Management of Visual Symptoms Post Concussion

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Allina Health

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Objectives

- Define vision, ambient and focal processing
- Identify prevalence, impact on recovery and function
- Identify screening considerations
- Discuss dysfunction vs hypersensitivity and contributing factors
- Determine treatment approach based on assessment results
- Utilize a case study to demonstrate differing presentations

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Vision-defined

- Definition of vision (Padula)
  - A dynamic, interactive process of motor and sensory function mediated by the eyes for the purpose of simultaneous organization of posture, movement, spatial orientation, and manipulation of the environment
- Sight vs Vision
  - Sight-20/20, ocular health
  - Vision-What the brain does with the information from the eyes

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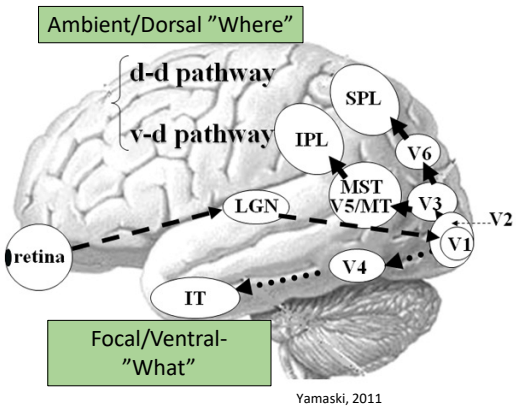
The Visual System

Ambient and Focal Visual Processing



Yamaski, 2011

Ambient	Focal
Peripheral	Central
Spatial discrimination	Detail Discrimination
Fast	Slow
Subconscious and proactive	Conscious and reactive
Provides feed forward spatial information for movement/balance/ posture/midline/spatial Readjusts and adapts to matching sensorimotor information from the cortex	

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Visual Problems-Impact on recovery and function

- Associated with decreased neurocognitive performance and gait impairments (Howell et al, 2018, Pearce et al, 2015, Galetta et al, 2013, Tjarks, et al., 2013)
- Protracted recovery (Duprey et al, Ellis et al, 2015)
  - "visual disturbance" included as a concussion symptom associated with increased odds of developing PCS/PPCS (Kerr, 2018)

Participation and quality of life for persons with oculomotor impairments after acquired brain injury

Sharon Gowdy Wagener, Robert Kreiger 2019

Recreation, education, work, home maintenance, volunteering, communicating in a group, reading, computer use and driving

Correlations between scores of visual symptoms and participation, and visual symptoms and physical quality of life

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Prevalence of Visual Problems Post Concussion

Athletes following sports related concussion

TEST	% Reporting Symptoms
Horizontal Saccades	42%
Near Point Convergence	34%
Vertical Saccades	33%
Smooth Pursuits	33%

Mucha, 2014

Vision Diagnoses After Concussion in Adolescents

69% had 1 or more of below	
Accommodative disorder	51%
Convergence insufficiency	49%
Saccadic dysfunction	46%
>1 vision diagnosis	46%

Master, Scheimann et al, 2016

Skill	Prevalence	Citation
Smooth Pursuit	43-60%	Hunt, 2016
Saccades	21.6-30%	Ciuffreda 2007, Merezhinskaya 2019
Convergence	47-55%	Pearce 2015, Howell 2018

Eye dysfunction following mTBI in active duty

	mTBI	Controls
Vertical Misalignments	55%	5%
Horizontal Misalignments	45%	5%
Accommodative Dysfunction	65%	15%
Convergence insufficiency	55%	5%

Capo-Aponte, 2012

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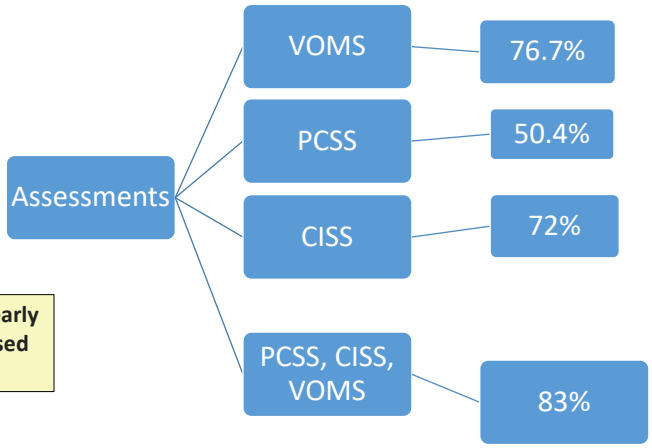
Screens

Sports Health. 2021 Nov-Dec; 13(6): 565–572. PMCID: PMC8559004
Published online 2021 Feb 22. doi: 10.1177/1941738121994116 PMID: 33618579

Contributions of PCSS, CISS, and VOMS for Identifying Vestibular/Ocular Motor Deficits in Pediatric Concussions

Rishi D. Patel, BA*† and Cynthia R. LaBella, MD†‡

- PCSS-50.4% "vision problems"
- CISS-72.1%
- VOMS-76.7%



Vestibular/ocular motor dysfunction were identified in nearly 83% of study subjects when PCSS, CISS, and VOMS are used together.

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Screens-VOMS false positive rates

- Risk Factors (Kontos, 2022)
  - History of motion sickness
  - History of migraine
  - Older Age
  - Hx of previous mTBI

Identified false positive rates

Population	Percent	Author (s)
Adolescent	9-13%	Mucha, 2014 Moran, 2018 Iverson, 2019
Collegiate	11%	Kontos, 2016
Military	10.6-21.9%	Kontos, 2021

"Results support a comprehensive baseline evaluation approach that includes an assessment of premorbid vestibular and oculomotor symptoms" Kontos, 2016

Additional therapy take away: the addition of function based screens and structured clinical interviews can help determine the need for therapy to intervene

The VOMS items false-positive rates
Smooth Pursuits 10.6%
Horizontal Saccades 11.8%
Vertical Saccades 12.0%
NPC distance 17.5%
Horizontal VOR 14.3%
Vertical VOR 13.3%
VMS 15.2%
(Kontos, 2022)

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Visual Symptoms-Contributing Factors

- Multiple concussion related factors can contribute to visual symptoms
  - Vestibular dysfunction
  - Cervical dysfunction

To make an accurate and asymptomatic eye movement, the ocular, vestibular, and cervical systems all need to be working in synchrony

Additional factors
- Sleep
- Anxiety and/or Stress
- Migraine

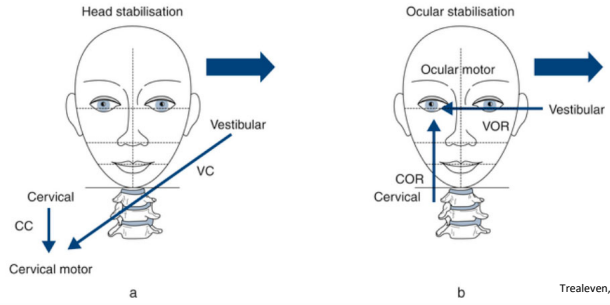

Figure 7.2 Reflex activity relating to the control of (a) head and (b) eye movement. COR = cervico-ocular reflex; VOR = vestibulooocular reflex; CCR = cervicocollic reflex; VCR =

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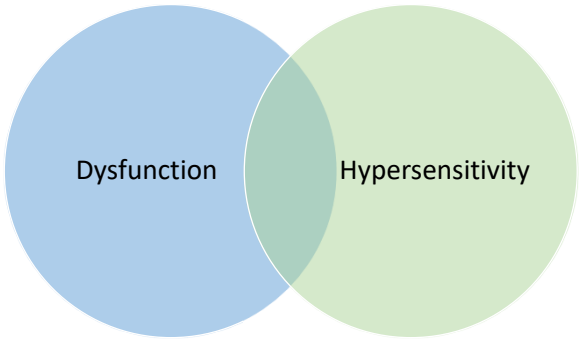
Assessment and Treatment

- Vision
  - Dysfunction
    - Impaired apparatus or end organ that results in abnormal function of the structures, pathways, reactions
    - Abnormal vision related to palsy
    - Abnormal motor control
    - Cannot perform tests accurately
  - Hypersensitivity
    - Can occur in the absence of dysfunction
    - Altered central processing/connectivity
    - Objective testing is negative, symptoms with testing
    - Symptoms worse in situations with increased optic flow



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Assessment:

Skill	Dysfunction	Hypersensitivity
Smooth Pursuit	Loss of target (saccadic intrusion) Poor symmetry	Withdrawal response Excessive blinking
Saccades	Under/overshoot Reduced latency Poor symmetry	Slow movement Excessive blinking Irritation with background
Convergence	Reduced speed Poor Symmetry Reduced NPC Fatigability Prescence of Misalignments	Slow movement Withdrawal response Irritation with background
Visual fields	Field Cut Field loss due to ocular health	Perceptual tunnel vision Symptoms with peripheral movement

- Subjective reports
  - Dysfunction: eye strain, headaches, visual fatigue, loss of place when reading, double vision
  - Hypersensitivity: dizziness, nausea, anxiety, poor tolerance for complex visual stimulation, challenges with watching hands move/patterns in the hallway

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Hypersensitivity Influencers

- Hypervigilance
- Hypersensitive sensory processing
- Heightened interoception
- Heightened sympathetic nervous system response
- Abnormal sensory weighting

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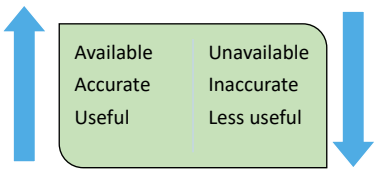
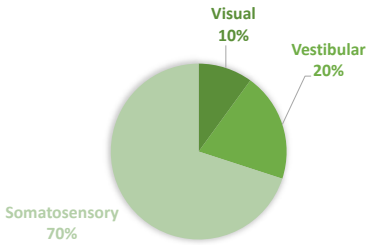
Sensory Weighting

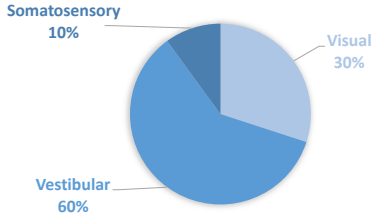
- Dynamic process that shifts based on environmental demands
- Sensory re-weighting
  - Prioritization of accurate and reliable sensory information over less reliable or inaccurate sensory information



CONTRIBUTION TO BALANCE ON A STABLE SURFACE



CONTRIBUTION TO BALANCE ON AN UNSTABLE SURFACE



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Hypersensitivity: Visual Dependency

- Visual dependency
  - Overweighting of vision due to dysfunction or reduced utilization of somatosensory and vestibular systems
  - Produces vulnerability to disorienting effects of complex or moving visual stimuli
    - Visual motion hypersensitivity
    - Visual Vertigo/PPPD
- Functional Presentation
  - Poor tolerance for visually complex settings
  - Difficulty with dim lighting
  - Challenges with navigating stairs
  - Loss of balance with eyes closed during showering
  - Avoidance of eyes closed during relaxation strategies

- Screens
  - Balance Error Scoring System
  - Modified Clinical test of sensory interaction in balance

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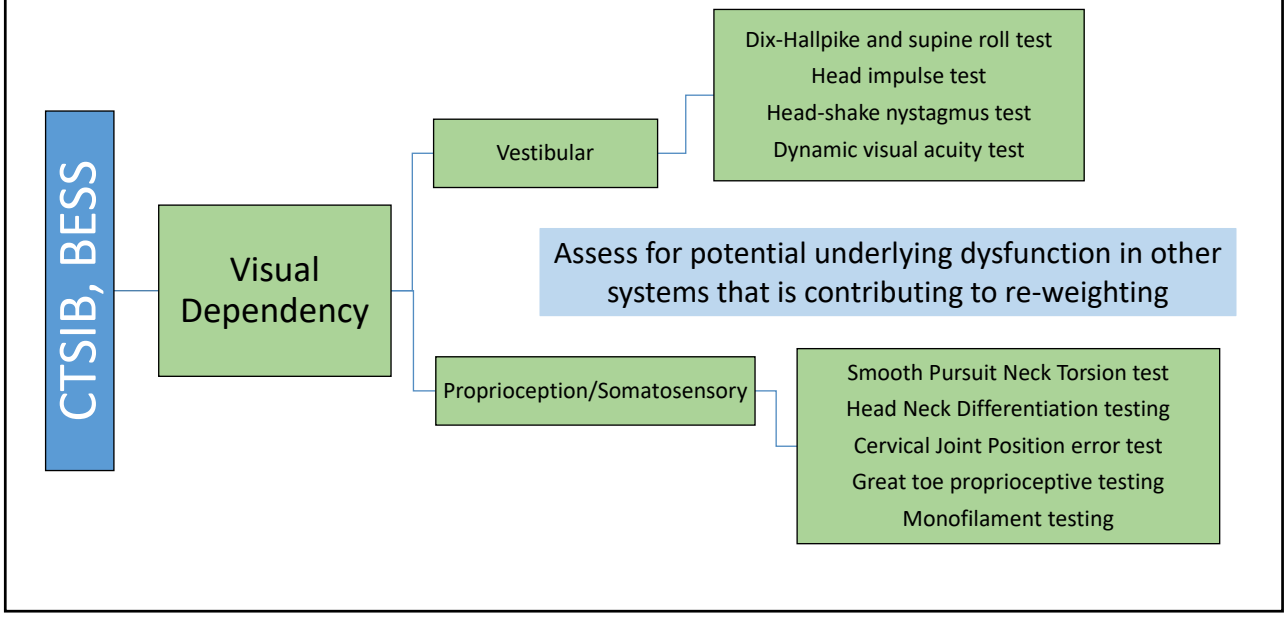
Visual Dependency: additional assessment considerations



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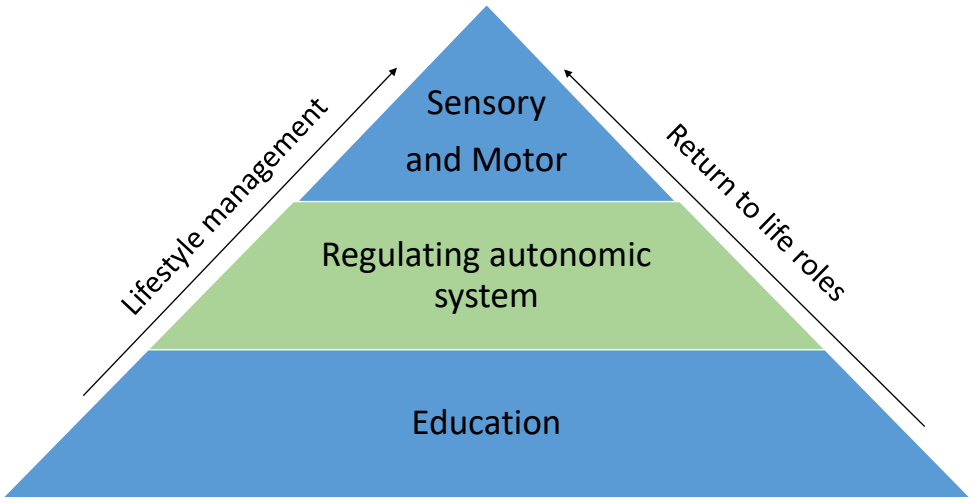
Treatment: Interventions



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Treatment: Education

- Findings on examination and relation to reported functional presentation
- Explain sensory weighting/dependencies if appropriate
  - Avoidance awareness and gradual exposure
- Visual energy management
  - Palming, 20/20/20, alternating task demands, appropriate glasses usage, posture

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Treatment: Regulating Autonomic Responses

- Finding an "off switch"
  - Grounding
    - Self
    - Environment (54321)
  - Breathing techniques
    - Extended exhale
    - Box breathing
  - Progressive relaxation
  - Body Scans
  - Yoga
  - Mindfulness
- Exercise

What makes you dizzy can heal you but only if it can be graded within the context of a sense of trust, control, and without fear based autonomic reactivity.
-Janene Holmberg

Goal to decouple fear-based responses

These strategies are specific to the person. Provide options to build their toolbox.

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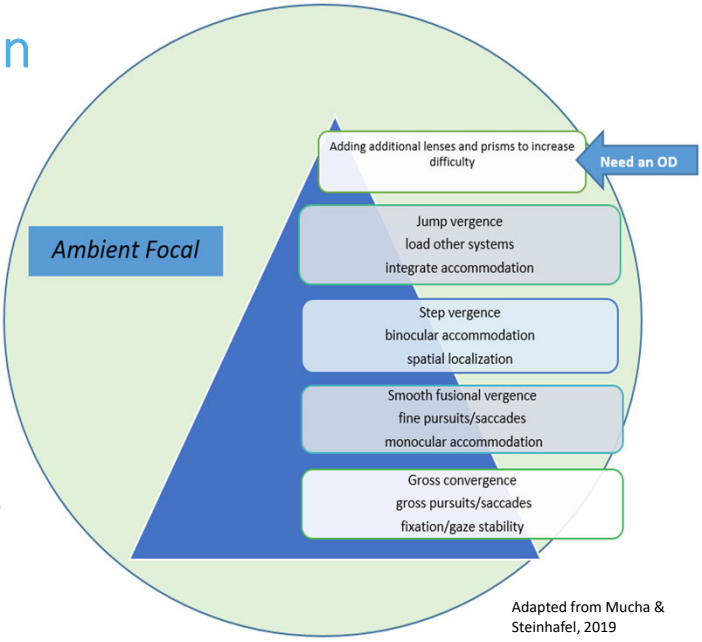
Treatment: Dysfunction

Goal: increase accuracy of skill

- Dysfunction
  - Progression based on visual hierarchy
  - Balance of central/peripheral activity
  - Exercises with built-in feedback
  - Monocular vs bi-ocular vs binocular
    - Awareness of pre-existing functioning
  - Emphasis on specific dysfunctional eye movement when able



Adapted from Mucha & Steinhafel, 2019

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Treatment: Hypersensitivity

Potential Contributing factors to visual dependency

- Visual Fixation Exercises
  - Convergence (pencil push-ups)
  - Saccades
  - VOR
  - Eyes open balance activities
  - Progressing optic flow too quickly

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Treatment: Hypersensitivity

- Visual Hypersensitivity
  - Incorporating regulation strategies throughout
  - Re-weighting of the sensory systems
  - Normalization of peripheral fields and reduction of focal dependency
  - Visual motor integration (feedback from the environment)
  - Habituation with ongoing awareness of the peripheral vision and management of optic flow
  - Incorporation of external focus

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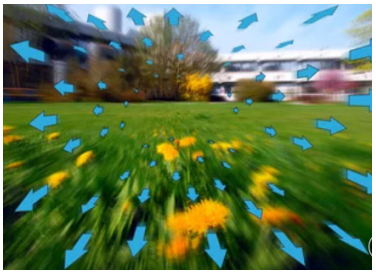
Optic Flow

- Vision Optic Flow
  - Self/body initiated
    - Head and body movement, riding a bike, driving
  - Eye motion initiated
    - Smooth pursuit, saccades, convergence
  - Vestibular/visual initiated
    - Head is moving, VOR, VOR-cancellation
  - Environmental/passive
    - Riding in a car
    - Standing still in a moving crowd
    - Scrolling

Self movement, object movement, and eye movements interact to create a dynamic visual scene



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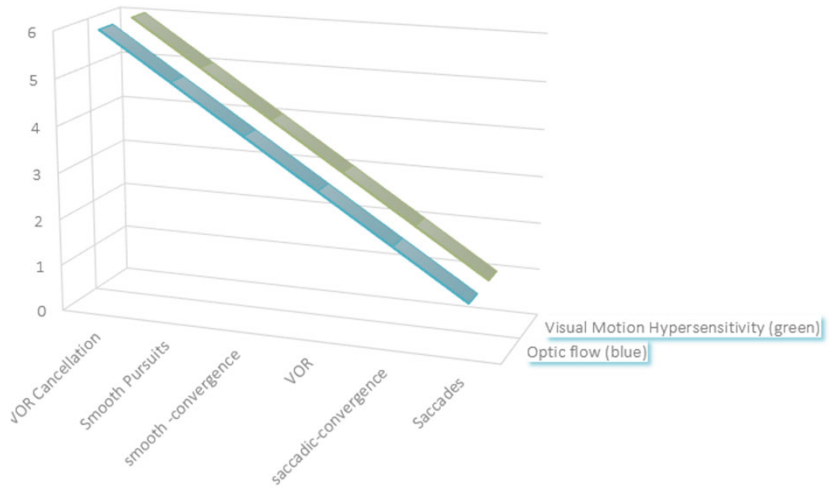
Optic Flow Theory

- Wahab-Deibes theory of Optic Flow (2021)
  - Least to most optic flow
    - Saccades
    - Jump vergence
    - VOR
    - Smooth vergence
    - Smooth pursuit
    - VOR cancellation



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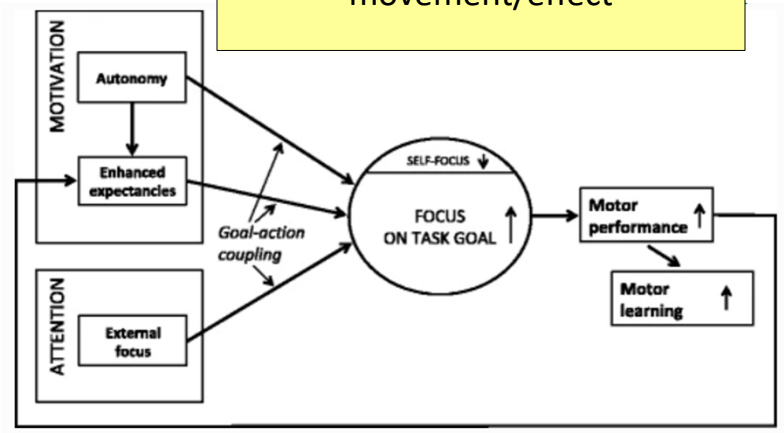
External focus

- Key component of the OPTIMAL theory
  (Optimizing Performance Through Intrinsic Motivation and Attention to Learning)
  (Wulf and Lewthwaite, 2016)

Direct attention away from one's body/self to the intended movement/effect



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Dosage Considerations

	Intensity of symptoms & need for graded exposure	Tolerance for HEP/allowable repetitions	Post-exercise Recovery	Delayed onset of symptoms with HEP
Dysfunction	Low	High	Minimal time, good recovery	Unlikely
Hypersensitivity	High	Low	Possible prolonged recovery time	Possible

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Case Study: "difficulty reading"

Dysfunction

-**ABI** (double vision, loss of place, re-reading)

Objective testing

-NPC 20 cm, exophoria, reduced NPA decreased accuracy with saccades and tracking

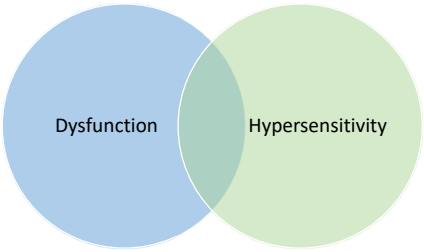
-**DEM**

(> 2 SD below mean for age level, 10 errors (missed), reported fatigue and doubling of image)

Additional complaints: frontal headaches

Treatment approach:

Education re: visual breaks, visual remediation (monocular>binocular) per visual hierarchy, gradual build in reading time and complexity



Hypersensitivity

-**ABI** (difficulty riding in the car, balance concerns, breaks with reading)

Objective testing:

-NPC WNL, accurate oculomotor but highly symptomatic, large loss of balance with eyes closed

-**DEM**

(no errors, time WNL, increased dizziness) "page is busy", (Pull-back when viewing), poor posture

Additional complaints: sub-occipital headache (moderate errors on JPET)

Treatment approach:

Referral to PT (manual and cervical proprioception training), education re: positioning when reading, re-weighting, habituation with focus on eye motion initiated optic flow (build background), gradual build in reading time and complexity

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Take-aways:

- Visual symptoms post concussion are common
- They have an impact on daily activities and quality of life
- The symptoms are treatable!
- The symptoms are often multi-factorial
- Considering dysfunction vs hypersensitivity can help ensure the appropriate treatment approach and reduce functional impact

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Courses

The Chronic "Invisible" Conditions and FND: PPPD, PPCS, and Chronic Pain Julie Hershberg, PT, DPT, NCS Mike Studer, DPT, PT, MHS, NCS, CEEAA, CWT, CSST, FAPTA A Positivie Spin on Dizziness, Jaimy Wahab PT, DPT NCS and Katherine Deines PT, DPT. 8/28/21

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