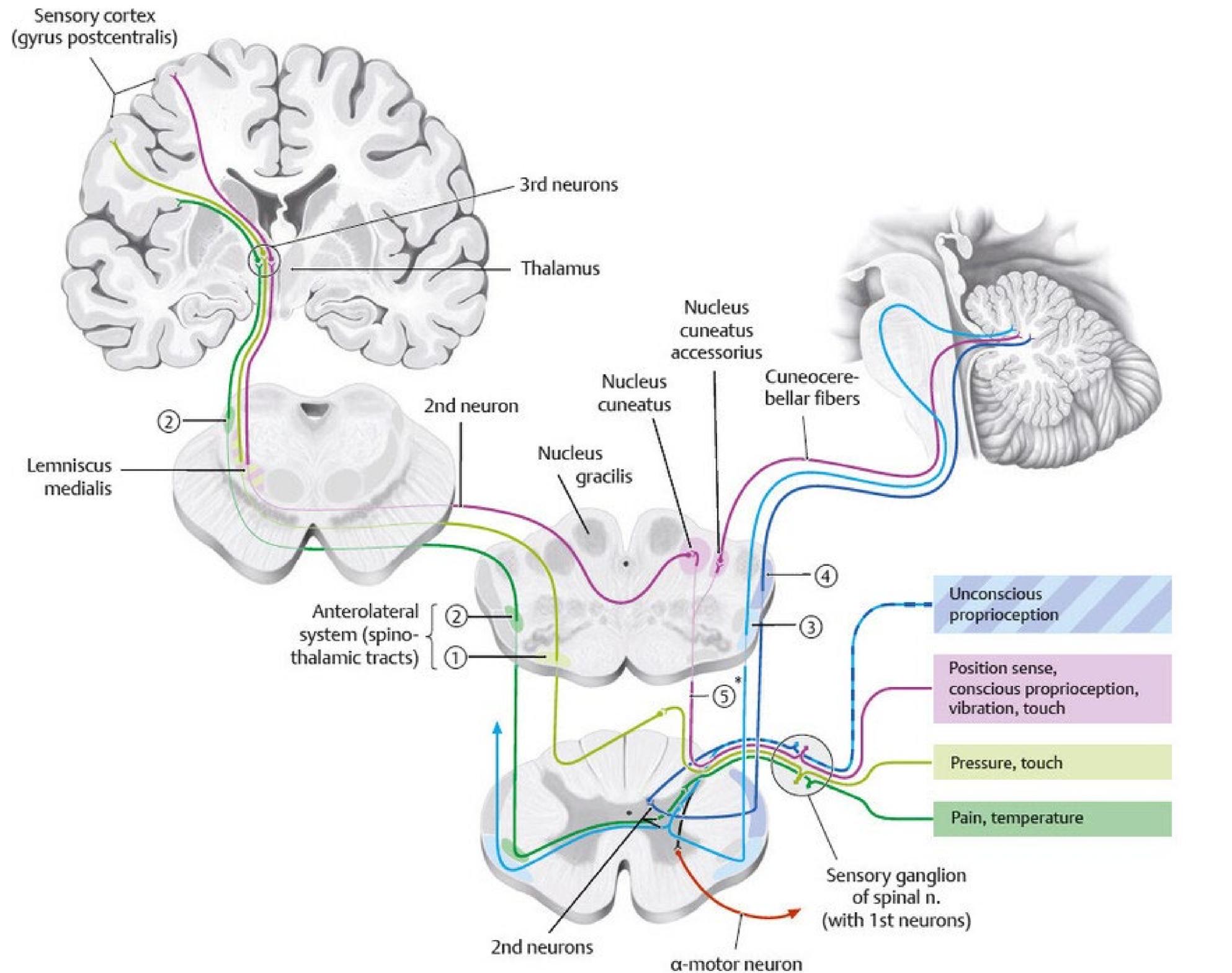
Int J Environ Res Public Health. 2023 Jul 1;20(13):6274. doi: [10.3390/ijerph20136274](https://doi.org/10.3390/ijerph20136274)

Cervical

- Acceleration/Deceleration—> Whiplash
- Why?
 - Zygoapophyseal joints/vertebral discs
 - Ligamentous disruption
 - Cervico-thoracic/cervico-scapular musculature
 - Suboccipital muscles
 - Cervical nerve roots
 - Trigemino-cervico nucleus



- Afferents from the upper cervical spine provide somatosensory information for head and neck position.
- Integration with visual and vestibular information in the cerebellum for oculomotor regulation.
- Multilevel integration occurs in the somatosensory cortex of the brain.
- Integration also occurs in the Thalamus.



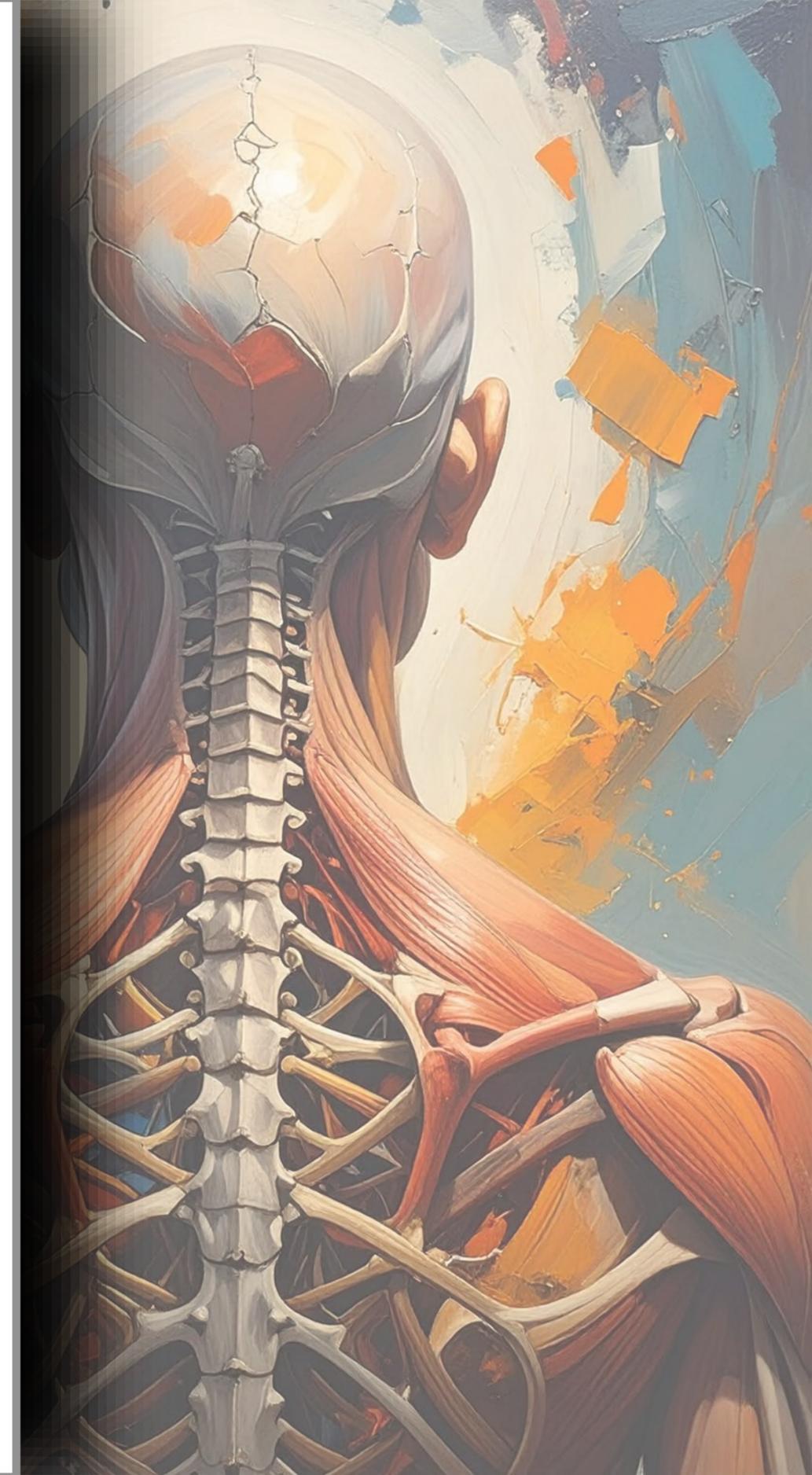
*The fasciculi cuneatus and gracilis convey information from the upper and lower limbs, respectively. At this spinal cord level, only the fasciculus cuneatus is present.



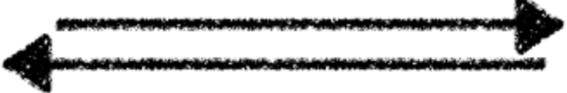
Table 1.

Commonality Symptoms of Concussion and Cervicogenic Injury

Symptom	Condition	
	Concussion	Cervical Injury
Headache ^{3,10,15,16-19}	X	X
Dizziness ^{3,10,16-20}	X	X
Tinnitus ¹⁰	X	X
Irritability ^{10,21}	X	X
Chronic traumatic encephalopathy ³	X	
Sleep disturbances ^{3,10,17}	X	X
Blurred vision ^{10,17}	X	X
Neck stiffness ^{10,18}	X	X
Balance disturbances ^{13-17,20,21}	X	X
Depression ^{2,3}	X	
Cognitive deficits ^{10,17,21,22}	X	X
Memory deficits ^{10,17,18,21,22}	X	
Attention deficits ^{10,17,18,21,22}	X	X
Decreased cervical range of motion ¹⁸		X
Decreased isometric neck strength ¹⁸	X	X

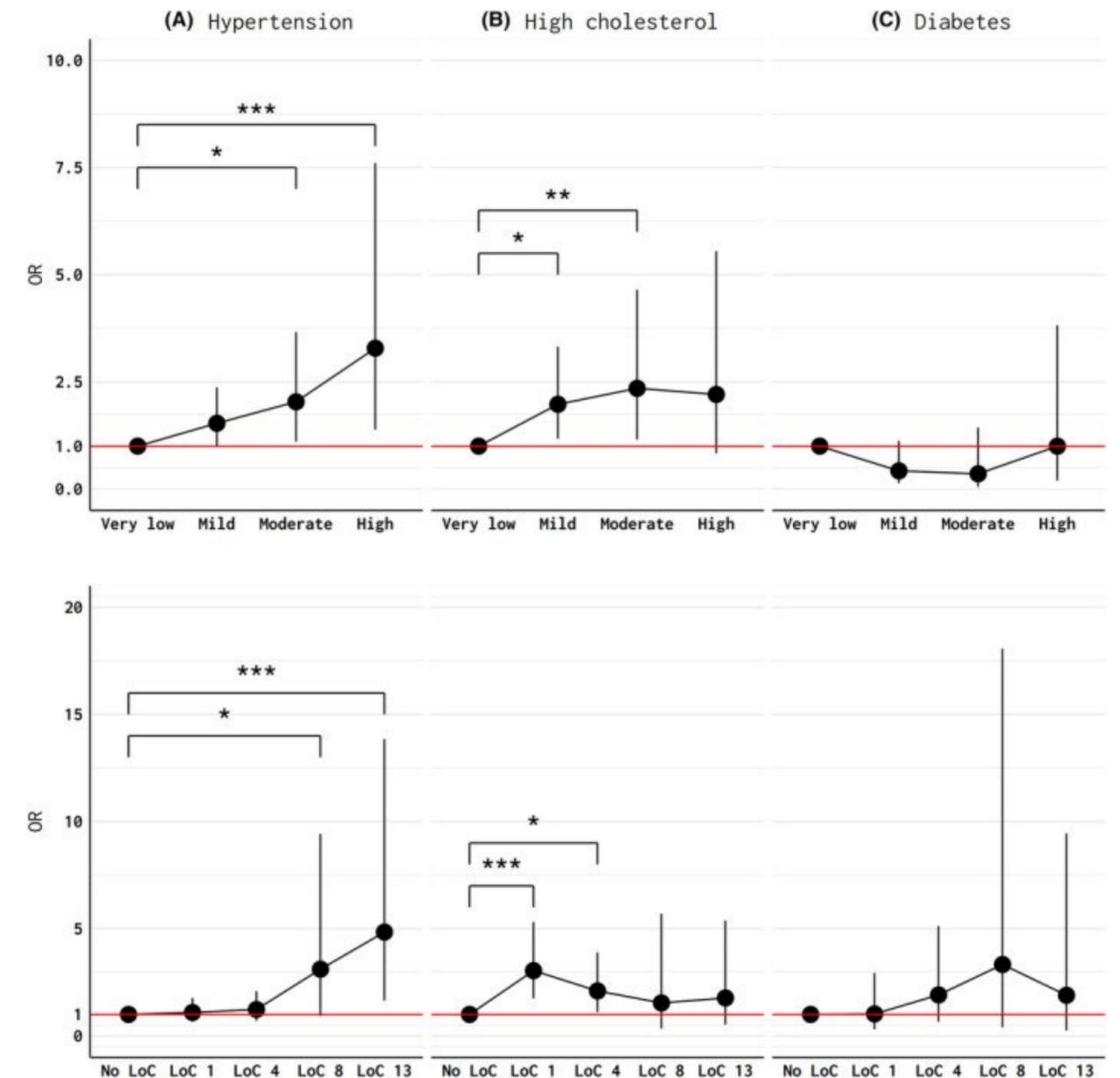


Headaches

- Headache is the most common symptom in a concussed patient SRC or otherwise.
 - > 90% of athletes with SRC experience HA (Cranton, 2017).
 - Migraine, tension, cervico-genic, post traumatic.
 - Pre-existing headaches are a risk factor, epp those with personal or family history of migraine.
 - New HA or exacerbation of previously existing.
 - Often Misdiagnosed  Mismanaged
 - Little literature managing PTH in the athlete.

Cardiovascular

- Newer area of focused research
- Exercise intolerance, alterations in HRV, POTS, Dysautonomia.
- 2016 study by Heyer et. found 71% of patients had either lightheadedness/vertigo, or POTS.
- Orthostatic vital signs should be part of routine evaluation in symptomatic athletes.
- 2025 study found concussions sustained in collegiate football athletes had independent markers for cardiovascular risk and maladaptive cardiovascular phenotypes later in life (Tan, 2024).
- Atherogenic cardiovascular profiles but not diabetes.



Cardiovascular

Cardio-Autonomic System: Heart Rate Variability (HRV)

- Beat-to-beat variation in the rate
 - Sympathetic + Parasympathetic influence on the autonomic NS
 - Balanced with the hearts mechanosensitive and chemosensitive inputs
- Pathophysiology...
 - Uncoupling of the brain/arterial baroreceptors?
 - Neurobiochemical cascade?
 - White matter tract damage?
- Longer post-exercise recovery

Cardiovascular

Recovery

- Concept behind Leddy and Willer's Buffalo Concussion Treadmill test (improved autonomic function, cerebral BF).
- Engaging in moderate exercise starting around day 3 post-concussion*.
- Research supports a 12 week sub-symptom threshold aerobic exercise intervention to improve overall symptom burden (Mercier 2024).
- Clarification: Rest until symptom free is an outdated management approach.
 - (Should be limited to < 24-48 hours post injury)

Vestibular

- Fairly well elucidated domain and well established in concussion screening and clinical examination.
- 81% of patients show vestibular abnormality on initial clinical examination.
 - Dizziness +/- ocular motor symptoms in 50% of concussed athletes, specifically (Mucha 2014).
- Information regarding head movement to maintain visual and balance control.
- Presence of vestibular symptoms increase risk of protracted recovery.

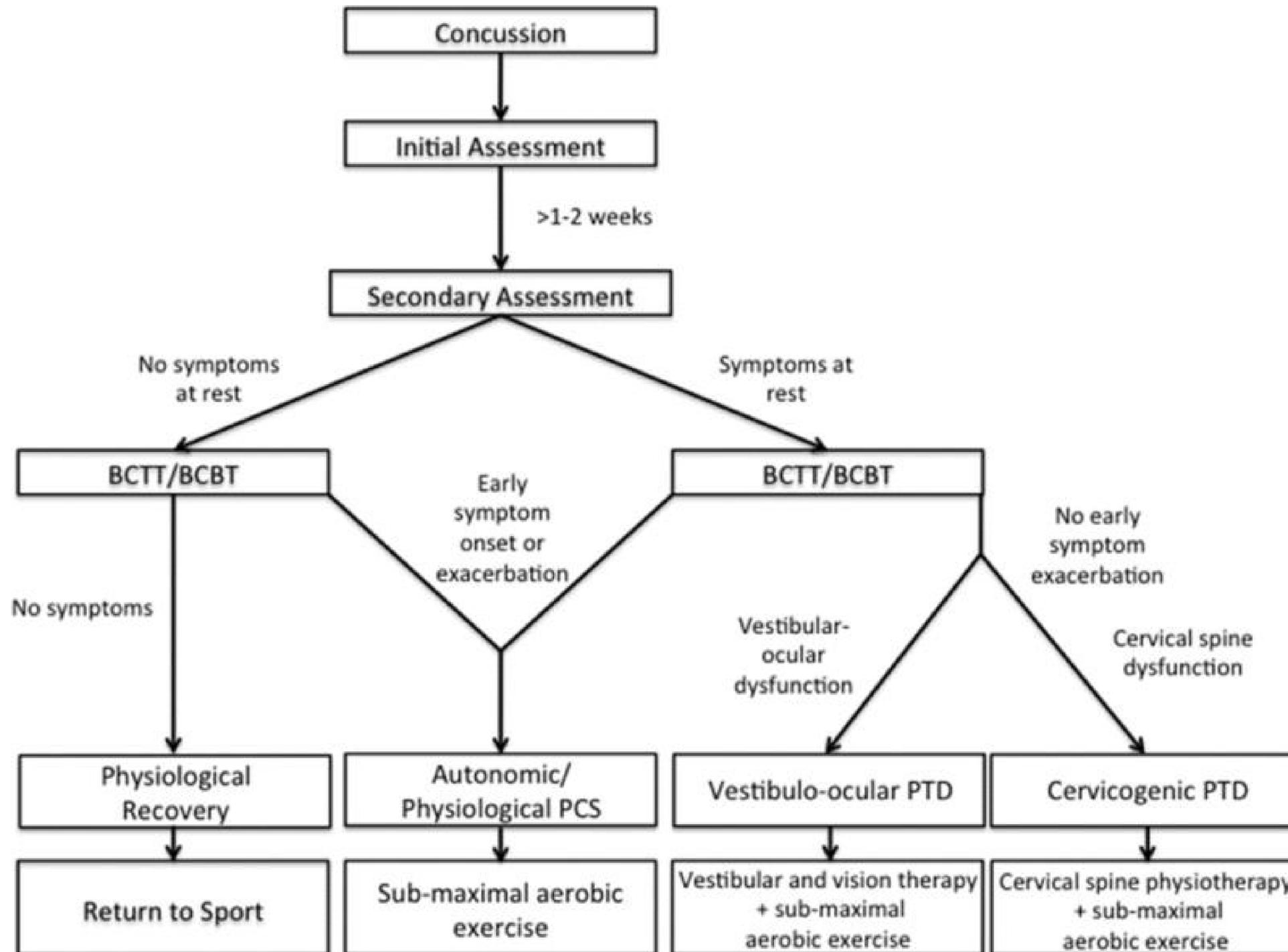
What do we do with this information?

Why is clinical phenotyping important?

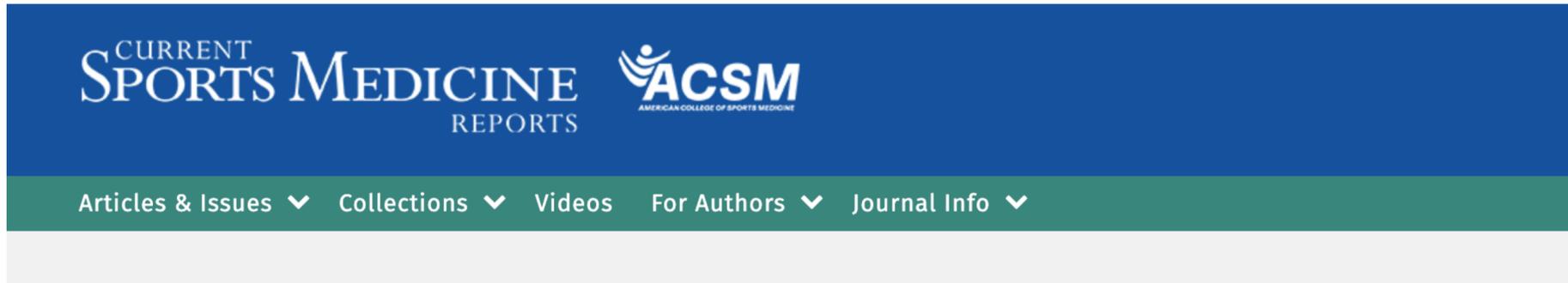
Treatment

- Only a few evidenced based therapies for SRC.
- No major study explores that treatment prescribed for youth with protracted concussion symptoms.
- Prompt treatment can help reduce development of depression and anxiety, can help return the student to school, and the athlete back to sport.
- Common & Classic: Education, Sleep Recommendations, Goal Setting, Energy Management (pacing).
- Less common & Needed & Heavily Supported: Aerobic exercise prescription.

Rehabilitation Framework



“Exercise is Medicine”



EXERCISE IS MEDICINE: SECTION ARTICLE

Exercise is Medicine for Concussion

Leddy, John J. MD, FACSM, FACP; Haider, Mohammad N. MD; Ellis, Michael MD, FRCSC; Willer, Barry S. PhD

[Author Information](#)

Current Sports Medicine Reports 17(8):p 262-270, August 2018. | DOI: 10.1249/JSR.0000000000000505

BUY

- Randomized control trial by Thomas et al. 2015 showed that strict rest beyond 2 days prolonged symptomatic recovery.
- Moderate levels of physical activity within the first week reduced PCS.

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Aerobic Exercise

VEGF

BDNF

IGF-1

Ketone Bodies

Cortisol

Catecholamines

Serotonin,
Dopamine, NE

Growth Hormone

Lactate

Endocannabinoids

IL-6

NO

↓ Cognitive Impairment

↓ Dementia Risk

↓ Anxiety Depression

↓ PCS

Exercise Prescription

- Frequency, Intensity, Time, and Type
- Stationary bike —> Treadmill
- Identify sub-maximal symptom exacerbation HR threshold (BCBT, BCTT).
- 80-90% of the threshold HR once per day x 6-7 days per week.
- OR increase HR target by 5-10 BPM every 1-2 weeks (Leddy, 2018).
- Can repeat BCBT/BCTT every 2 weeks to obtain new threshold.
- Physiological recovery: exercise until voluntary exhaustion at > 80% age predicted HR for 20 minutes w/o symptom exacerbation.

PROTOCOL
Concussion Specialist

HOMONCULUS
MEDICAL
CENTER

Clinic Hours:
All Day Every Day

123 Head Injury
Way, Thalamus,
Ponsylvania

Patient's name: _____ Age: _____
Address: _____ Date: _____

RX

FREQUENCY

INTENSITY

TIME

TYPE

Cerebellum

Signature

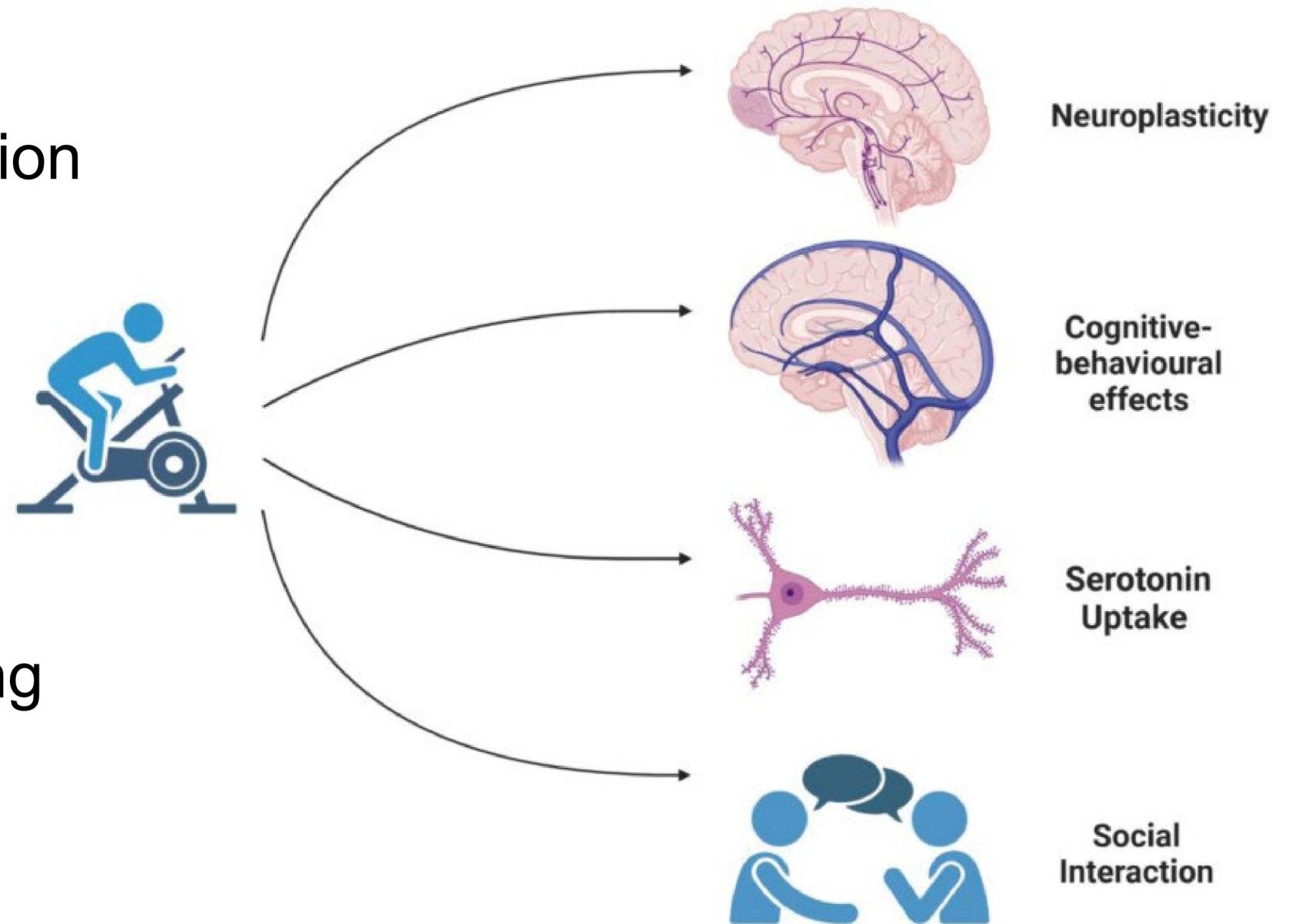
Signature

Cerebellum

The Brain Doesn't Heal in Isolation

Psychosocial & Mental Health Considerations

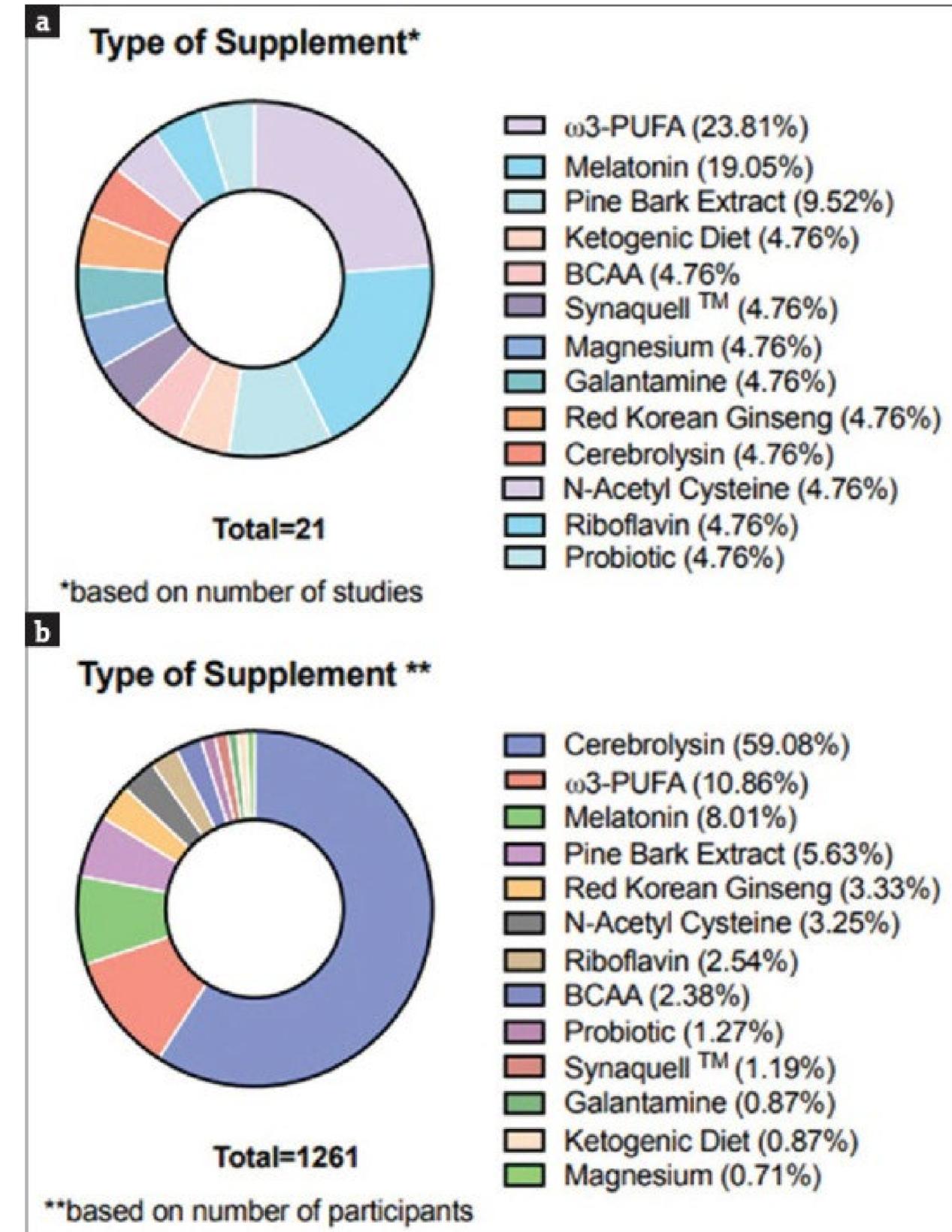
- Anxiety driven symptom amplification
- Falling behind
- Fear of reinjury
- Identity loss in athletes
- Sleep, mood, stress, deconditioning



Supplement Protocol

Research Supported

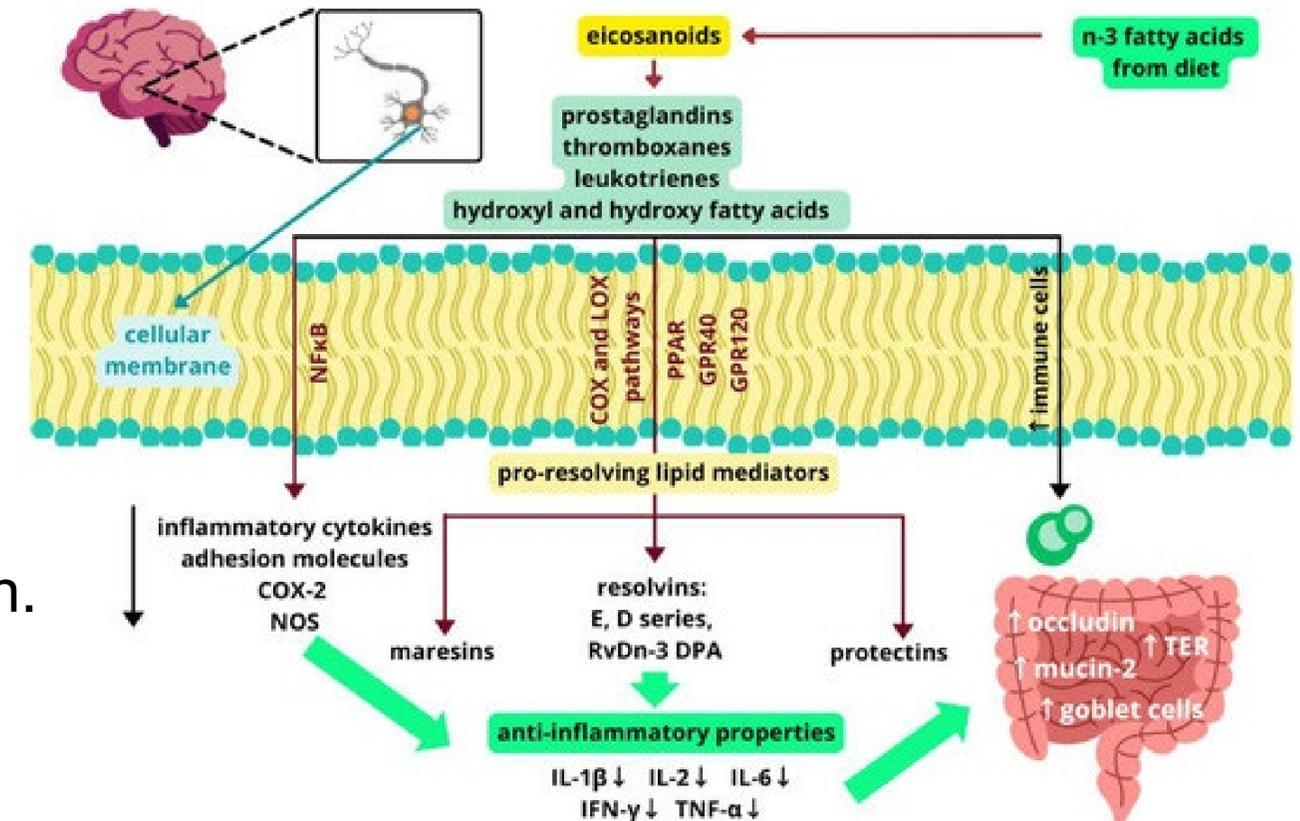
- Various preclinical studies have demonstrated efficacy of various dietary supplements for mild-TBI.
 - Omega-3 FA
 - Melatonin
 - Creatine
 - Curcumin
 - Vitamin D
- DHA, Mag-Ox, and Melatonin are most studied in Pediatric/Adolescent population.



Docosahexaenoic Acid (DHA)

Pediatrics

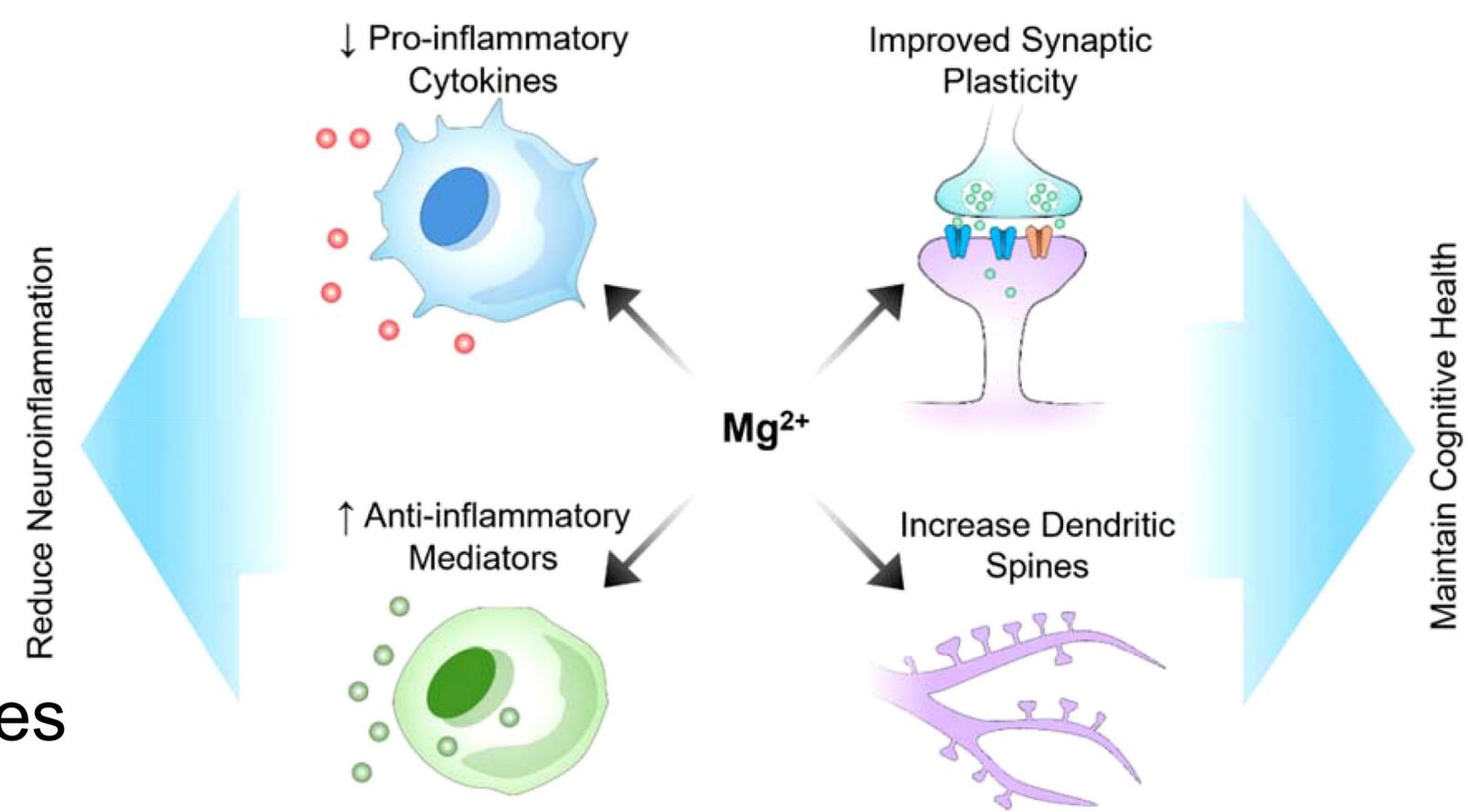
- Type of Omega-3 FA found in fish oil and Algae.
- Vital component of cell membranes & throughout the entire NS.
 - Well known to improve eye development in babies/children.
 - Implicated in cardiovascular disease and macular degeneration.
- Anti-inflammatory properties.
- Several clinical trials:
 - 2 g daily within 4 days of symptom onset resulted in patients being symptom free with RTS 5 days sooner than placebo (clinical trial ID: NCT01903525).
 - Clinical trail investigating high dose omega-3 FA and return to play time (clinical trial ID: NCT 01814527).
- S/e: Belching in 5% of those studied.



Magnesium

Pediatrics

- 3 “Types”
 - Oxide: Constipation, heart burn, headaches
 - Threonate: Sleep quality, reduce anxiety, neuroplasticity. Crosses BBB.
 - Glycinate: Muscle cramps, stress, anxiety, sleep, headaches. Readily absorbed.
- The level of magnesium depletion has been shown to correlate to the severity of head injury (Standiford, 2021).
- In pediatrics, Mag-Ox is the most studied. 400 mg 2x daily. Significant reduction in Post Concussion Symptom Scale compared to placebo (Siahaan, 2025).



Melatonin

- Sleep disturbance is a common post-concussion symptom, and sleep disturbance severity increases with subsequent concussions and is associated with prolonged concussion symptoms (Oyegbile¹, 2020).
- No significant difference in youth and adolescents PCS scores compared to placebo based on a randomized clinical trial (Barlow 2020).
- Some studies suggest that it does help with sleep quality and mental health in TBI patients (not restricted to concussions) (Grima, 2018).
- Favorable side effect profile, cheap and readily available, naturally occurring.
- Official recommendations remain conflicted.

BCAAs

Adolescents and Young Adults

Barone's Essential Amino Acid Mnemonic

^ **PVT. TIM HALL** ^

P Phenylalanine
V Valine
T Tryptophan

T Threonine
I Isoleucine
M Methionine

H Histidine
A Arginine
L Lysine
L Leucine

Essential Amino Acids...
Line up for roll call!

There will be...
No **HIS**y fits
No **ARG**uing &
No **LY**ing
in the **BASIC** Training **HALL**!!!!

BASIC Amino Acids
Histidine
Arginine
Lysine
BASIC Training **HALL**

BRANCHED-Chain
Amino Acids
Leucine
Isoleucine
Valine

I **LIVE** for this **BRANCH**
of the military!

Barone **ROCKS**!!!

At the **End** of **Two** weeks of
training you be **ketogenic**!

Last 2 are
Ketogenic
Amino Acids

PVT. TIM HALL

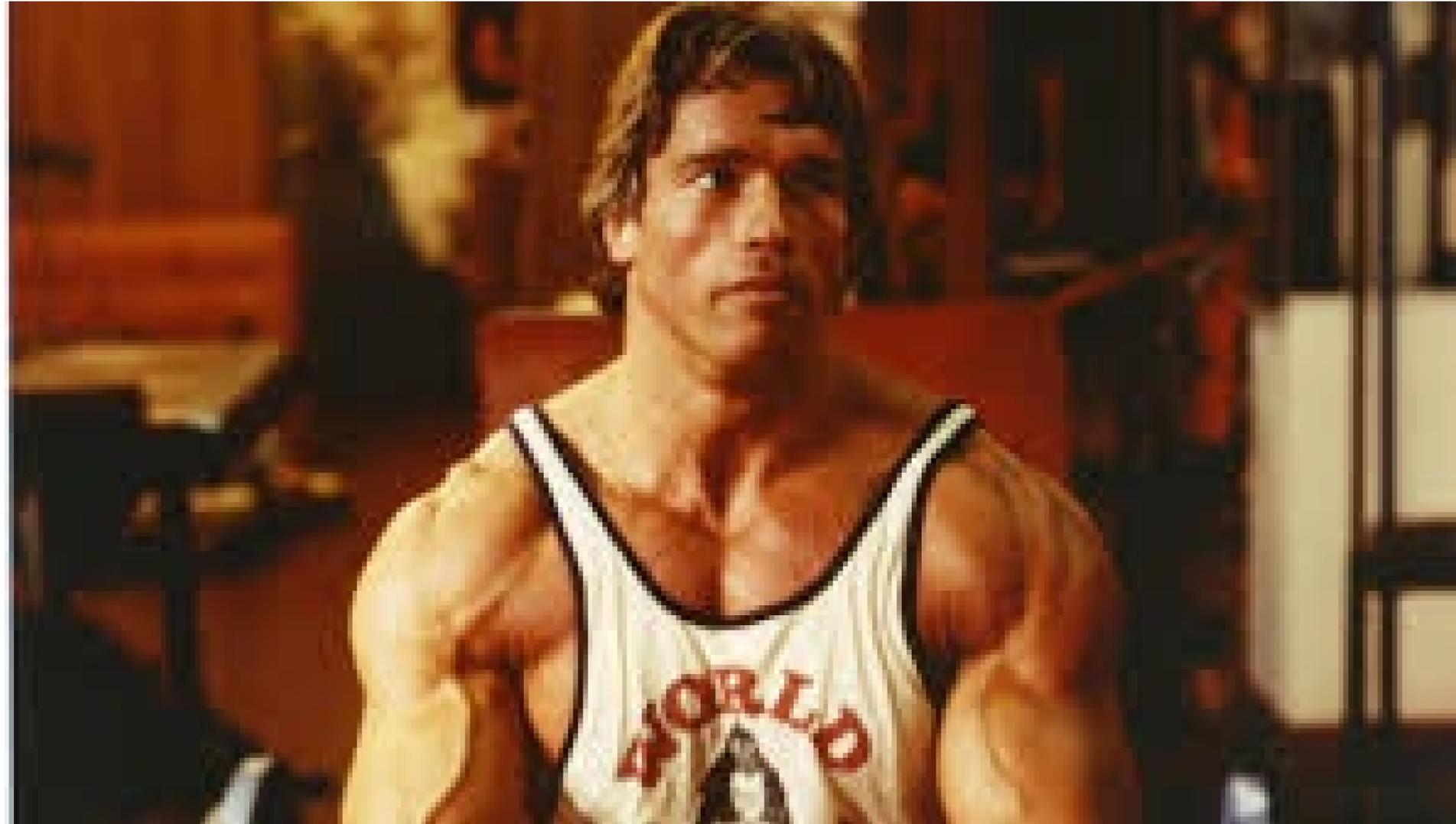
Barone Rocks.com
The Official Site of John Barone, M.D.

- Several pre-clinical animal model studies show improvements in neurocognition and sleep.
- Several Human TBI studies have shown reduction in various BCAA levels following severe TBI, one small study showed similar in mTBI.
- Recent pilot study in adolescents and young adults showed significant reduction in total symptom score, and return to play time.
- Well tolerated up to 45 g/day.

Adults

- Creatine
- Pink bark extract
- Probiotics
- Ketogenic diet
- Red Korean ginseng
- Galantamine
- Cerebrolysin

CREATINE?



YES, CREATINE.



YES, CREATINE.

Neuroprotective effects of creatine supplementation in management among contact sport athletes

[John E Giraldo](#)^{a,b,✉}, [Diego A Bor](#)

^a, [Mayra M Márquez](#)^a, [Jorge L Pe](#)

> [Med J \(Ft Sam Houst Tex\)](#). 2023 Apr-Jun:(1

Neuroprotection and Therapeut

Supplementation for Brain Injury Complications

► [Auth information](#) ► [Article](#)

PMC

> [Ann Neurol](#). 2000 Nov;48(5):723-9.

Dietary supplement creatine protects against traumatic brain injury

[P G Sullivan](#)¹, [J D Geiger](#), [M P Mattson](#), [S W Scheff](#)

Affiliations + expand

PMID: 11079535

> [Front Neurol](#). 2023 Jul 5:14:1209548. doi: 10.3389/fneur.2023.1209548. eCollection 2023.

Pilot study protocol of a randomized controlled trial for the potential effects of creatine monohydrate on persistent post-concussive symptoms

[Ronni Lykke Bødker](#)^{1 2}, [Michael Marcussen](#)^{2 3}

Affiliations + expand

PMID: 37475743

PMCID: [PMC10354866](#)

DOI: [10.3389/fneur.2023.1209548](#)

Review

> [Eur J Sport Sci](#). 2019 Feb;19(1):1-14.

doi: 10.1080/17461391.2018.1500644. Epub 2018 Aug 7.

Beyond muscle: the effects of creatine supplementation on brain creatine, cognitive processing, and traumatic brain injury

[Eimear Dolan](#)¹, [Bruno Gualano](#)¹, [Eric S Rawson](#)²

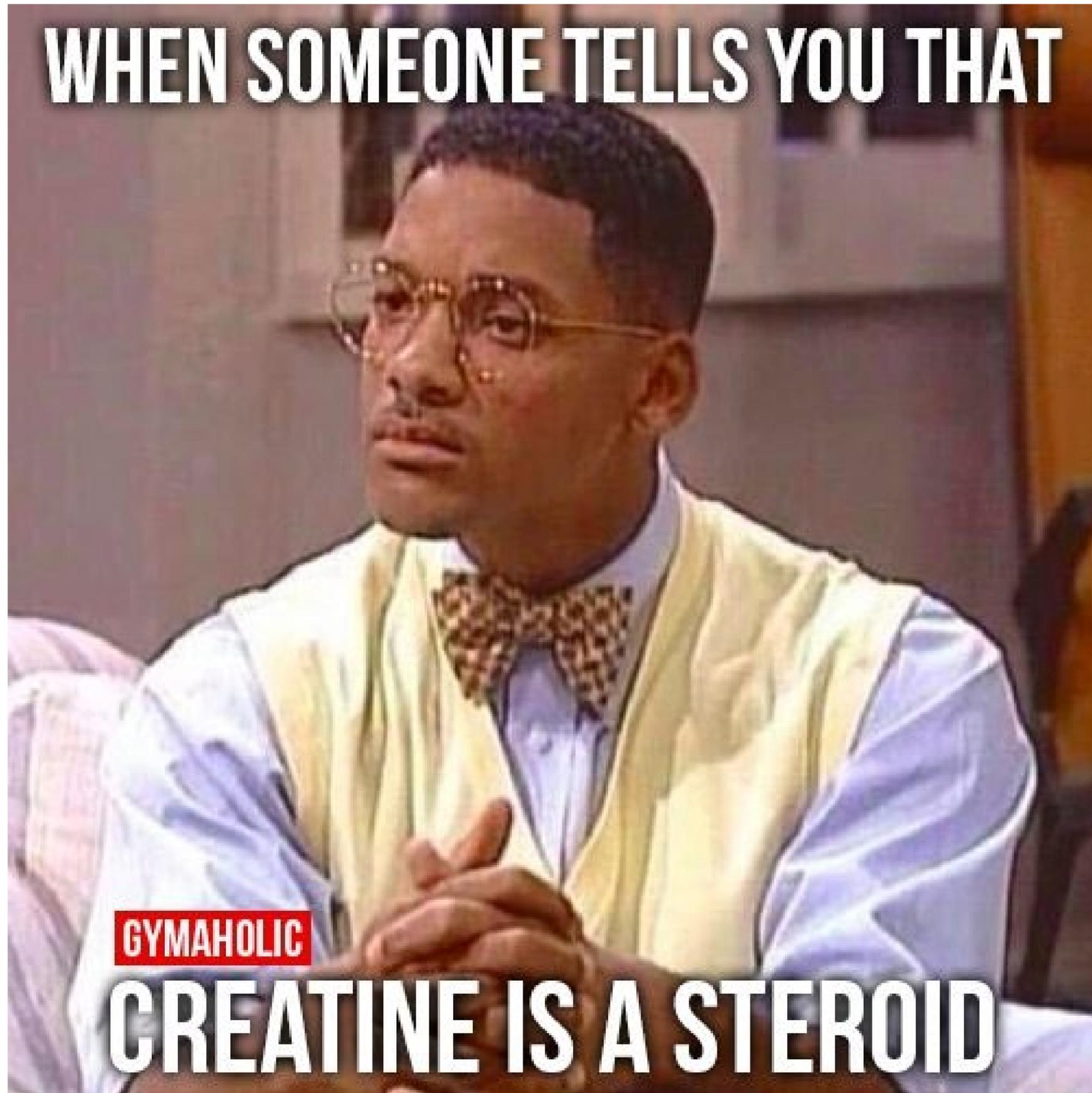
Affiliations + expand

PMID: 30086660

DOI: [10.1080/17461391.2018.1500644](#)

Free article

WHEN SOMEONE TELLS YOU THAT

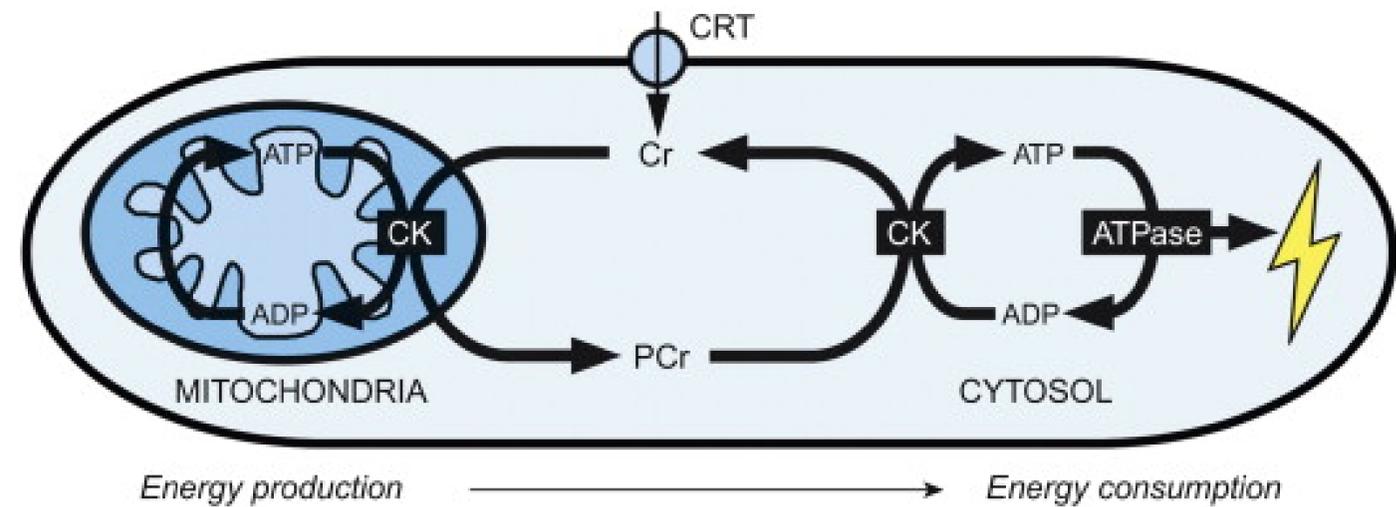


GYMAHOLIC

CREATINE IS A STEROID

Creatine

Creatine Monohydrate



- An amino acid-like compound that is used in energy metabolism to regenerate ATP.
- Ergogenic and therapeutic effects on muscle by way of creatine supplementation is well-recognized.
- Creatine is becoming a hot topic for research in the brain (TBI to Alzheimer's), heart disease, neuropathies, neurodegenerative diseases (Parkinson and Huntington's diseases) pregnancy, fibromyalgia, and complimentary to various psychiatric treatments (depression, PTSD).
- The brain has creatine (well-known) and is responsive to supplemental creatine.
 - MR Spectroscopy studies show that supplementation increases brain creatine levels.
 - Studies show that the increase in brain creatine translates to improved cognitive behavior.

Creatine, cont.

- A review of 52 studies showed that creatine supplementation reduced lactate accumulation and post-injury tissue damage.
- Studies have shown potential treatment for post concussive symptoms (Clinical trial NCT05562232).
- Profound studies showing reduction in cortical damage in rats by 50%.
- S/e: Widely used supplement with minimal side effects and no significant health risks based on prior studies with human data (hepatic, renal, cardiac).



Creatine Dosing in mTBI



- Data from MR Spectroscopy suggest
 - Loading dose 0.3g/kg/day for 7 days increases brain creatine levels.
 - ~20g/day distributed across the day
 - Maintenance 10 g/day
 - Vegans/vegetarians may require a higher maintenance dose.

Pine Bark Extract (*Pinus radiata*)

Adults

- Enzogenol
- Flavonoid with antioxidant and anti-inflammatory properties
- Shown to improve working memory in healthy adults
- Phase II RCT investigating Enzogenol in m-TBI
- Class IIB evidence that Enzogenol at 1000mg/day is well tolerated and may reduce self-perceived cognitive failures in patients 3-12 months post mild-TBI
- S/e: Headache, sleep disturbances reported



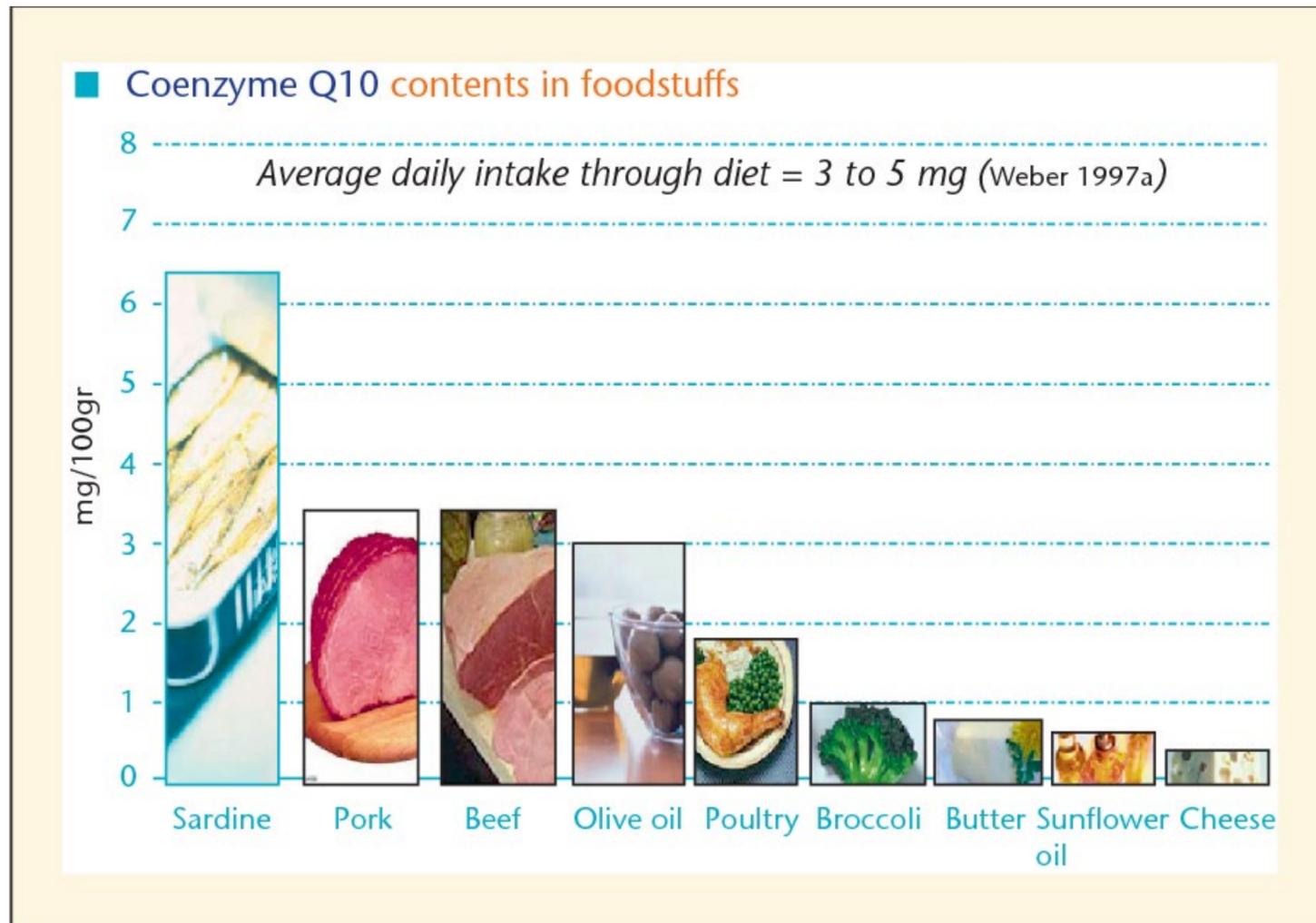
Probiotics

- Bioimmunomodulatory probiotics (*Lactobacillus reuteri*)
- Complex MOA: bind to dendritic cell-specific intracellular adhesion molecule-3 (DC-SIGN), induce proliferation of regulatory T-cells, increase production of anti-inflammatory cytokines, induce IL-10 and TGF- β production.
- Several preclinical and clinical studies suggest that there is a component of gut dysbiosis in the pathogenesis and progression of TBI complications.
- Phase 1 clinical trial (NCT02723344) studying veterans with PCS and PTSD.

Ketogenic Diet

- Impaired cerebral glucose metabolism with brain injury.
- Ketones are alternative energy substrate for the brain.
- Use as treatment adjunct in pediatric seizures, Parkinsonism, other neurological pathology.
- Macronutrient targets of > 70% fat >20% protein <10% carbohydrate
- Pilot and prospective studies with mixed results.
- In one study, participants showed non-significant improvement in ImPACT visual memory domain by 12 points and non-significant improvement in PCSS by 9 points.

Coenzyme Q10



Okamoto T, et al. Internat J Vit Nutr Res 59; 288-92; Aberg et al. Archives of Biochemistry and Biophysics and Biophysics 1992; 295: 230-4; Shindo Y, et al. J Invest Dermatol 1994; 102 : 122-4.

- Role in mitochondrial function, antioxidant and anti-inflammatory properties.
- One of the secondary injuries in TBI is the energy imbalance. Mitochondria, play a pivotal role in energy production.
 - Inflammatory cytokines, neuroinflammation.
- Decline in ATP production has been shown in TBI patients (surgical specimens, immediate post-mortem, cerebral micro dialysis).
- No clinical trials to date, but promising results in hospitalized patients with severe TBI.
- Intranasal > oral but efficacy TBD.

Nicotinamide (NAM)

Vitamine B3 Derivative

1 Tuna (Yellowfin)  234% DV (37.5mg) in a 6oz fillet 221 calories	2 Lean Chicken Breast  100% DV (16.1mg) in a 6oz breast 267 calories
3 Lean Pork Chops  85% DV (13.6mg) in a 6oz chop 332 calories	4 Beef (Skirt Steak)  60% DV (9.5mg) per 6oz steak 456 calories
5 Portabella Mushrooms  47% DV (7.6mg) per cup sliced 35 calories	6 Brown Rice  32% DV (5.2mg) per cup 248 calories
7 Peanuts (Dry Roasted)  25% DV (4.1mg) per oz 167 calories	8 Avocados  22% DV (3.5mg) per avocado 322 calories
9 Green Peas  20% DV (3.2mg) per cup cooked 134 calories	10 Sweet Potatoes  15% DV (2.4mg) per cup mashed 258 calories

- Long history of use in the treatment of stroke and ischemic brain injury.
- Rat/Mice models of TBI significantly reversed synaptic protein loss and improved memory impairments and behavioral outcomes.
- Preclinical models of mTBI have shown improved behavioral outcomes vs placebo.

What about the rest of the vitamins?

- Vitamins are nutrients that are required for normal physiologic function.
- Vitamin B1 (Thiamine) and B12 (Cobalamin) have important roles in maintaining nerve function.
 - Deficiencies —> Neuropathy
- Vitamin B2 (Riboflavin). Powerful antioxidant. In experimental models has been shown to have significant positive effects on sensorimotor function and working spatial memory. (B2+ Magnesium) >>)
- Vitamin C. Levels have been shown to be reduced immediately after TBI. Suggested neuroprotective role.



What about the rest of the vitamins?



- Vitamin D. Largely studied vitamin. Known to have neuroprotective role, assists in intestinal absorption of other vitamins/elements, role in endocrine system. Greater supplemental benefit on Vit-D deficient patients.
- May attenuate secondary injury in concussions and TBI by stabilizing excitotoxicity cascade (Saadatmand, 2021).

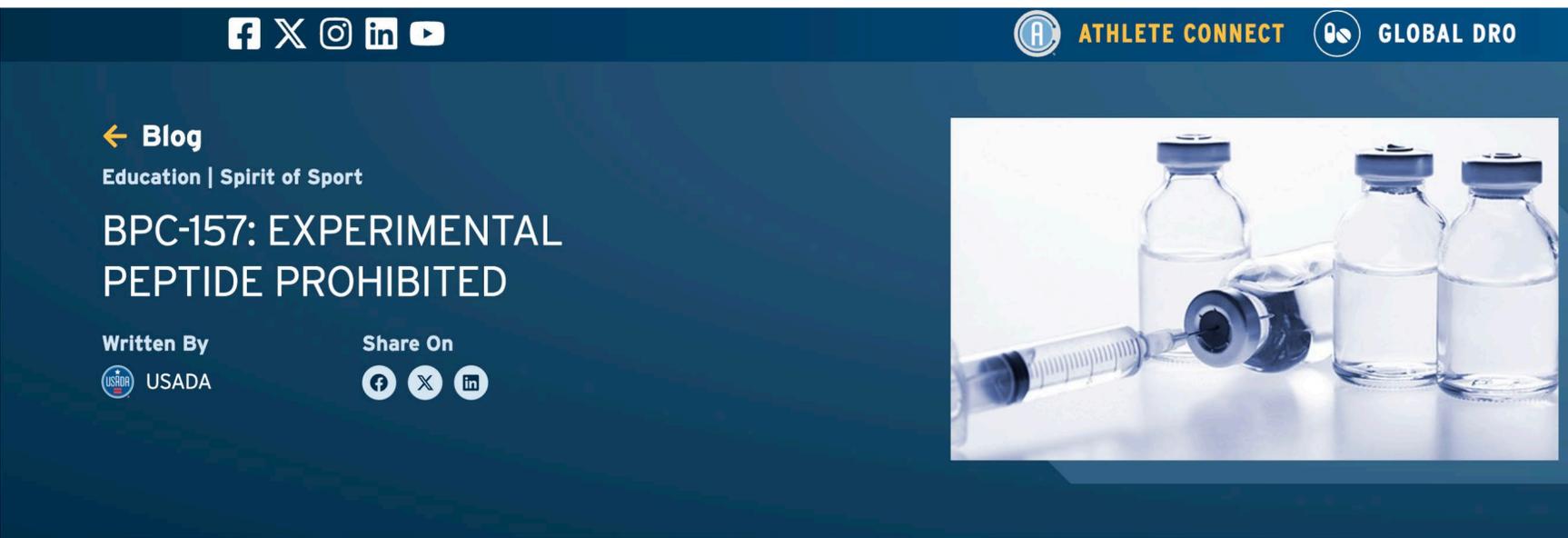
- Vitamin E. Mediates the production of oxidative free radicals. Has been shown to reduce amyloidosis and improve cognition after repetitive TBI in Alzheimer's disease model.



BPC 157?

Too soon to tell...

- No human studies.
- No human clinical safety data.
- Mice studies show marked attenuation of damage with improved early outcome in TBI models.
- Effects on CNS?
 - Studies show positive effects on dopamine disturbances, schizophrenia, spinal cord injury, vascular occlusion disturbances (stroke).
- Other studies show enhanced cell survival, cell migration, accelerated soft tissue healing, etc.



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Education | Spirit of Sport
BPC-157: EXPERIMENTAL PEPTIDE PROHIBITED

Written By
USADA

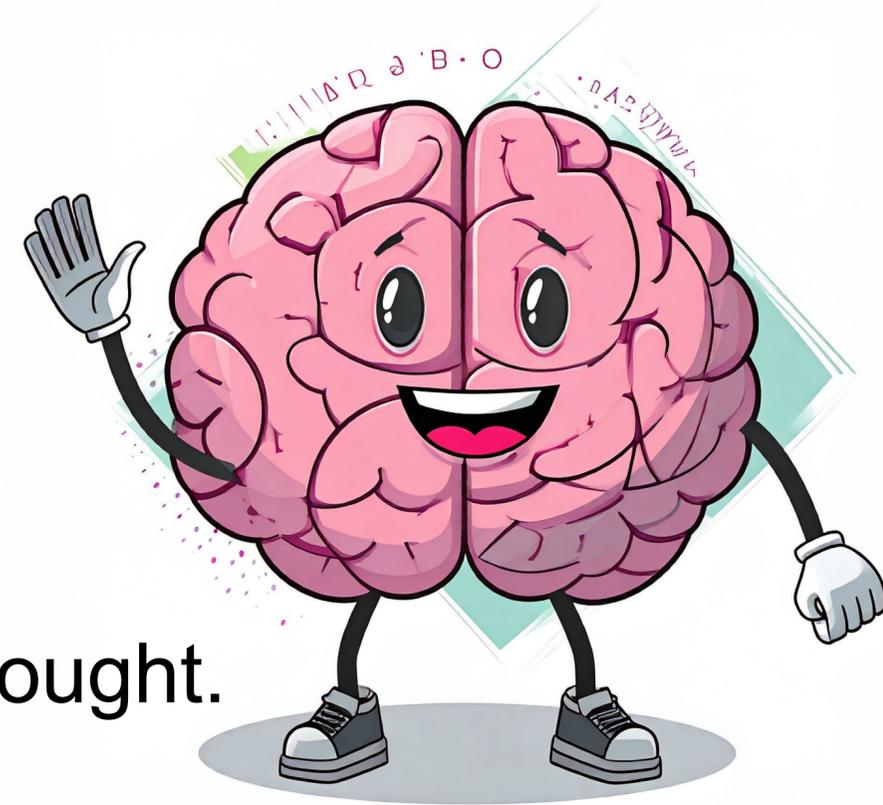
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The experimental peptide BPC-157 is prohibited under the World Anti-Doping Agency (WADA) Prohibited List in the category of SO Unapproved Substances. Furthermore, this substance is not approved for human clinical use by any global regulatory authority and it may lead to negative health effects.

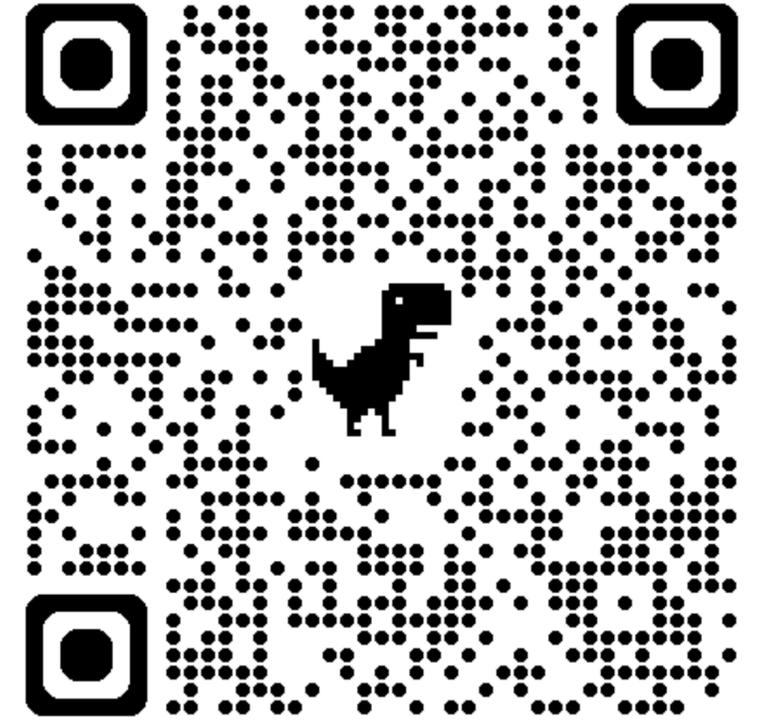
In Summary...

- Concussions are a form of traumatic brain injury.
- The injury may lie deeper (think thalamus) than we once thought.
- Not all concussions are the same, and our response may be different with each concussion.
- Early treatment is the best treatment.
- Exercise is medicine and start 24-48 hours!
- Supplemental support: Fish Oil, Magnesium, BCAAs, Super B Complex, Creatine, amongst others.



Citations

- See Pub Med Collection for full list:
<https://www.ncbi.nlm.nih.gov/sites/myncbi/daniel.scura.1/collections/66494532/public/>



Thank you for your time, attention,
and willingness to learn.