

Optometry in the Game: Putting Primary Care ODs on the Concussion Starting Lineup

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Disclosures

Course contributor and Advisory Board Member of Complete Concussions

All relevant relationships have been mitigated.

Concussion Definition

A concussion is a type of traumatic brain injury—or TBI—caused by a bump, blow, or jolt to the head or by a hit to the body that causes the head and brain to move rapidly back and forth.

This sudden movement can cause the brain to bounce around or twist in the skull, creating chemical changes in the brain and sometimes stretching and damaging brain cells.

- Centers for Disease Control and Prevention

Prevalence of Concussion

Data from the National Health Interview Survey – CDC:

- In 2020, **6.8%** of children aged 17 years and under experienced symptoms of a concussion or brain injury.
- The percentage of children aged 17 years and under who had ever had a diagnosis of a concussion or brain injury by a health care provider was **3.9%**.

Statistics Canada: 2022

- Sports related: 1 in 4 (24%), and 2 in 3 (63%) youth age 12-17
- Household chores: 1 in 7 (16%)
- Motor vehicle accident: 1 in 10
- Work related: 8%
- Falls: 2/3 of reported concussions - seniors (86%), 12-17 and 18-49 (52%)

Prevalence of Concussion

- 200,000 Ontarians experience a concussion each year (Brain Injury Canada)
- Approximately 85% recover after approximately 2-4 weeks, however...
- Recovery longer if:
 - Pre-existing history: ADHD, anxiety, depression, migraine, motion sickness
 - Injury occurrence during late Luteal phase for females
 - Prior history of unresolved concussion or shorter time between concussions
 - Delay in treatment

Concussion and Sport

Fister et al, 2020 (youth and adolescent athletes)

Rates per 1000 AE:

Rugby: 4.18

Ice hockey: 1.20

American football: 0.53

Lacrosse: 0.24

Soccer: 0.23

Wrestling: 0.17

Basketball: 0.13

Softball / field hockey: ~0.10

Baseball: 0.06

Volleyball: 0.03

Cheerleading: 0.07

Females > Males

Soccer

Basketball

Females = Males

Baseball / softball

Ice hockey

Lacrosse

Swimming/diving

Track and field

(Cheng et al. 2019)

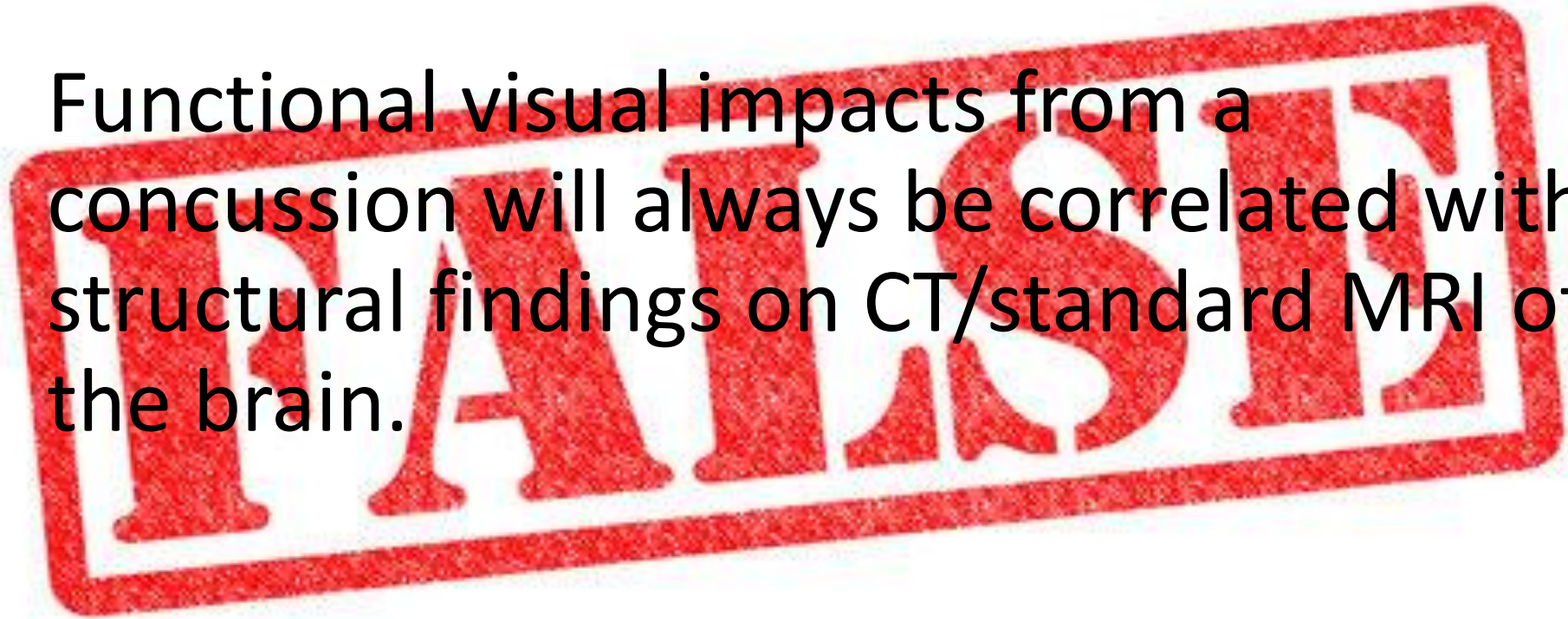


› [Med Hypotheses](#). 2017 Mar;100:10-14. doi: 10.1016/j.mehy.2016.12.016. Epub 2017 Jan 5.

Lack of eye discipline during headers in high school girls soccer: A possible mechanism for increased concussion rates

Joseph F Clark ¹, Hagar T Elgendy-Peerman ², Jon G Divine ², Robert E Mangine ³,
Kimberly A Hasselfeld ², Jane C Khoury ⁴, Angelo J Colosimo ²

Functional visual impacts from a concussion will always be correlated with structural findings on CT/standard MRI of the brain.



The appropriate protocol for an acute concussion is to rest in a dark room with no activity for 7 days.




Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport–Amsterdam, October 2022

- “Relative rest” immediately (from sport or cognitive activity)
- Light physical activity (e.g. walking) may begin within 24-48 hours, provided it does not worsen symptoms.
- Cognitive exertion (screens, schoolwork), advised to be reduced, but not entirely eliminated as long as tolerated.

Concussion Metabolics

- In TBI, shear forces cause a primary insult to neurons, axons, glia and blood vessels; this initial damage activates a wave of metabolic and inflammatory cascades (Lyons et al., 2024)

► [Neurosurgery](#). Author manuscript; available in PMC: 2015 Jun 24.

Published in final edited form as: [Neurosurgery](#). 2014 Oct;75(0 4):S24–S33. doi: [10.1227/NEU.0000000000000505](https://doi.org/10.1227/NEU.0000000000000505) 

The New Neurometabolic Cascade of Concussion

[Christopher C Giza](#)^{1,2,3,4}, [David A Hovda](#)^{1,2,3,4}

- Potassium efflux and calcium and sodium influx
- Glutamate release
- Energy crisis – ATP pumps go into overdrive
- Reduced cerebral blood flow
- Neuroinflammation – activation of microglia
- Leaky gut, mitochondrial dysfunction (Howell et al, 2021)

Concussion Systemic Impacts

Original Investigation | Neurology

Association of Traumatic Brain Injury With the Risk of Developing Chronic Cardiovascular, Endocrine, Neurological, and Psychiatric Disorders

Saef Izzy, MD^{1,2}; Patrick M. Chen, MD^{1,2}; Zabreen Tahir, MD¹; [et al](#)

Prospective longitudinal cohort study, 55% M, 45% F, ages 18-40, 41-60, >60 years

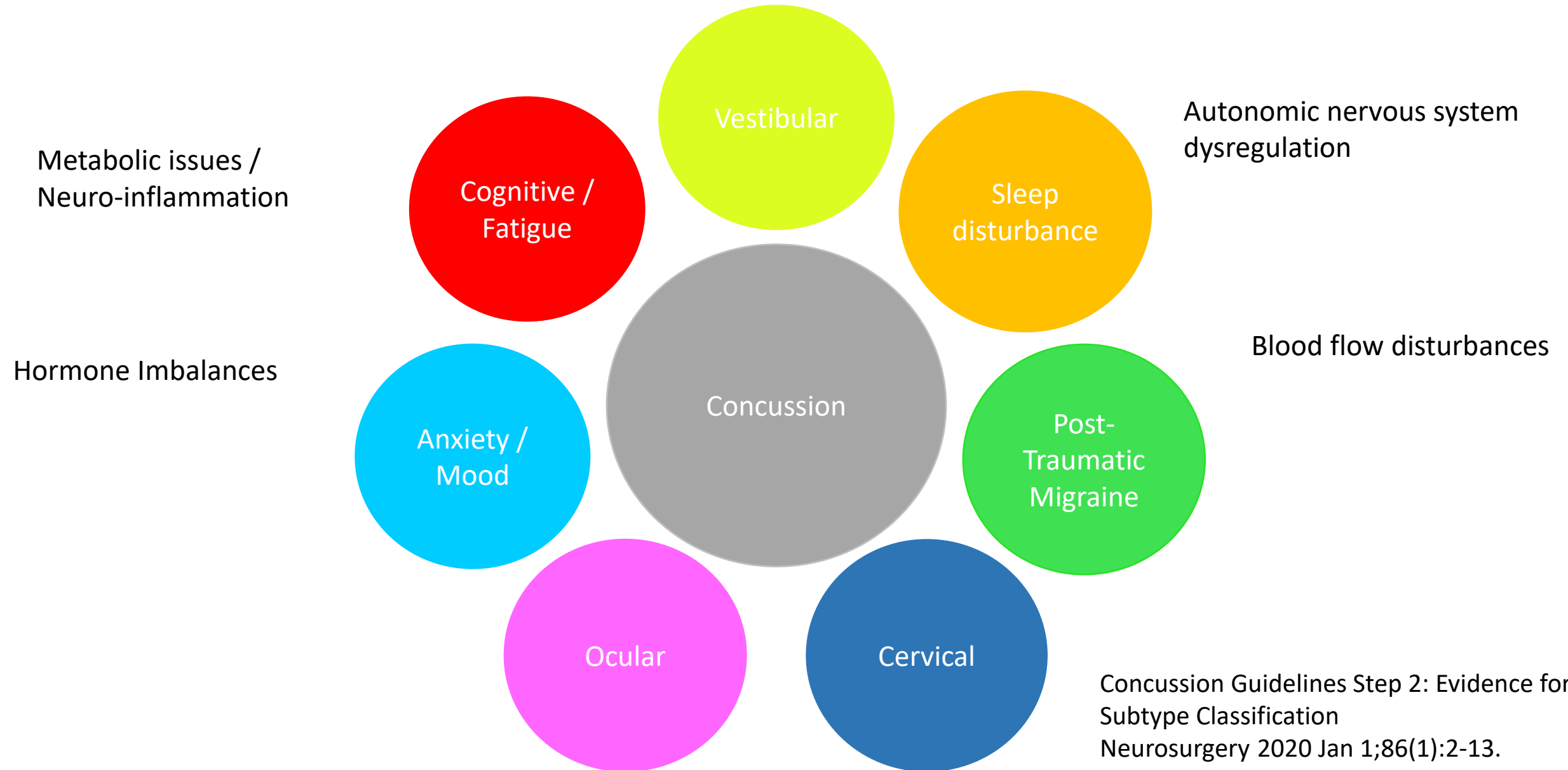
Increased risk (mild and moderate/severe TBI after 3 years):

18-40: Hypertension, diabetes, hyperlipidemia, post-traumatic seizures, psychiatric disorders

41-60: Ischemic stroke, TIA

>60: cardiovascular and neuropsychiatric disorders, significantly greater anxiety disorder

Concussion Trajectories



A close-up photograph of a bird's eye, showing the intricate patterns of the iris in shades of green and yellow. The pupil is a solid black circle in the center. Overlaid on the eye is a title in a red, outlined, serif font. The title is framed by two horizontal lines.

STRANGE THINGS ABOUT THE EYES



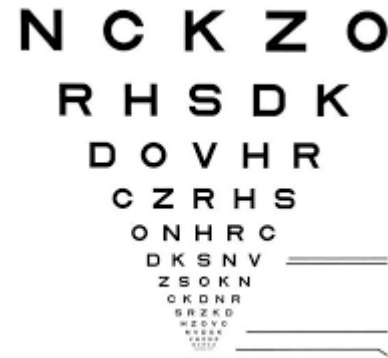
Vision and Concussion – Fun Facts

- 80% of our sensory information goes through the eyes.
- 100% of the brain is involved in the visual system in some way.
- It is estimated that 50-90% of individuals will experience some sort of visual dysfunction after a concussion.

Central vs peripheral visual processing

CENTRAL:

- seeing fine details and colours
- identification of what we are seeing
- conscious vision
- slower process than...

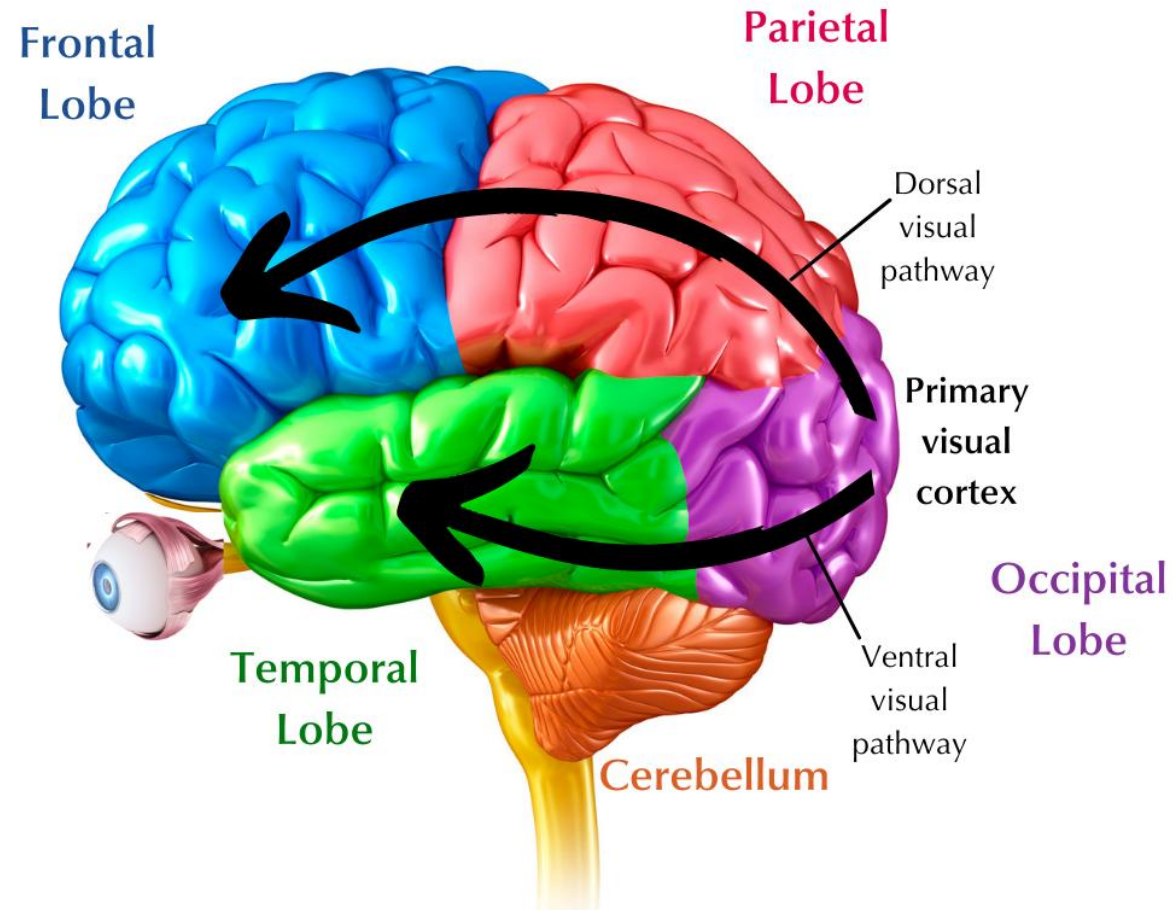


PERIPHERAL:

- Motion processing system, spatial processing
- Peripheral range vs peripheral awareness vs situational awareness
- Conscious vs subconscious peripheral vision
- 10-20% of ganglion cells transmit visual information *subconsciously* to the midbrain for integration with vestibular and proprioception systems.
 - Where we are in space, where something is relative to us, how fast it is moving, and plan for action
- Faster than central process
- Predictive, anticipatory, and reflexive (“read and react”)



Dorsal and Ventral Cortical Streams



Vestibular System

3 semicircular canals

- Anterior/Superior

(lowering head)

- Posterior/Inferior

(elevating head)

- Horizontal Canal

(turning head to side)

Graviception

Utricle:

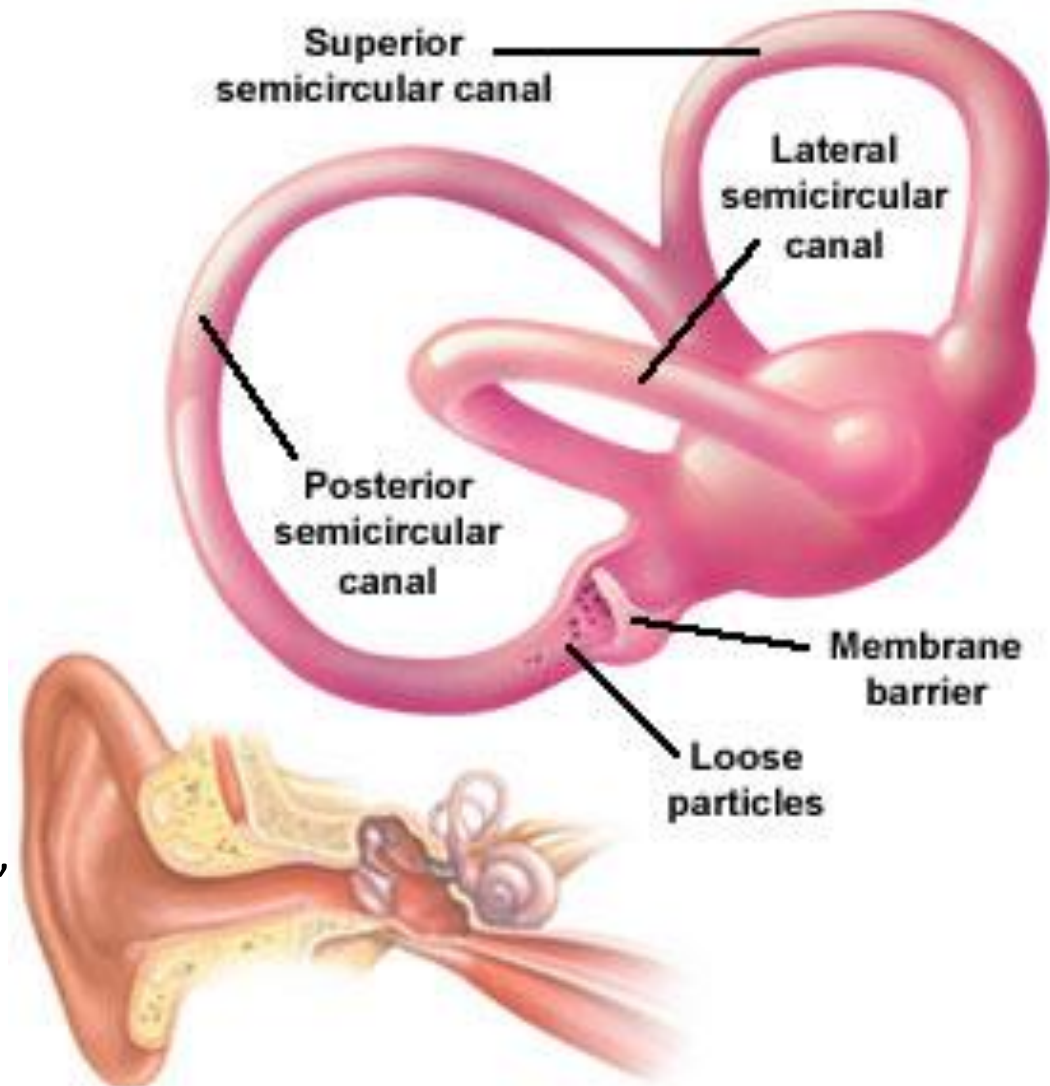
Linear acceleration

(forward and back, side to side translation, head/body tilt)

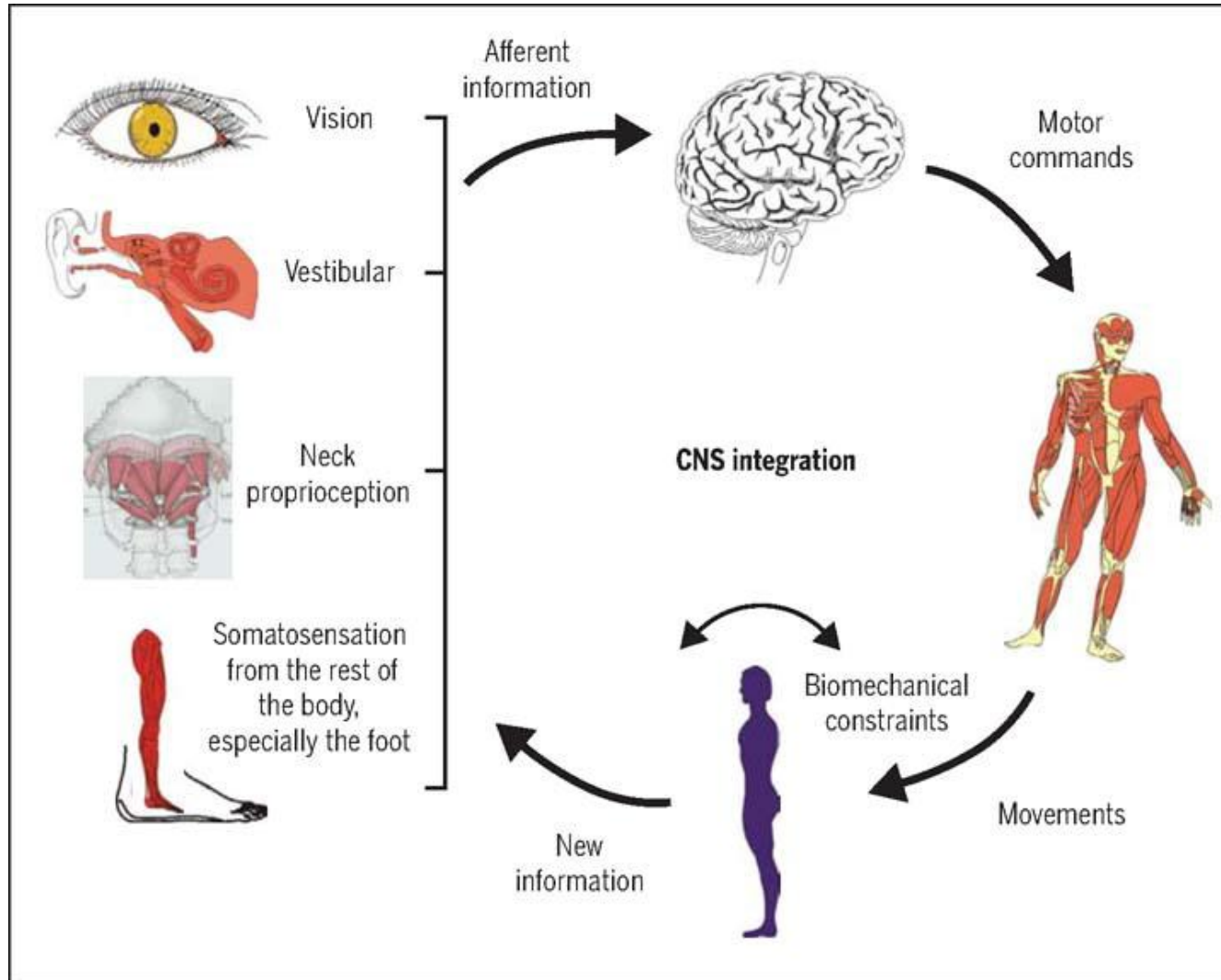
Sacculle:

Vertical motion

(jumping, elevator)



Sensory Integration



Top down and bottom up interactions between the visual, vestibular, and proprioceptive systems to establish where we are, where we intend to go, timing of when to act, and how we will accomplish this.

Influence of neck torsion on near point convergence in subjects with idiopathic neck pain.

Giffard P¹, Daly L², Treleaven J³.

⊕ Author information

Abstract

BACKGROUND: People with neck pain (NP) experience sensorimotor and oculomotor deficits thought to be due to abnormal cervical afferent input. Convergence insufficiency (CI) measured by near point convergence (NPC) may be a feature in NP and neck torsion might help to differentiate a cervical cause.

OBJECTIVES: This study aimed to investigate repeatability and reliability of NPC in neutral and torsion and compare between idiopathic NP and controls along with correlation to the Convergence Insufficiency Symptom Survey (CISS).

DESIGN: Comparative cross sectional observational study.

METHOD: A Royal Airforce (RAF) Rule measured NPC with the neck in neutral and in 45° torsion to the left and right in 42 subjects. A revised 15 item CISS was also completed. The average of 3 trials in each position and torsion difference were calculated. Within one week, NPC inter-rater and test-retest reliability was evaluated in 10 subjects.

RESULTS: A significant NPC torsion difference was demonstrated in participants with NP compared to controls ($P = 0.01$). No significant differences were seen for NPC values in neutral ($P = 0.73$). High inter-rater reliability ($ICC = 0.95$) and repeatability ($ICC = 0.84$) was obtained. No correlations were present between the CISS and NPC measures ($r \leq 0.18$).

CONCLUSIONS: NPC is impaired in neck torsion compared to neutral in NP supporting a cervical afferent cause. NPC, measured using the RAF Rule, is a reliable and repeatable measure and can be used to assess NPC and CI in those with NP. Objective rather than self-reported measures should be used to examine CI in NP.

- Study: comparison of NPC bw pts with idiopathic neck pain and healthy controls, measured in neutral position and in neck torsion
- Results: significantly greater left, right, and average torsion diff in NPC with INP compared to controls

Fixation Stability

Stable vision with self and/or target in motion

- Need sensory integration (vision, vestibular, somatosensory) for stability
 - **VOR** (vestibulo-ocular reflex) – stable vision with head motion; responds best to fast head movement
 - **COR** (cervical-ocular reflex) – stable vision with neck torsion; responds to slower head movement
 - **OKR** (optokinetic reflex) – stable vision with moving visual stimuli in visual field; responds to slower head movements
 - **Ocular Counter Roll** - Otolith response to head or body tilt

Proprioceptors from deep neck muscles and joint capsules from C1 to C3 and the vestibular nuclei are stimulated with head movement, leading to opposing movement of the eyes.

> [Brain Inj.](#) 2021 Jan 18;35(2):209-214. doi: 10.1080/02699052.2020.1865566. Epub 2020 Dec 24.

Fixation stability as a biomarker for differentiating mild traumatic brain injury from age matched controls in pediatrics

Melissa Hunfalvy¹, Nicholas P Murray², Frederick Robert Carrick^{3 4 5}

91 Dx with mTBI within 2 days of the assessment, 140 age and gender-matched controls
Ages 6-18 years, 165 M, 66 F
Significantly larger gaze spread in mTBI vs controls

VOR (Vestibular-Ocular Reflex)

Head Motion (angular or linear)

Semicircular canals and otoliths

Vestibular nerve (CN VIII)

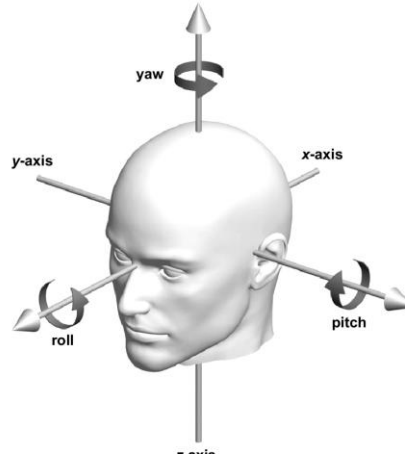
Vestibular nuclei

Cerebellum (Flocculus and Nodulus adjust VOR gain)

Medial Longitudinal Fasciculus (MLF)

Oculomotor nuclei (CNs III, IV, VI)

Extraocular muscles (compensatory eye movement)



COR (Cervical Ocular Reflex)

Neck Rotation or Position Change

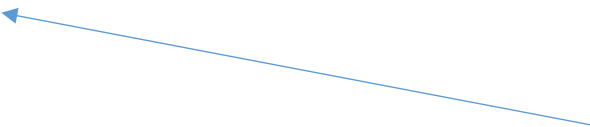
Cervical proprioceptors (muscle spindles, joints)

Spinal input (C1-C3)

Ascending proprioception pathways for conscious proprioception

(Dorsal root ganglion to the cerebellum for subconscious proprioception)

Vestibular nuclei (integration point)



Visual-Vestibular Integration

> [J Vestib Res. 2020 Jul 15. doi: 10.3233/VES-200706. Online ahead of print.](#)

Gaze stability in young adults with previous concussion history

Linda J D'Silva¹, Catherine F Siengsukon², Hannes Devos²

- Dynamic visual acuity in yaw (lateral head motion) and pitch (vertical head motion) planes and sleep surveys (Pittsburgh Sleep Quality Index (PSQI) and Epworth Sleepiness Scale (ESS))
- 34 adults (mean age 23.35+/- 1.3 yrs): 17 with history of concussion on average 4 yrs since injury compared to 17 age/gender matched controls with no injury history

Results:

- Significant pitch plane DVA loss in concussion group compared to controls
- Significant correlation between DVA loss and Sleep Quality Index survey in concussion group

Common Visual Dysfunctions Following a Concussion

Vergence

Accommodation

Oculomotor (saccades and pursuits)

Vestibulo-ocular reflex (VOR)

Fixation stability

Reaction time

Spatial problems

Post-Trauma Vision Syndrome Prevalences

- Systematic review and meta-analysis of 22 publications: (Merezhinskaya et al. 2019)
 - Accommodation: 42.8%
 - Vergence (Convergence Insufficiency): 36.3% vs 11.0-15.% in healthy university athletes (Badovinac et al., 2017)
 - Visual field loss: only in 6.6% in mild TBI versus 39.8% in moderate to severe TBI
 - No visual acuity loss in any of the studies reviewed.
- Frequency of oculomotor dysfunction in adolescents 4-12 weeks after a concussion (Scheiman et al., 2021):
 - 70% found to have 1 or more oculomotor deficiencies (vergence disorders: 60%, accommodation disorders in 57%, and saccadic dysfunction in 18%)
- Saccade dysfunction: 30% (Master et al. 2016), 51.3% (Ciuffreda et al. 2007); smooth pursuit dysfunction: 43-60% (Hunt et al., 2016)
- VOR dysfunction and concussion:
 - 50- 75% of individuals experience dizziness and vertigo after a concussion, which includes the vestibulo-ocular reflex
 - Vestibulo-ocular dysfunction: Ellis et. Al., 2016, J Neurosurg. Pediatr.); < 30 days post-injury
 - Symptom recovery: 40 days with SRC and VOD, vs 21 days without VOD

Post-concussion clinical findings of oculomotor function in paediatric patients with persisting symptoms compared to healthy controls

Participation from: Boston Children's Hospital, Stanford University and Salus University's Pennsylvania College of Optometry

Metrics looked at: vergence and accommodation

71 participants:

34 concussed subjects (mean age 14, 74% F, 26% M) compared to 31 controls (mean age 12, 56% F, 44% M)

Time from concussion: 4 weeks to 9 months

Results:

NPC ave 9.3 concussed vs 3.9 controls

Accommodation amplitude: 9.9 vs 13.8

Distinction between convergence deficit (35%) vs convergence insufficiency (21%)

Symptoms of Post-Trauma Vision Syndrome (PTVS)

Dizziness

Balance problems

Motion sensitivity

Light sensitivity

Blurry vision (with/without movement)

Double vision

Peripheral vision problems

Headaches

Depth perception issues

Slow reaction time

Discomfort with reading (e.g. losing place, re-reading, word movement/blur)

Intolerance to computer screens (brightness, scrolling)

Red, gritty, watery eyes

Discomfort with busy environments or patterns

Reduced sense of where body is in space, reduced confidence navigating

Difficulty recalling visual information, what is seen or read (visual memory)



Photophobia

- ipRGCs: < 1% of retinal ganglion cells, stimulated by blue light (460-480 nm)
- They project to the trigeminovascular neurons of the thalamus that transmit nociceptive information from the dura to the cortex
- ipRGCs
 1. project to the suprachiasmatic nucleus in the hypothalamus and regulates circadian rhythms
 2. Regulate release of melatonin from the pineal gland
 3. Influence the pupillary light reflex; help with sustained constriction
- ipRGCs: neurotransmitter is glutamate
- Glutamate excess after TBI (Guerriero et al., 2015)
- Migraineurs show amplification of ipRGC pathway resulting in photophobia (McAdams et al., 2020)
- Rule out ocular causes: uveitis, dry eye, corneal conditions, etc.

The Primary Care Optometric Exam



History

Medical conditions (neurological, physical, cardiovascular, psychological, autoimmune, endocrine, post-infection)

Medications

- I. Typical medications that cause dizziness: Anti-Depressants (SSRIs), Diuretics, Anti-hypertensives, NSAIDs and Analgesics, Cholesterol-lowering, Anti-psychotics, Parkinsonian drugs
- II. Vision blur: Tricyclic Anti-Depressants, SSRIs Benzodiazepines

Pre-existing conditions:

- I. Anxiety
- II. Depression
- III. ADHD
- IV. Learning Disabilities
- V. Migraine
- VI. Motion sickness

History - Symptoms

Dizziness

Lightheaded

Spinning

Imbalanced/on a boat

'Drunken' feeling

Headaches

Localization

Duration

Triggers and relief measures

Double vision

Monocular or binocular

Horizontal, vertical, or diagonal

Intermittent or constant

Isolated to particular viewing distance or gaze angle?

- Difficulty with visual motion
- Photosensitivity: natural or artificial lighting
- Blurry vs unstable vision
- Screen tolerance, reading tolerance
- Visual snow: palinopsia, photophobia

CONVERGENCE INSUFFICIENCY SYMPTOM SURVEY

Name _____

Date ___/___/___

Please answer the following questions about how your eyes feel when reading or doing close work.

SYMPTOMS (Please fill this out with your child)					
	NEVER	INFREQUENTLY	SOMETIMES	FAIRLY OFTEN	ALWAYS
Do your eyes feel tired when reading or doing close work?					
Do your eyes feel uncomfortable when reading or doing close work?					
Do you have headaches when reading or doing close work?					
Do you feel sleepy when reading or doing close work?					
Do you lose concentration when reading or doing close work?					
Do you have trouble remembering what you have read?					
Do you have double vision when reading or doing close work?					
Do you see the words move, jump, swim or appear to float on the page?					
Do you feel like you read slowly?					
Do your eyes ever hurt when reading or doing close work?					
Do your eyes ever feel sore when reading or doing close work?					
Do you feel a pulling feeling around your eyes when reading or doing close work?					
Do you notice the words blurring or coming in and out of focus when reading or doing close work?					
Do you lose your place while reading or doing close work?					
Do you have to reread the same line of words when reading?					
TOTAL (Please add up each of the columns)					
MULTIPLY THE TOTAL BY THE FOLLOWING:	x0	x1	x2	x3	x4
SUBTOTAL					
GRAND TOTAL: (Sum of Subtotals)					

Convergence Insufficiency Symptom Survey (CISS)

- 15 Items
- Score greater than 21 is suggestive of Convergence Insufficiency

To score the survey, simply add the check marks in each column and multiply the amount by the multiplier at the bottom of the survey. A score of 16 or more indicates the need of a developmental vision exam.

This symptom survey is derived from the National Institute of Health's Convergence Insufficiency Treatment Trial.

BIVSS CHECKLIST (Brain Injury Vision Symptom Survey)

Patient Name: _____ Today's date: _____

My brain injury was: _____ years ago My age is: _____ years today's date: _____

 I have had a medical diagnosis of brain injury (check box if true) Cause of injury: _____ I sustained a brain injury without medical diagnosis (check box if true) _____ I have NOT ever sustained a brain injury (check box if true) _____

Please check the most appropriate box, or circle the item number that best matches your observations. All information will be held in confidence. Thank you for your help!

SYMPTOM CHECKLIST

Circle a number below:

Please rate each behavior. How often does each behavior occur? (circle a number)	Never	Seldom	Occasionally	Frequently	Always
EYESIGHT CLARITY					
Distance vision blurred and not clear -- even with lenses	0	1	2	3	4
Near vision blurred and not clear -- even with lenses	0	1	2	3	4
Clarity of vision changes or fluctuates during the day	0	1	2	3	4
Poor night vision / can't see well to drive at night	0	1	2	3	4
VISUAL COMFORT					
Eye discomfort / sore eyes / eyestrain	0	1	2	3	4
Headaches or dizziness after using eyes	0	1	2	3	4
Eye fatigue / very tired after using eyes all day	0	1	2	3	4
Feel "pulling" around the eyes	0	1	2	3	4
DOUBLING					
Double vision -- especially when tired	0	1	2	3	4
Have to close or cover one eye to see clearly	0	1	2	3	4
Print moves in and out of focus when reading	0	1	2	3	4
LIGHT SENSITIVITY					
Normal indoor lighting is uncomfortable -- too much glare	0	1	2	3	4
Outdoor light too bright -- have to use sunglasses	0	1	2	3	4
Indoors fluorescent lighting is bothersome or annoying	0	1	2	3	4
DRY EYES					
Eyes feel "dry" and sting	0	1	2	3	4
"Stare" into space without blinking	0	1	2	3	4
Have to rub the eyes a lot	0	1	2	3	4
DEPTH PERCEPTION					
Clumsiness / misjudge where objects really are	0	1	2	3	4
Lack of confidence walking / missing steps / stumbling	0	1	2	3	4
Poor handwriting (spacing, size, legibility)	0	1	2	3	4
PERIPHERAL VISION					
Side vision distorted / objects move or change position	0	1	2	3	4
What looks straight ahead--isn't always straight ahead	0	1	2	3	4
Avoid crowds / can't tolerate "visually-busy" places	0	1	2	3	4
READING					
Short attention span / easily distracted when reading	0	1	2	3	4
Difficulty / slowness with reading and writing	0	1	2	3	4
Poor reading comprehension / can't remember what was read	0	1	2	3	4
Confusion of words / skip words during reading	0	1	2	3	4
Lose place / have to use finger not to lose place when reading	0	1	2	3	4

Brain Injury Vision Symptom Survey (BIVSS)

- 28 item survey: score of greater than or equal to 31 separates significant visual problems and separates TBI from the non-TBI population.
- Data analyzed from 219 individuals (62 TBI, 157 non-TBI)

Post-Concussion Symptom Inventory

*** Please answer each questions based on how you feel RIGHT NOW ***

Name: _____

Date: ___/___/___

Severity Rating

(Please use this scale to rate each symptom)

Current Symptoms	Severity Rating						
	None	Mild	Moderate	Severe			
Headache	0	1	2	3	4	5	6
Nausea	0	1	2	3	4	5	6
Vomiting	0	1	2	3	4	5	6
Balance problems	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Lightheadedness	0	1	2	3	4	5	6
Fatigue	0	1	2	3	4	5	6
Trouble falling asleep	0	1	2	3	4	5	6
Sleeping more than usual	0	1	2	3	4	5	6
Sleeping less than usual	0	1	2	3	4	5	6
Drowsiness	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
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervous/Anxious	0	1	2	3	4	5	6
Feeling more emotional	0	1	2	3	4	5	6
Numbness or tingling	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
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Visual problems	0	1	2	3	4	5	6

Symptom Score: _____

Post-Concussion Symptom Scale

- Self reported grading of symptoms over the past 2 days
- 22 symptoms, grading 0-6, max score of 132
- The higher the number, the greater the symptom severity
- Great to track over time

History

School:

- Grade or post-secondary level and area of study
- IEP?
- Accommodations?
- Full or part time? Virtual vs in-person

Work:

- Type of work
- Self employed or employee
- Support
- Hybrid versus working from home or office
- Current work status - if off, if intention to return
- Devices/workstation set-up

Sport:

- Type of sport(s)
- Whether cleared by physician
- Full or non-contact practice, or if playing games
- Intention on returning to sport if not cleared

Current therapy providers (physiotherapy, chiropractor, psychologist, occupational therapist, speech-language therapist, sports medicine doctor, etc.)

Examination

- Visual acuity
- Refraction
 - Having patient close eyes in between lens changes can help with tolerance
 - Binocular vs monocular
 - Final Rx always to be trial framed, sitting, and walking if able for distance Rx, or wait until the neuro-optometry assessment prior to prescribing
- Extraocular motilities, function of cranial nerves III, IV, and VI
- Fixation: steady, flutter, or nystagmus
- Near point of convergence (repeat 3x to check for recession)
 - Accommodation target
 - Red light target
- Accommodation amplitude
- Cover test distance and near
- Check for subtle vertical heterophoria (e.g., Maddox Rod if possible)

Examination

- Pupil evaluation
- Ocular health evaluation
 - Dry eye evaluation
 - 15% in TBI (Chen, 2023)
 - 37% in veterans with TBI, vs 29% in vets with no TBI
 - DFE, OCT
- Visual fields
- Lighting considerations
- Pt to be seated in a quieter area of office if available/possible

OCT changes with concussion

- About 30% of those with mTBI experience RNFL thinning over the first 6 months
- Thinning of the RNFL and not the GCL
- Observed at approximately 6 weeks post-injury
- mTBI RNFL 114 μm vs 120 μm in healthy controls
- Can get *thickening* of RNFL within first 3 months
- mTBI over time: ave 18 μm loss of RNFL in first 12 months, and annual loss of 1.47 μm in mTBI vs 0.31 in controls over 5 years
- Even one mTBI can result in progressive changes, especially with a history of prior concussions
- Global or inferonasal sector in particular

Lyons et al. A systematic review of optical coherence tomography findings in adults with mild traumatic brain injury. *Eye* 2024 Apr;38(6):1077-1083.

Laws et al. Retinal manifestations of traumatic brain injury. *Sci Rep.* 2025 Apr 29;15(1):14992.

Gilmore et al. Association of Optical Coherence Tomography With Longitudinal Neurodegeneration in Veterans With Chronic Mild Traumatic Brain Injury. *JAMA* 2020 Dec 1;3(12).

Kelman et al. Retinal nerve fibre changes in sports-related repetitive traumatic brain injury. *Clin Exp Ophthalmol* . 2020 Mar;48(2):204-211.

The Neuro-Optometric Assessment

- Eye alignment : stability, consistency in different positions of gaze, stereopsis, sensory fusion
- Oculomotor evaluation (saccades, pursuits, CNs 3, 6, 4, vergence ability, ease, and flexibility)
- Gaze stability / visual-vestibular function / cervical-ocular integration
- Accommodation ability, stamina, and flexibility
- Visuo-spatial function and visual midline shift testing (static or dynamic)
- Visual perception (visual memory, spatial relations, analyzing complex visual patterns, finding details in a busy background)
- Visual-verbal, visual-auditory, and visuomotor integration
- Static balance
- Visual motion and pattern sensitivity
- Visual reaction time

Interventions - Optical



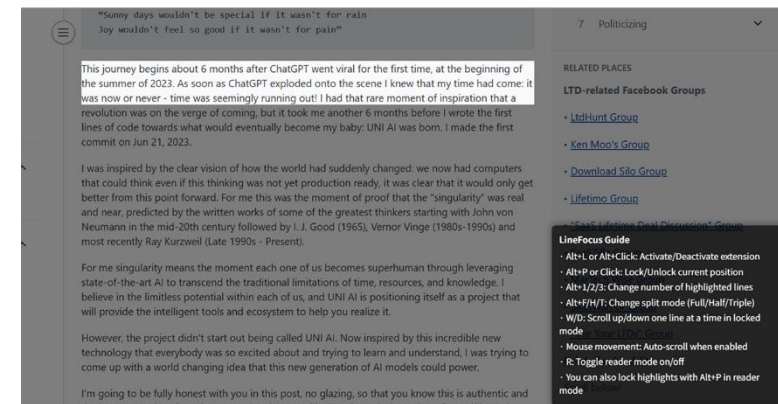
- Tints (FL-41, e.g. Theraspecs, NORA Trauma Filter Kit from Chadwick Optical)
- Blue-light filter (not to be worn full time, to allow circadian rhythm regulation)
- Avulux migraine tint
 - Block blue (450-500 nm), Amber (550-600 nm), and Red
 - Let in green (500-570 nm)
- Tinted contact lenses (Altius, Orion – US based)
- Avoid PALS if possible
- Prism
 - Yoked vs non-yoked microprism (e.g. BI OU or BD OU)
- Lenses (low plus for near, always trial frame, especially cyl)
- CLs: multifocal, MyDay Energys for near relief
- Binasal tape occlusion



Interventions - Tools

- Flicker free monitor (BenQ), screens with high refresh rate (> 60Hz), and/or e-ink
- Overlays or screen tinting software (Opticalm)
- Speech to text
 - NaturalReader – converts documents/web pages to audio
 - Speechify – read-aloud with adjustable speed and voice choices
- AI transcription and summary for meetings, lectures
- Voice assistants
- Screen readers: NVDA (Windows), TalkBack (Android), VoiceOver (iOS)
- Reading ease: LineFocus, Reading Mask (Chrome), Microsoft Immersive Reader, BeeLine Reader
- Anxiety control: Mindshift CBT app
- Todoist app: Organization of tasks, time management

Suffering from screen fatigue? We're here to help! BeeLine Reader makes reading on-screen easier, faster, and more enjoyable. We use a simple cognitive trick – an eye-guiding color gradient – to pull your eyes through long blocks of text. This helps you read more effectively and maintain your focus better.



Interventions – Nutrition (and Dry Eye)

Brain Recovery Diet

- Low Carbohydrate
- Omega 3 and Healthy Fats
- Hydration
- Non-inflammatory foods
- High antioxidant
- No refined sugar

Nutraceuticals:

Mg L-Theonate

Co-Q10

Curcumin

Omega 3 – 5:1 EPA/DHA

Lutein

Vitamin D

Interventions – Vision Rehabilitation

Vision Rehabilitation involves training the brain to use the eyes more effortlessly and efficiently, and integrate with other systems more effectively.

The goal is not to "strengthen the eye muscles"!



Vision Rehabilitation

Yadav NK, Thiagarajan P, Ciuffreda KJ. **Effect of oculomotor vision rehabilitation on the visual-evoked potential and visual attention in mild traumatic brain injury.** Brain Inj 2014;28(7): 922-9

oculomotor vision rehabilitation improved visual function based on VEP

Ciuffreda KJ, Rutner D, Kapoor N, Suchoff IB, Craig S, Han ME. **Vision therapy for oculomotor dysfunctions in acquired brain injury: a retrospective analysis.** Optometry 2008; 79: 18-22

-visually symptomatic sample of 33 persons with TBI (out of 160)

-30/33 showed reduction of at least 1 primary symptom and 1 clinical sign after completing an optometric vision therapy program

Thiagarajan P, Ciuffreda KJ. **Versional eye tracking in mild traumatic brain injury (mTBI): effects of oculomotor training.** Brain Inj 2014;28(7): 930-43

6 weeks of therapy; increased saccadic gain with subjects; no change with placebo

Vision Rehabilitation

Vision rehabilitation interventions following mild traumatic brain injury: a scoping review

Mary E. Simpson-Jones & Anne W. Hunt

To cite this article: Mary E. Simpson-Jones & Anne W. Hunt (2019) Vision rehabilitation interventions following mild traumatic brain injury: a scoping review, *Disability and Rehabilitation*, 41:18, 2206-2222, DOI: [10.1080/09638288.2018.1460407](https://doi.org/10.1080/09638288.2018.1460407)

Conclusion:

“Findings from this scoping review indicate that there are promising interventions for vision rehabilitation that include the use of optical devices (e.g., prism glasses), vision or oculomotor therapy (e.g., targeted exercises to train eye movements), and a combination of optical devices and vision therapy.”

There were no studies consisting of multi-disciplinary intervention – only Optometric

Vision Rehabilitation

Convergence Insufficiency Treatment Trial

A Randomized Clinical Trial of Treatments for Symptomatic Convergence Insufficiency in Children

Published in Arch Ophthalmol 2008

211 children with Convergence Insufficiency assigned to 1 of 4 txs

Result: office-based optometric vision therapy (over a 12 week period) supported with home reinforcement was the most effective form of treatment with 73% improvement in at least one symptom and clinical sign.

43% improved outcome for home-based computer therapy with pencil push ups

33% home based pencil push ups

35% office based placebo therapy with home reinforcement

Vision Rehabilitation

➤ [J Sport Rehabil. 2020 Nov 1;29\(8\):1179-1193. doi: 10.1123/jsr.2019-0428. Epub 2020 Mar 4.](#)

Near Point of Convergence Deficits and Treatment Following Concussion: A Systematic Review

[Ashley L Santo](#), [Melissa L Race](#), [Elizabeth F Teel](#)

Conclusions: The authors' main findings suggest that there is a moderate level of evidence that patients have impaired NPC up to several months postconcussion, and a low level of evidence that impairments can be successfully treated with oculomotor therapy. These findings should be cautiously evaluated; the studies are limited by weak/moderate quality, small sample sizes, varied methodology, and nonrandomized treatment groups.

1. Convergence requires more than the eyes!
2. Need multi-disciplinary, larger, high quality studies

Vision Rehabilitation

› Br J Sports Med. 2025 Oct 1:bjsports-2025-109807. doi: 10.1136/bjsports-2025-109807.

Online ahead of print.

CONCUSS randomised clinical trial of vergence/accommodative therapy for concussion-related symptomatic convergence insufficiency

Tara L Alvarez ^{# 1}, Mitchell Scheiman ^{# 2}, Farzin Hajebrahimi ³, Melissa Noble ³, Suril Gohel ⁴, Rebecca Baro ⁵, Josie A Bachman ⁵, Christina L Master ^{6 7}, Arlene Goodman ⁸;

CONCUSS Investigator Group

- 4-12 weeks post-concussion
- Metrics: NPC, positive fusional vergence, CISS
- Criteria: NPC > 6, PFV failing Sheards or < 15 break, CISS score ≥ 16 for ages 11–17, ≥ 21 ages 18–25 years
- Immediate treatment (2x weekly x 16 sessions, n=54), versus delayed treatment by 6 weeks (n=52)
- **Outcomes measured at 6 weeks in, and after delayed group completed 16 sessions**

Vision Rehabilitation

RESULTS:

- 88% in the immediate therapy group were successful or improved vs 8% in the delayed group improved during the waiting period.
- NPC improved by 7-9 cm in the immediate group, vs 1.8 cm in the delayed group
- PFV increased by + 17.5 PD vs + 2.5 PD in the delayed group
- CISS scores reduced by 19 points in the immediate group, vs 6.5 points in the delayed group
- After the entire treatment was completed by the delayed group: 81% success in immediate, and 82% in delayed group. Therefore, treatment and not spontaneous recovery resulted in improvements.
- Proposed reasonable treatment period of twice weekly for 8 weeks

Collaboration with a Neuro-OD

Vision Therapy Canada

<https://www.visiontherapycanada.com/>

NORA (Neuro-Optometric Rehabilitation Association)

www.nora.cc

COVD (College of Optometrists in Vision Development)

www.covd.org

**Class of 2001
Retroirises**

