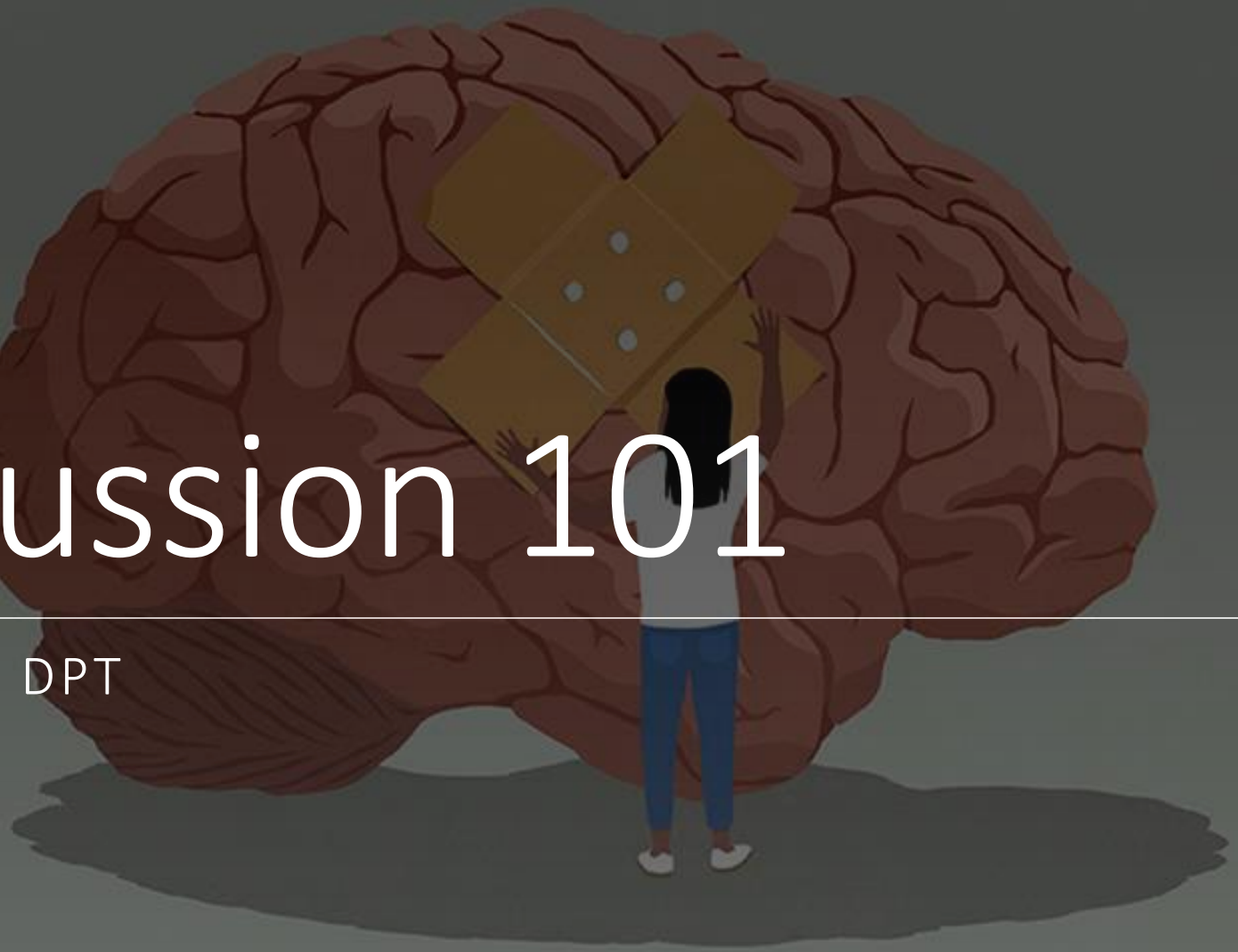
Concussion 101

TRAY RUSH PT, DPT



INSTITUTE OF ADVANCED MUSCULOSKELETAL TREATMENTS

Concussion Management

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What is a concussion?

2022 Amsterdam
Concussion
Consensus Conference

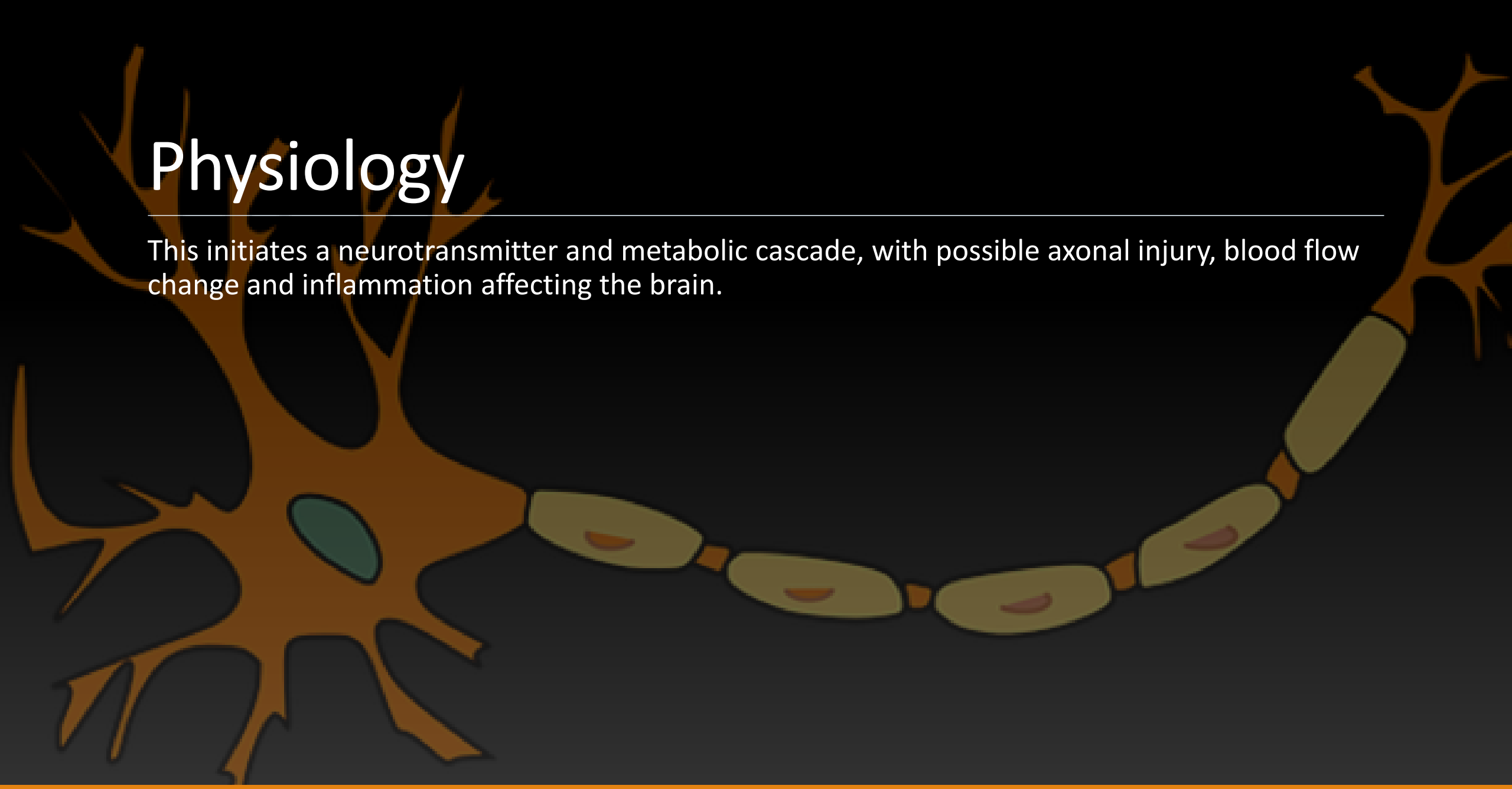
- Biomechanics
- Physiology
- Timeline
- Neuroimaging
- Clinical Symptoms

Biomechanics

Sport-related concussion is a traumatic brain injury caused by a direct blow to the head, neck or body resulting in an impulsive force being transmitted to the brain that occurs in sports and exercise-related activities.

Physiology

This initiates a neurotransmitter and metabolic cascade, with possible axonal injury, blood flow change and inflammation affecting the brain.



Timeline

Symptoms and signs may present immediately, or evolve over minutes or hours, and commonly resolve within days, but may be prolonged.

Neuroimaging

No abnormality is seen on standard structural neuroimaging studies (computed tomography or magnetic resonance imaging T1- and T2-weighted images), but in the research setting, abnormalities may be present on functional, blood flow or metabolic imaging studies.

Clinical Symptoms

- Sport-related concussion results in a range of clinical symptoms and signs that may or may not involve loss of consciousness.
- The clinical symptoms and signs of concussion cannot be explained solely by (but may occur concomitantly with) drug, alcohol, or medication use, other injuries (such as cervical injuries, peripheral vestibular dysfunction) or other comorbidities (such as psychological factors or coexisting medical conditions).

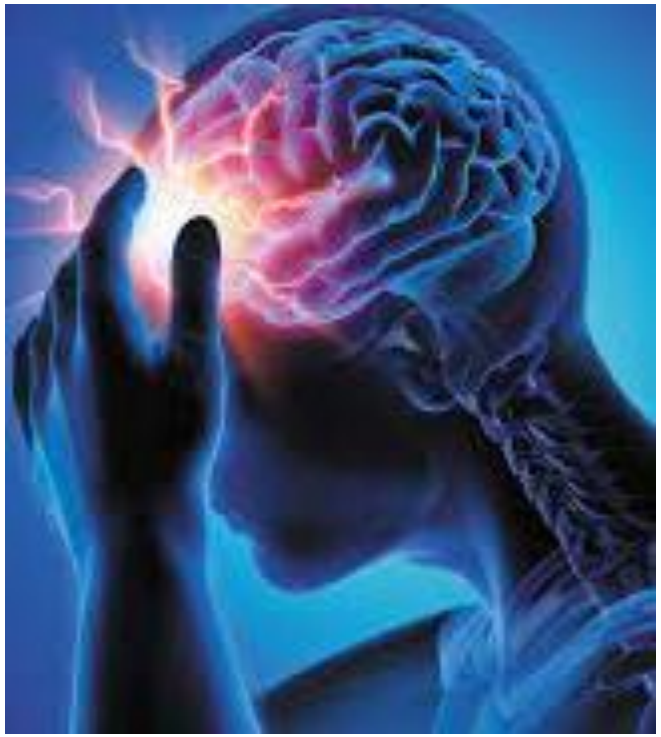
Playing through it: Delayed reporting and removal from athletic activity after concussion predicts prolonged recovery, JAT, 2016

Asken, McCrea, Clugston, Snyder, Houck, Bauer

- 51% of 97 athletes did not immediately report concussion symptoms and reported a 4.9 day increase in recovery compared to those who did.
- Indicate 30-50% of concussions go unreported by athletes

Removal From Play After Concussion and Recovery Time, Pediatrics, 2016

Elbin, Sufrinko, Schatz, French, Henry, Burkhart, Collins, Kontos



- Players who played through concussion symptoms typically reported: lower verbal memory, visual memory, processing speed, and higher symptom scores
- Players who continued to play were 8x more likely to have protracted recovery (≥21 days)

24-48 Hours: Active Recovery

- Best practice:
  - Relative rest during first 48 hours (not strict)
  - Introduction of ADLs
  - Light physical activity
  - Advice to reduce screen time.

Table 2 Return-to-sport (RTS) strategy—each step typically takes a minimum of 24 hours

Step	Exercise strategy	Activity at each step	Goal
1	Symptom-limited activity	Daily activities that do not exacerbate symptoms (eg, walking).	Gradual reintroduction of work/school
2	Aerobic exercise **2A—Light** (up to approximately 55% maxHR) **then** **2B—Moderate** (up to approximately 70% maxHR)	Stationary cycling or walking at slow to medium pace. May start light resistance training that does not result in more than mild and brief exacerbation* of concussion symptoms.	Increase heart rate
3	Individual sport-specific exercise Note: If sport-specific training involves any risk of inadvertent head impact, medical clearance should occur prior to Step 3	Sport-specific training away from the team environment (eg, running, change of direction and/or individual training drills away from the team environment). No activities at risk of head impact.	Add movement, change of direction
Steps 4–6 should begin after the resolution of any symptoms, abnormalities in cognitive function and any other clinical findings related to the current concussion, including with and after physical exertion.			
4	Non-contact training drills	Exercise to high intensity including more challenging training drills (eg, passing drills, multiplayer training) can integrate into a team environment.	Resume usual intensity of exercise, coordination and increased thinking
5	Full contact practice	Participate in normal training activities.	Restore confidence and assess functional skills by coaching staff
6	Return to sport	Normal game play.	

*Mild and brief exacerbation of symptoms (ie, an increase of no more than 2 points on a 0–10 point scale for less than an hour when compared with the baseline value reported prior to physical activity). Athletes may begin Step 1 (ie, symptom-limited activity) within 24 hours of injury, with progression through each subsequent step typically taking a minimum of 24 hours. If more than mild exacerbation of symptoms (ie, more than 2 points on a 0–10 scale) occurs during Steps 1–3, the athlete should stop and attempt to exercise the next day. Athletes experiencing concussion-related symptoms during Steps 4–6 should return to Step 3 to establish full resolution of symptoms with exertion before engaging in at-risk activities. Written determination of readiness to RTS should be provided by an HCP before unrestricted RTS as directed by local laws and/or sporting regulations.

HCP, healthcare professional; maxHR, predicted maximal heart rate according to age (ie, 220-age).

Clinical Risk Score for Persistent Postconcussion Syndrome [22]

Age	Risk Points
5-7	0
8-12	1
13-<18	2
Sex	
Male	0
Female	1
Bess Errors	
0-3	0
≥4	1

Headache	Risk Points
No	0
Yes	1
Sensitivity to Noise	
No	0
Yes	1
Fatigue	
No	0
Yes	2

Prior Concussion Symptom Duration	Risk Points
No prior concussion or symptoms lasting <1 wk	0
Prior concussion symptoms lasting ≥1 wk	1
Physician Diagnosed Migraine history	
No	0
Yes	1
Answering Questions Slowly	
No	0
Yes	1

Scoring [5]

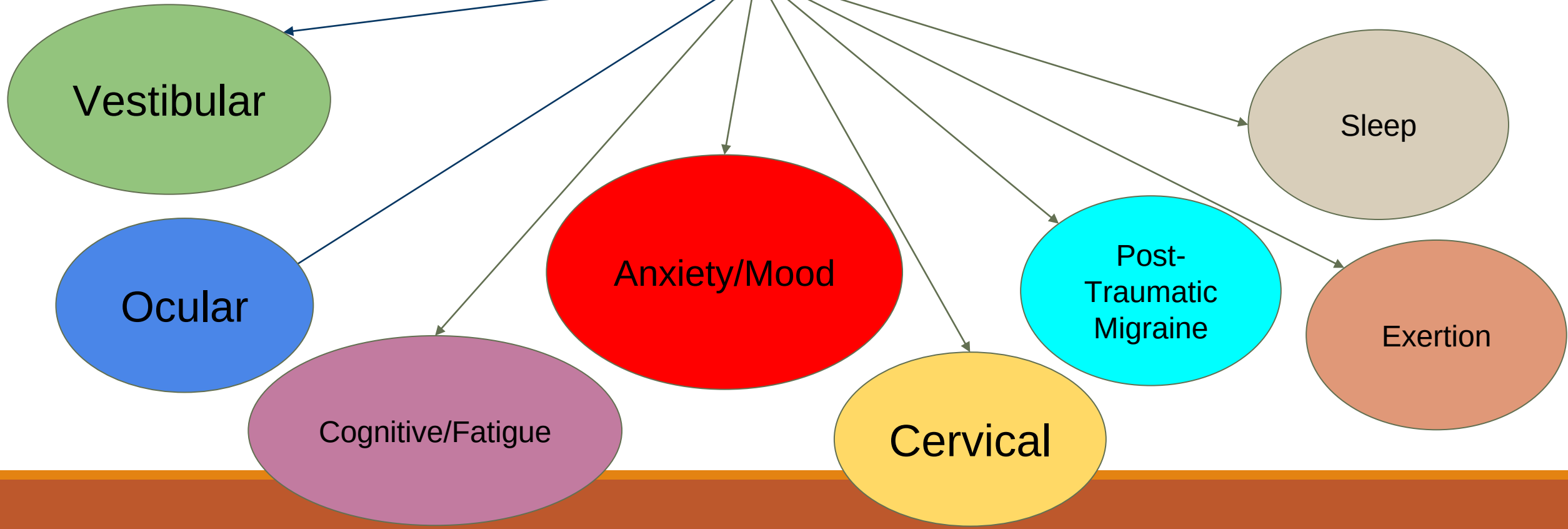
- The only validated study to predict persistent post concussion symptoms at this time (CDC, 2018)
- Persistent post concussion syndrome was defined by this study as symptoms persisting 28 days or longer.
- Validated for ages 5-18 years.

PPSC Risk Category	Total Number of Risk Points	Estimated Risk of PPSC %
Low Risk	0	4.1%
	1	5.8%
	2	8.3%
	3	11.8%
Medium Risk	4	16.4%
	5	22.3%
	6	29.7%
	7	38.2%
	8	47.6%
High Risk	9	57.12%
	10	66.1%
	11	74.1%
	12	80.8%

Exposure Stage: Day 2-10

- Concussion symptom exacerbation is brief, does not delay recovery and should not prevent resumption of activity/exercise after brief relative rest.
- Physical activity and prescribed aerobic exercise can be progressed systematically according to the degree of symptom exacerbation experienced during serial bouts of activity/exercise.
  - Clinicians with access to exercise testing can prescribe targeted HR aerobic exercise treatment based on 90% of the individual's HRt at the more-than-mild (>2/10) symptom exacerbation point.
- Individuals should be advised to avoid risk of repeat head injury until they are medically released.

Concussion Profiles



CP Screen

C

CP SCREEN SCORING SHEET

None= 0, Mild= 1, Moderate= 2, Severe= 3

PROFILE SCORES:

	RAW		AVERAGE
ANXIETY/MOOD (Items 1, 5, 10, 26, 29)=	_____	÷5=	_____
COGNITIVE/FATIGUE (Items 13, 24, 28)=	_____	÷3=	_____
MIGRAINE (Items 2, 6, 11, 20, 27)=	_____	÷5=	_____
OCULAR (Items 3, 7, 8, 14, 19)=	_____	÷5=	_____
VESTIBULAR (Items 4, 9, 12, 15, 21)=	_____	÷5=	_____

MODIFIER SCORES:

	RAW		AVERAGE
SLEEP (Items 17, 18, 22, 23)=	_____	÷4=	_____
NECK (Items 16, 25)=	_____	÷2=	_____

CP SCREEN TOTAL RAW SCORE= _____

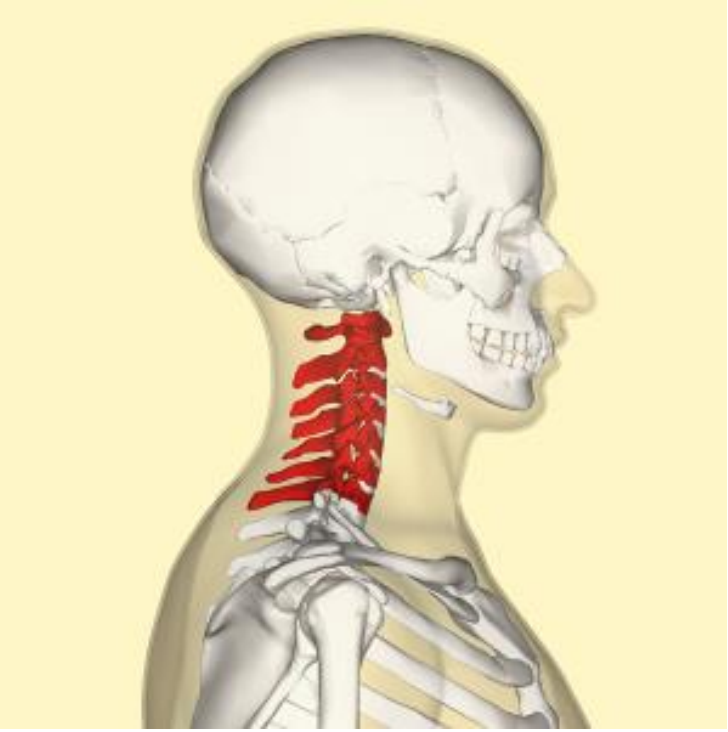
FIGURE 1. *Continued*

Symptom	*Please indicate your symptom severity below:*			
1. *Feeling sad*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
2. *Headache when you wake up*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
3. *Difficulty or headache when looking at a phone or computer screen*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
4. *Dizziness when you move your head*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
5. *Difficulty turning off your thoughts (e.g., rumination)*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
6. *Headache with nausea or upset stomach*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
7. *Trouble focusing your eyes while reading*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
8. *Frontal headache*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
9. *Difficulty or discomfort in busy environments*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
10. *Constantly thinking about your symptoms*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
11. *Headache with sensitivity to light or noise*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
12. *Feeling motion sick ("sea or car sick")*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
13. *Feeling more tired at the end of the day*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
14. *Blurry or double vision*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
15. *Feeling or sensation of slow wavy dizziness (i.e., lightheadedness)*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
16. *Neck pain or stiffness*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
17. *Sleeping more than usual*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
18. *Sleeping less than usual*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
19. *Eye strain (eyes feel tired) during visual activities*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
20. *Visual aura (e.g., flashes, stars, spots, flickering light) with or without headache*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
21. *Feeling or sensation of fast spinning dizziness (i.e., vertigo)*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
22. *Difficulty falling asleep*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
23. *Difficulty staying asleep*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
24. *Trouble remembering things (e.g., what you completed today or having to re-read information)*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
25. *Difficulty moving your neck*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
26. *Feeling nervous or anxious*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
27. *Increased headache following physical activity*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
28. *Increased headache following cognitive activity*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**
29. *Feeling more stressed than usual*	☐ **None** (Not Experiencing This Symptom)	☐ **Mild**	☐ **Moderate**	☐ **Severe**

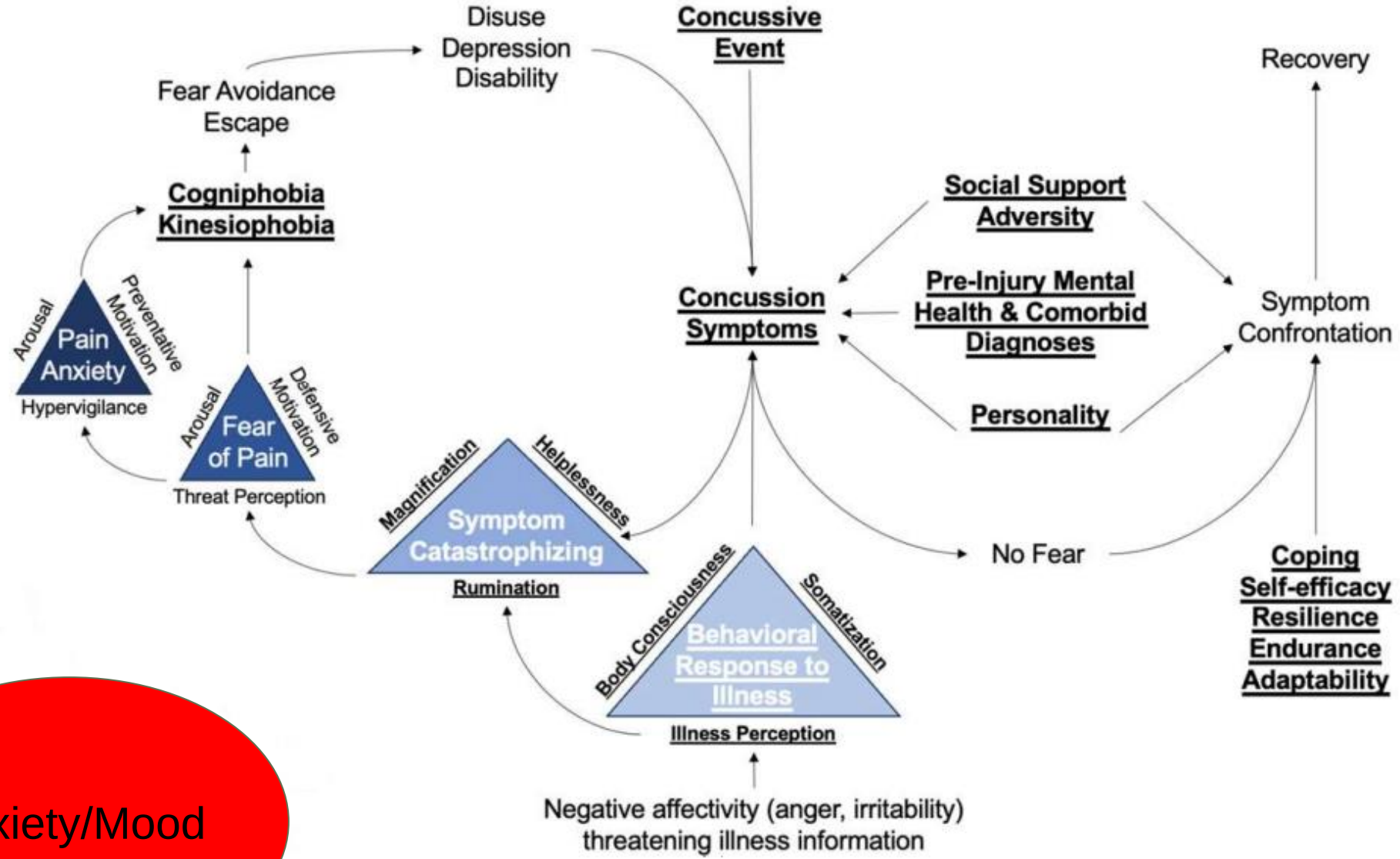
Australian Guidelines for Management of Acute Whiplash Associated Disorders

- These should be used as first line treatment for acute WAD.
  - Reassure and stay active.
  - Return to usual activities.
  - Range of motion, low load isometric, postural endurance and strengthening exercises

Cervical



The Fear Avoidance Model for Persisting Symptoms after Concussion



Anxiety/Mood

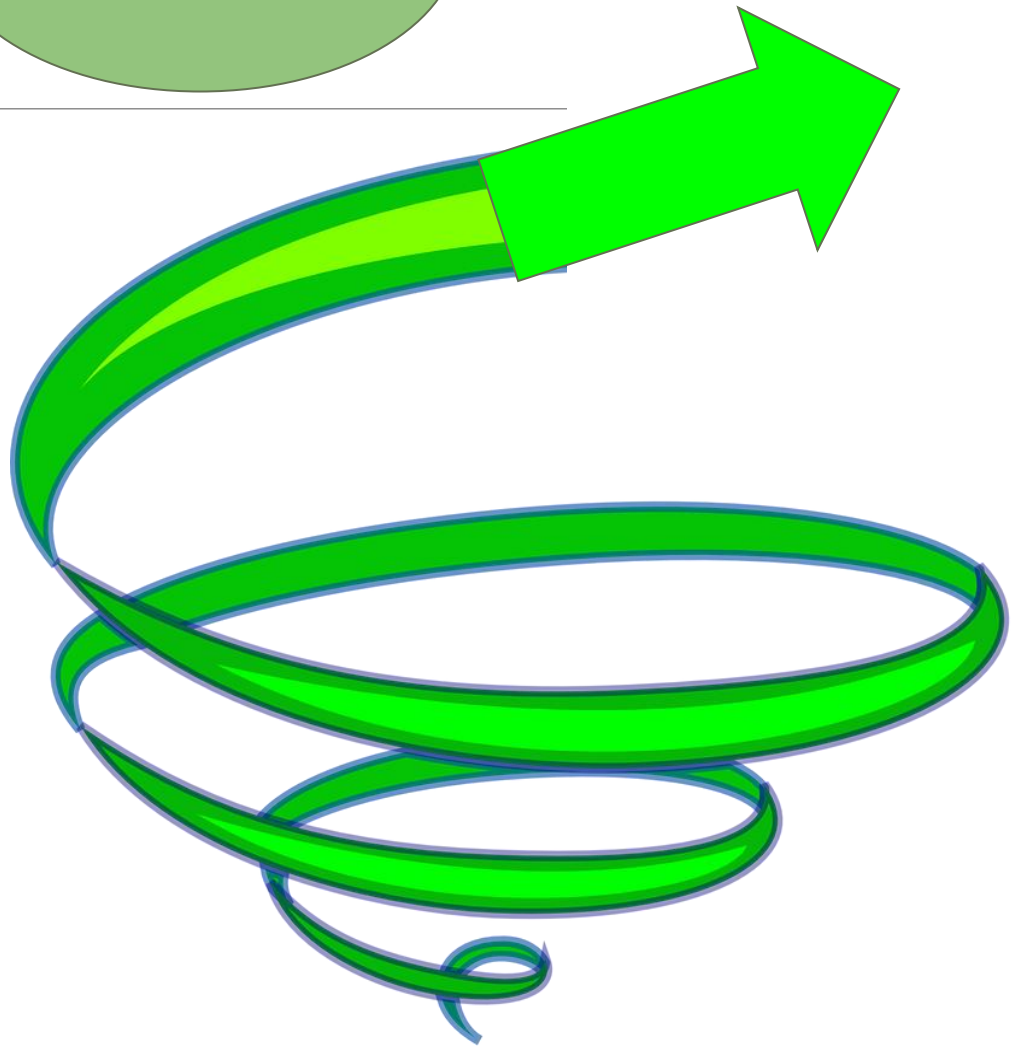
Anxiety and Dizziness

Vestibular

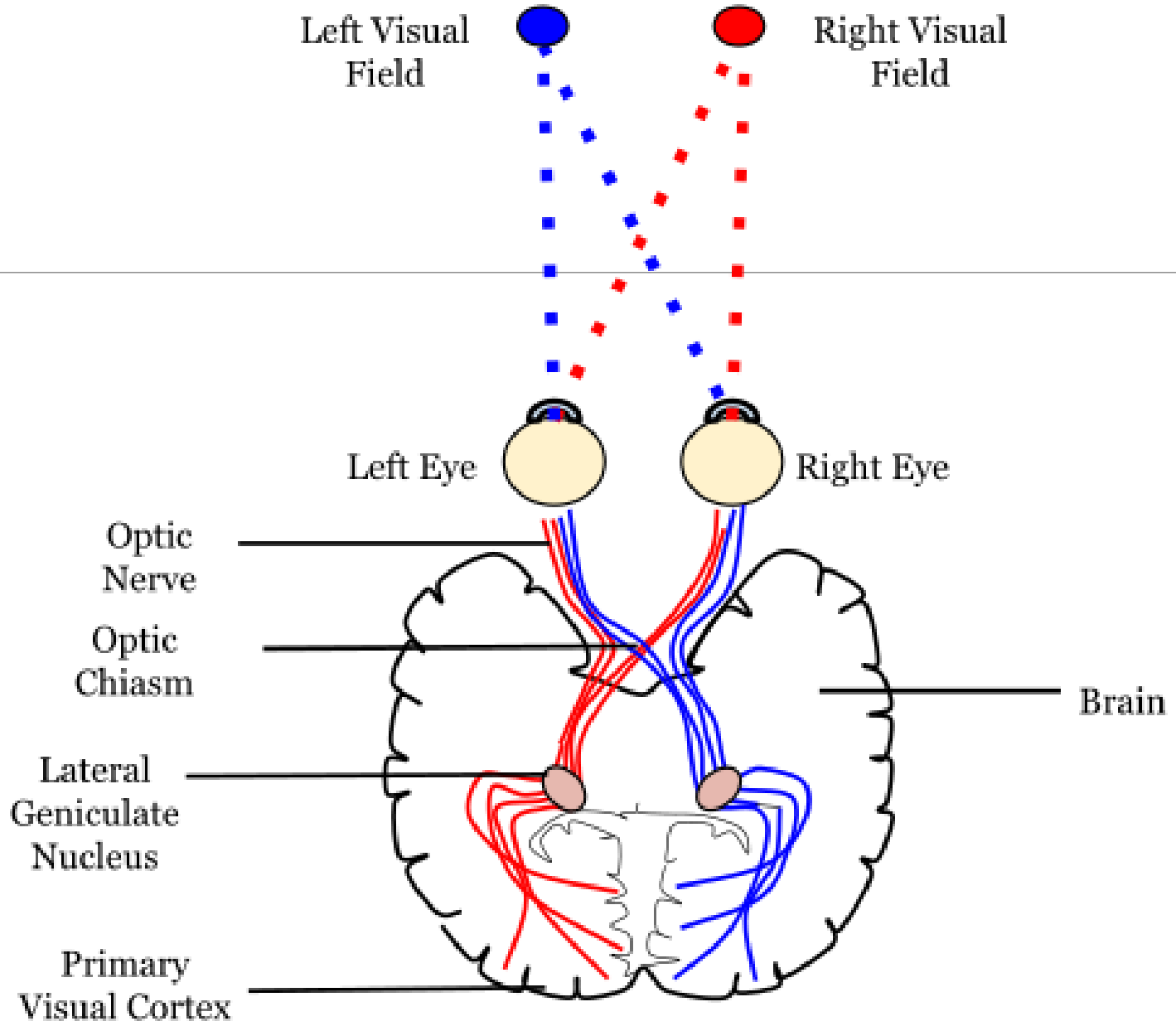
Neurological bases for balance-anxiety links, J Anxiety Disord, 2001.

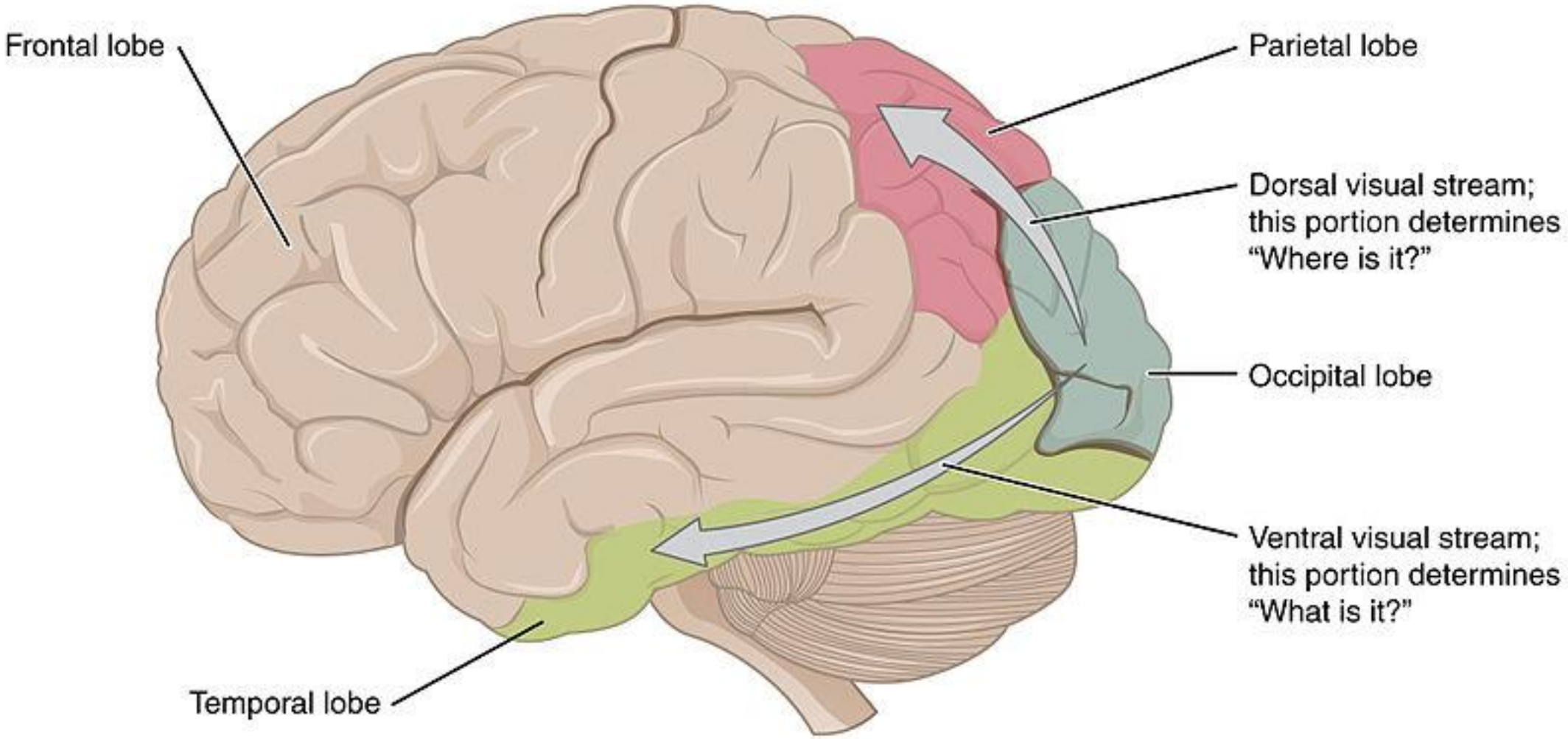
Balaban, Thayer

- " The parabrachial nucleus is a site of convergence of vestibular information processing and somatic and visceral sensory information processing in pathways that appear to be involved in avoidance conditioning, anxiety, and conditioned fear."



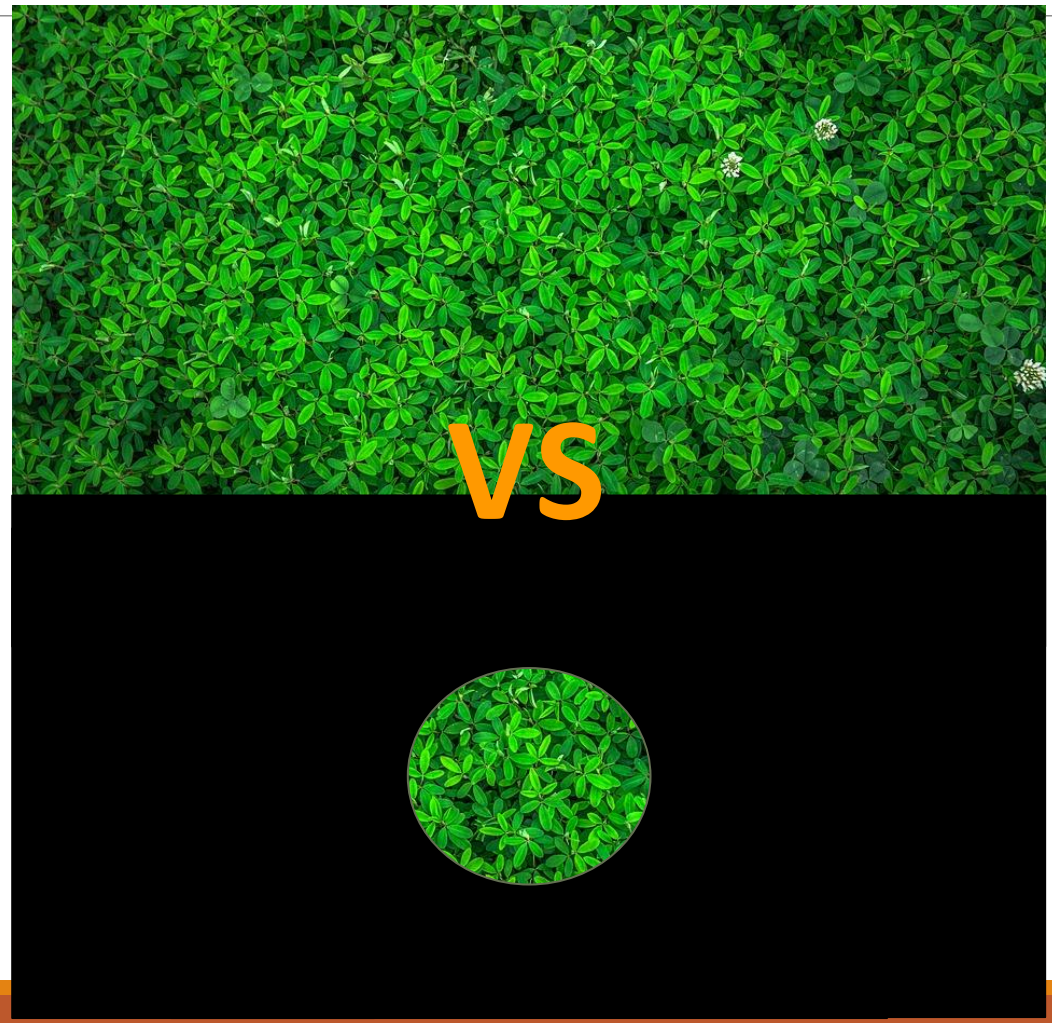
Ocular


Left Visual Field
Right Visual Field
Left Eye
Right Eye
Optic Nerve
Optic Chiasm
Lateral Geniculate Nucleus
Primary Visual Cortex
Brain


Frontal lobe
Parietal lobe
Dorsal visual stream;
this portion determines
"Where is it?"
Occipital lobe
Ventral visual stream;
this portion determines
"What is it?"
Temporal lobe

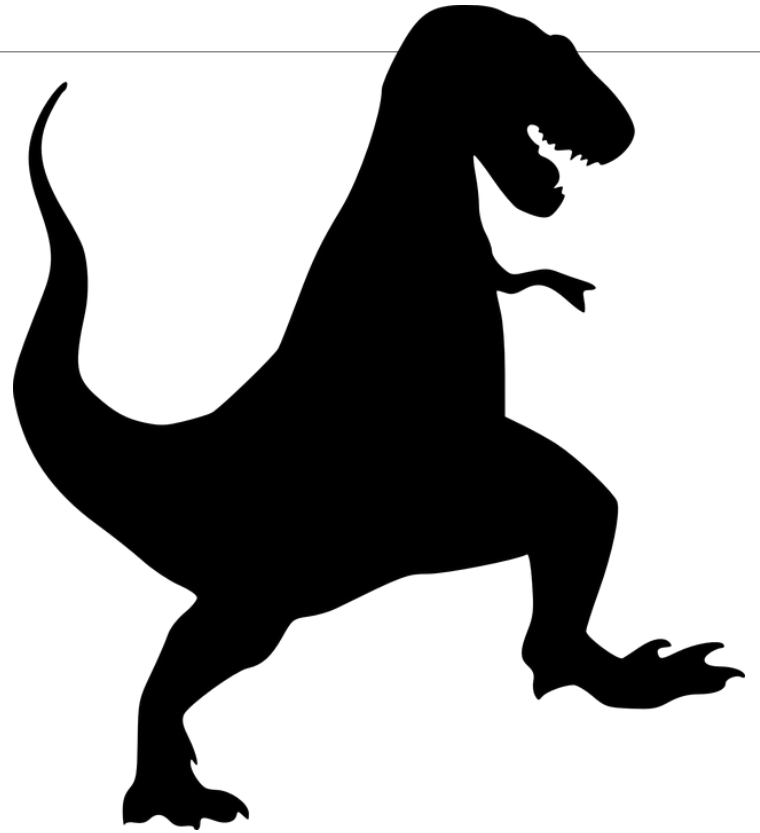
Parvocellular Pathway (Ventral visual stream)

- What is it?
  - Identification and classification of objects, color and detail.
- Transfers from the Occipital Lobe to the temporal lobe
- Slower process
- Tightly focused with hyper detail

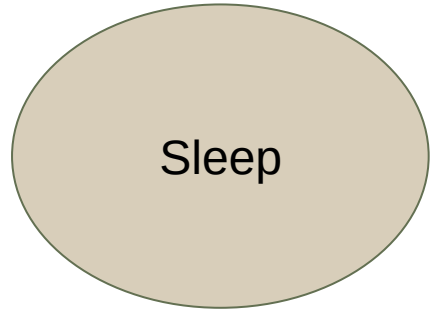


Magnocellular Pathway (Dorsal visual stream)

- Where is it?
  - peripheral awareness, motion detection, and location of objects
- Transfers from occipital lobe to parietal lobe
- Faster process (preconscious)
- More movement based with less detail



Unstable Ambient Vision (Magnocellular)



Concussion and Sleep

- An estimated 30-70% of TBI patients report difficulty sleeping in the first few weeks.
- Hypersomnia is likely present in 25% of TBI patients within the first few days after injury
- Insomnia symptoms are reported in 30% of people with TBI
- Circadian Rhythm Shifts – present in approximately 36% of those in the post-acute stage.
- 43-73% report fatigue

Concussion and Sleep cont.

- Insomnia after concussion can persist 2-3 years after injury.
- Concussion patients tend to note greater incident of sleep disturbance compared to mod-severe TBI
- Sleep disturbance in the 10 days after concussion is associated with an increased risk of persisting symptoms (>4 weeks).

Factors Associated with Symptom reporting in U.S. Service academy cadets and NCAA student athletes without concussion (2021)

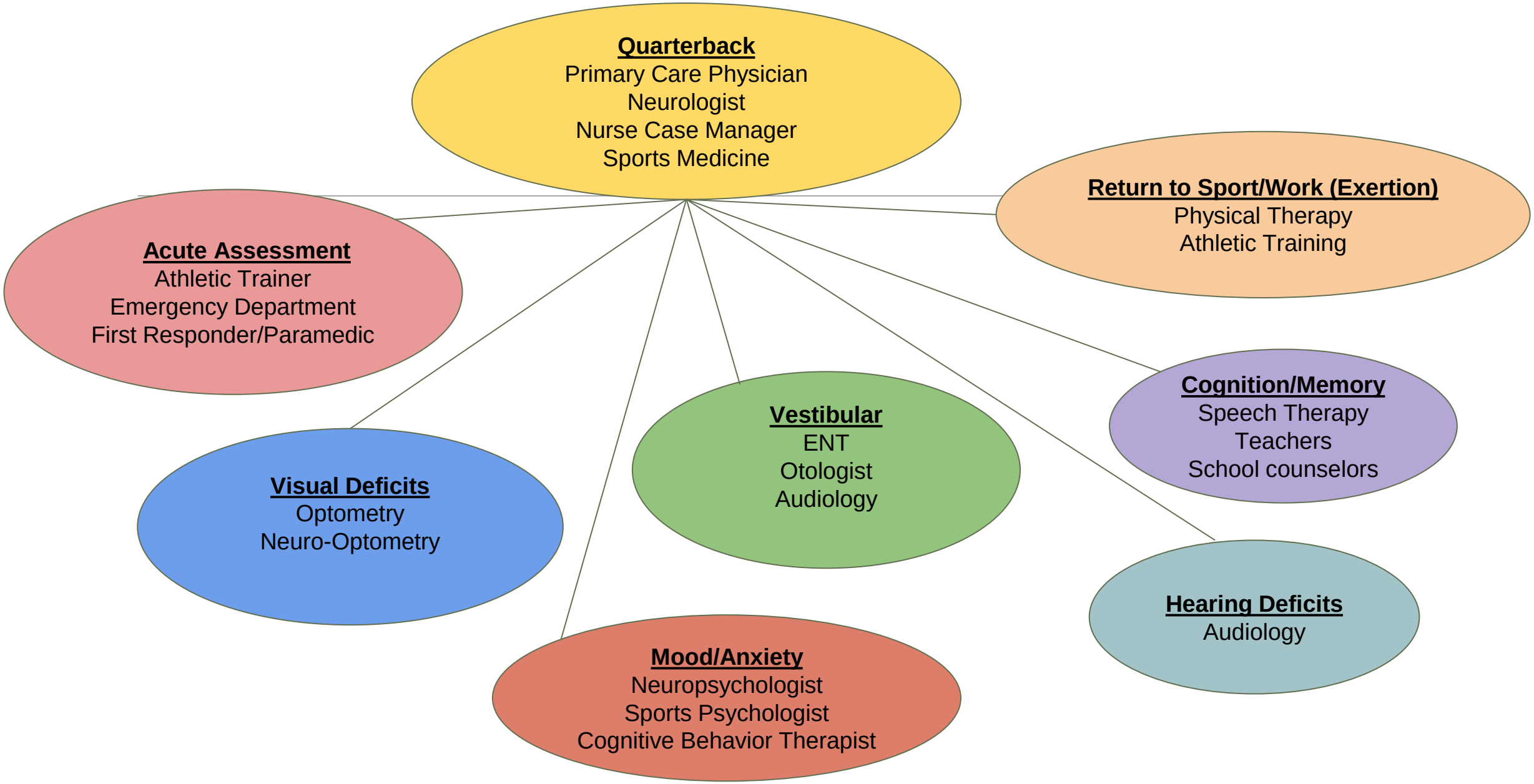
- 12,039 cadets and 18,5498 student athletes
- Administered SCAT-3 symptoms evaluation for baseline preseason and/or boot camp testing.
- ICD-10 symptom criteria for postconcussional syndrom e can be mimicked by pre-existing conditions, **insufficient sleep**, and/or stress.

Day 10+: Physical Therapy

- Amsterdam Recommendations
  - Cervicovestibular rehabilitation is recommended if dizziness, neck pain and/or headaches last longer than 10 days.

Day 28: “Persistent” Symptoms

- Amsterdam Recommendations
  - A multimodal clinical assessment, ideally by a multidisciplinary team is indicated to characterize individuals with persisting symptoms
  - Active rehabilitation and collaborative care may be necessary after 4 weeks.


Quarterback
Primary Care Physician
Neurologist
Nurse Case Manager
Sports Medicine
Return to Sport/Work (Exertion)
Physical Therapy
Athletic Training
Acute Assessment
Athletic Trainer
Emergency Department
First Responder/Paramedic
Cognition/Memory
Speech Therapy
Teachers
School counselors
Vestibular
ENT
Otologist
Audiology
Visual Deficits
Optometry
Neuro-Optometry
Hearing Deficits
Audiology
Mood/Anxiety
Neuropsychologist
Sports Psychologist
Cognitive Behavior Therapist

Increased Risk of Further Injury

- Collegiate athletes who suffered a concussion possessed a 58% greater risk of sustaining a lower extremity musculoskeletal injury compared to those who did not.
  - Especially during the first 90 days.
- Re-evaluation of movement quality after clearance to return to play may be helpful in reducing lower extremity injury risk.
- Several systems may be affected:
  - Processing,
  - Motor coordination at high levels
  - Previous lower body injuries
  - Degradation of sensory inputs
  - Reduced speed of response to stimulus

References

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