Vestibular Rehabilitation: Post Concussion

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Financial Disclosure

I, Melissa Naquin, PT, DPT, have no financial interests or relationships to disclose.

Objectives

- Discuss the incidence of vestibular impairments post concussion
- Distinguish between central and peripheral vestibular impairments
- Discuss vestibular impairments related to concussion
- Become familiar with vestibular assessment/ screening
- Describe role of PT in vestibular rehabilitation

~60% of Sports Related Concussion (SRC) have vestibular and oculomotor symptoms. (Mucha, 2014)

50-80% of SRC have vestibular impairments. (Kontos, 2012; Corwin, 2015; Merritt, 2015)

43% report balance problems. (Lovell, 2004)

Balance issues have been reported years after concussions. (Kleffelgaard, 2012)

- Vestibular & oculomotor symptoms may be associated with worse outcomes- SRC (Kontos, 2017) (Corwin, 2015) (Lau, 2011)
- Presence of dizziness, nausea, & headache- strongly associated with severity of complaints at 6 months (DeKruijk, 2002)
- Dizziness at 2 weeks- single predictor of persistent PCS (Yang, 2009)
- Vestibular impairment is associated with lower score on verbal memory, processing speed, and reaction time. (Corwin, 2015)

Vestibular Impairments

Central vestibular impairments:

- Dizziness lasting longer than “minutes”
- May report unsteadiness/ lightheadedness
- May report diplopia, dysphagia, dysarthria, dysmetria
- Impaired smooth pursuits & saccades
- Impaired VOR cancellation (visual motion sensitivity)
- Rotational, horizontal, or vertical nystagmus

Peripheral vestibular impairments:

- Dizziness usually a short duration (seconds-minutes)
- Tinnitus
- Room spinning dizziness
- Associated with positional changes
- Imbalance
- Horizontal or rotational nystagmus

Vestibular reflexes

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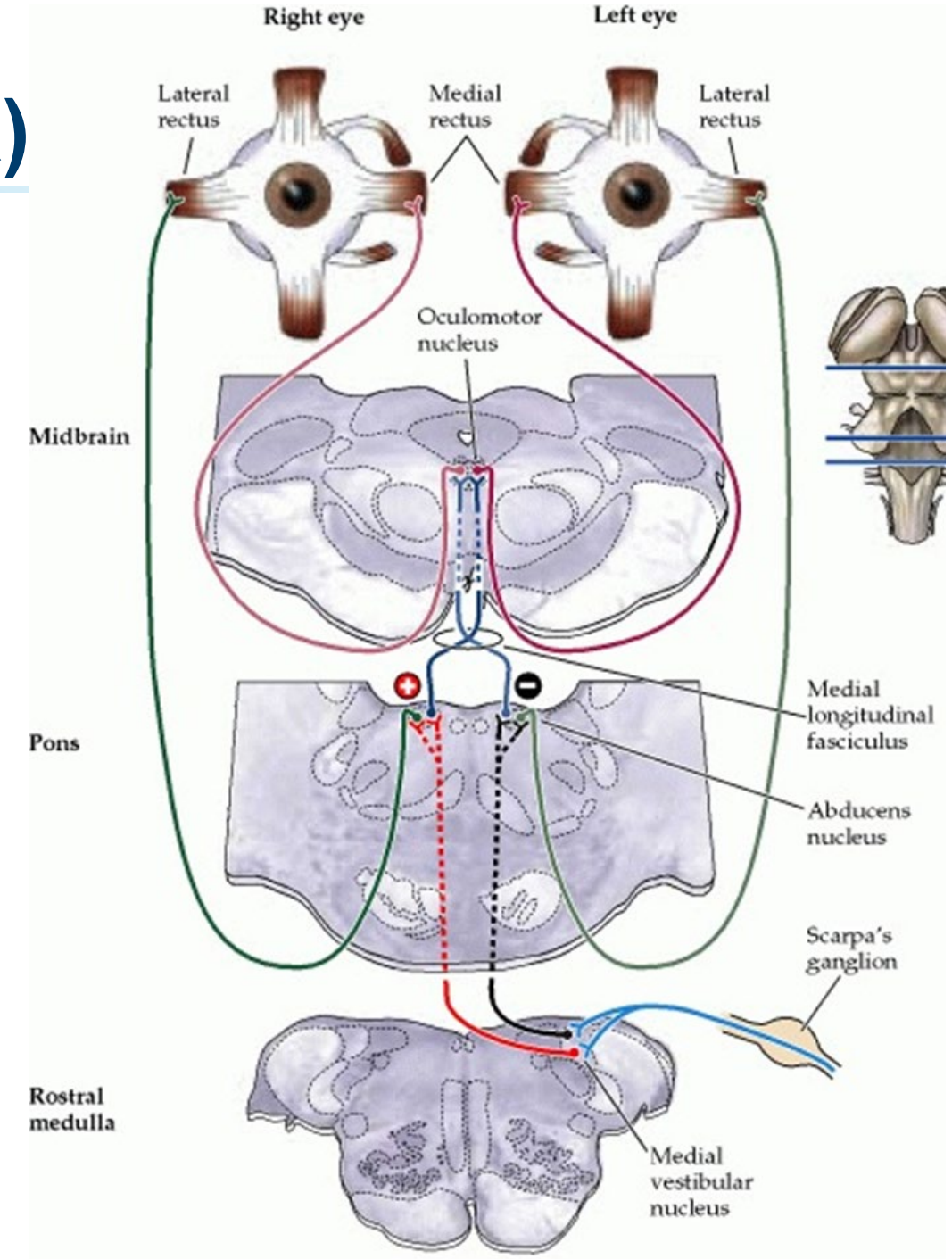
Vestibulo-Ocular Reflex (VOR)

The purpose of VOR is to provide stable vision during head motion. This mechanism produces eye movements that counter head movements.

Cause of impairment:

- Peripheral injury
- Central vestibular connections/ structures in brainstem or cerebellum
- Dysfunction in premotor cortex



Vestibulo-Spinal Reflex (VSR)

The purpose of the VSR is to stabilize the body during head motion/ postural control.

Impairment:

- may result in inappropriate righting reactions, including use of hip or stepping strategies.

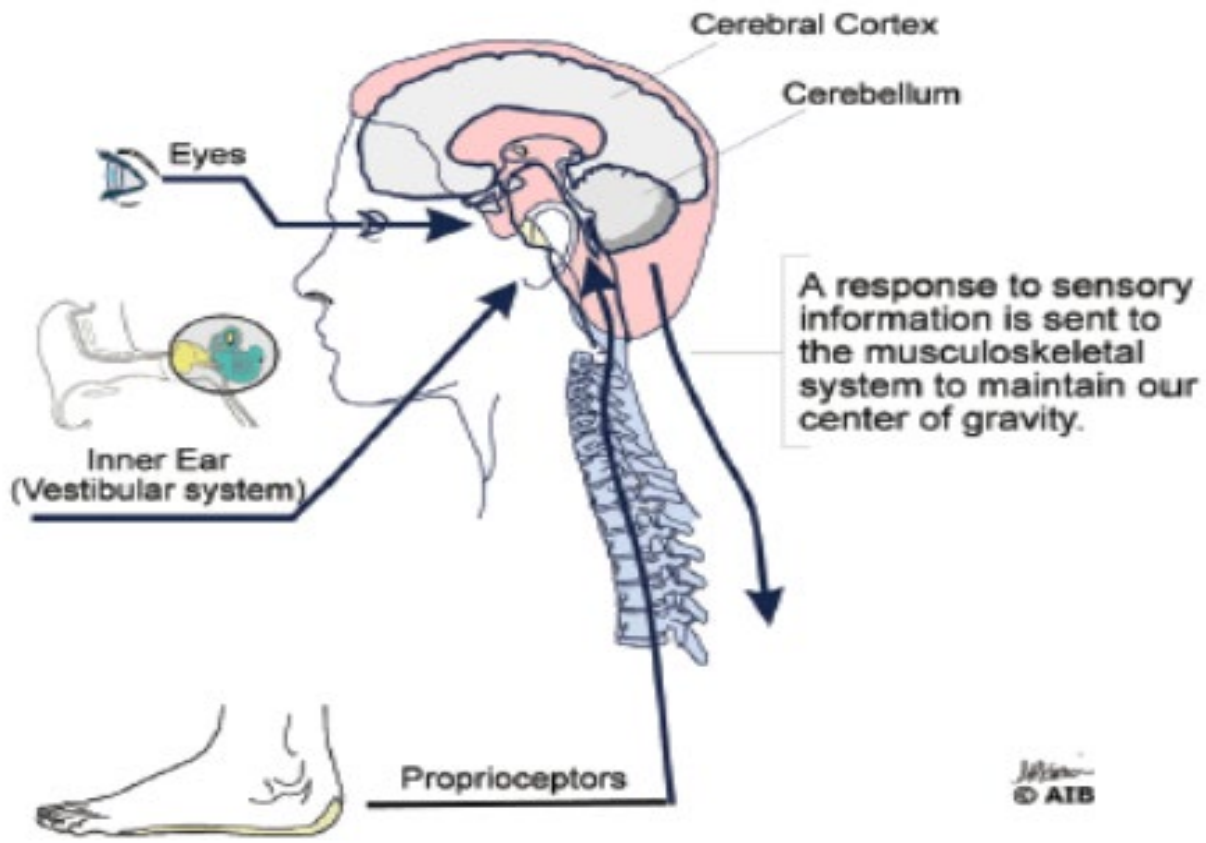
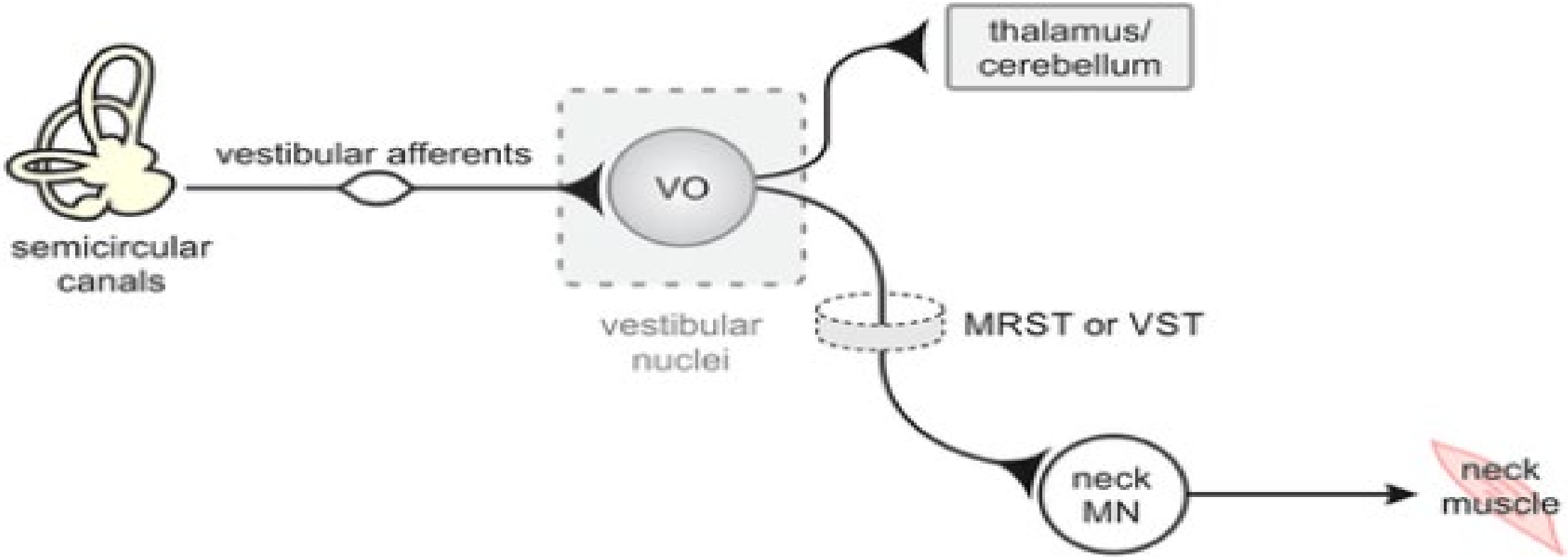


Figure 4: Normal equilibrium requires correct input from sensory modalities.

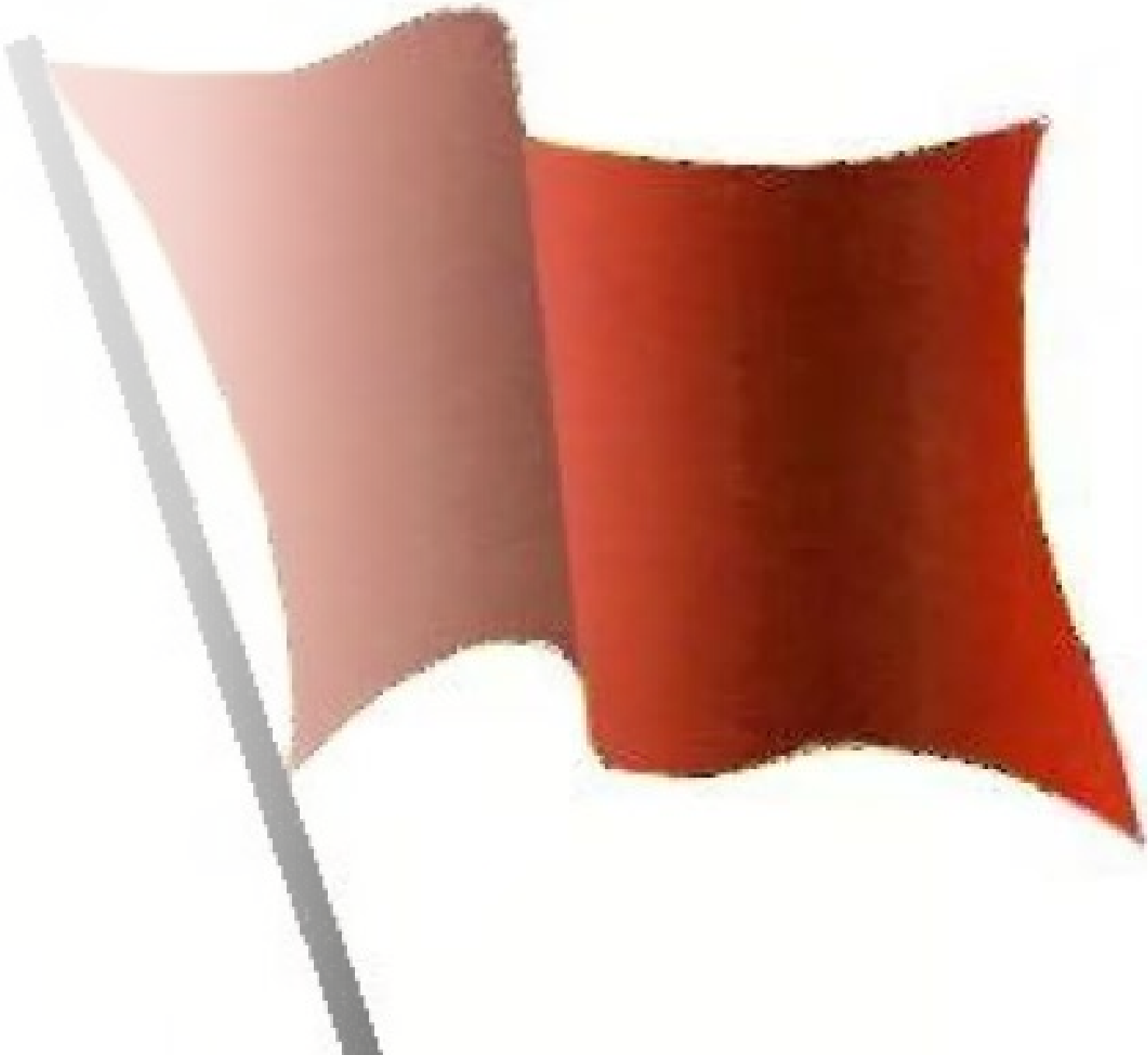
Vestibulocolic Reflex (VCR)



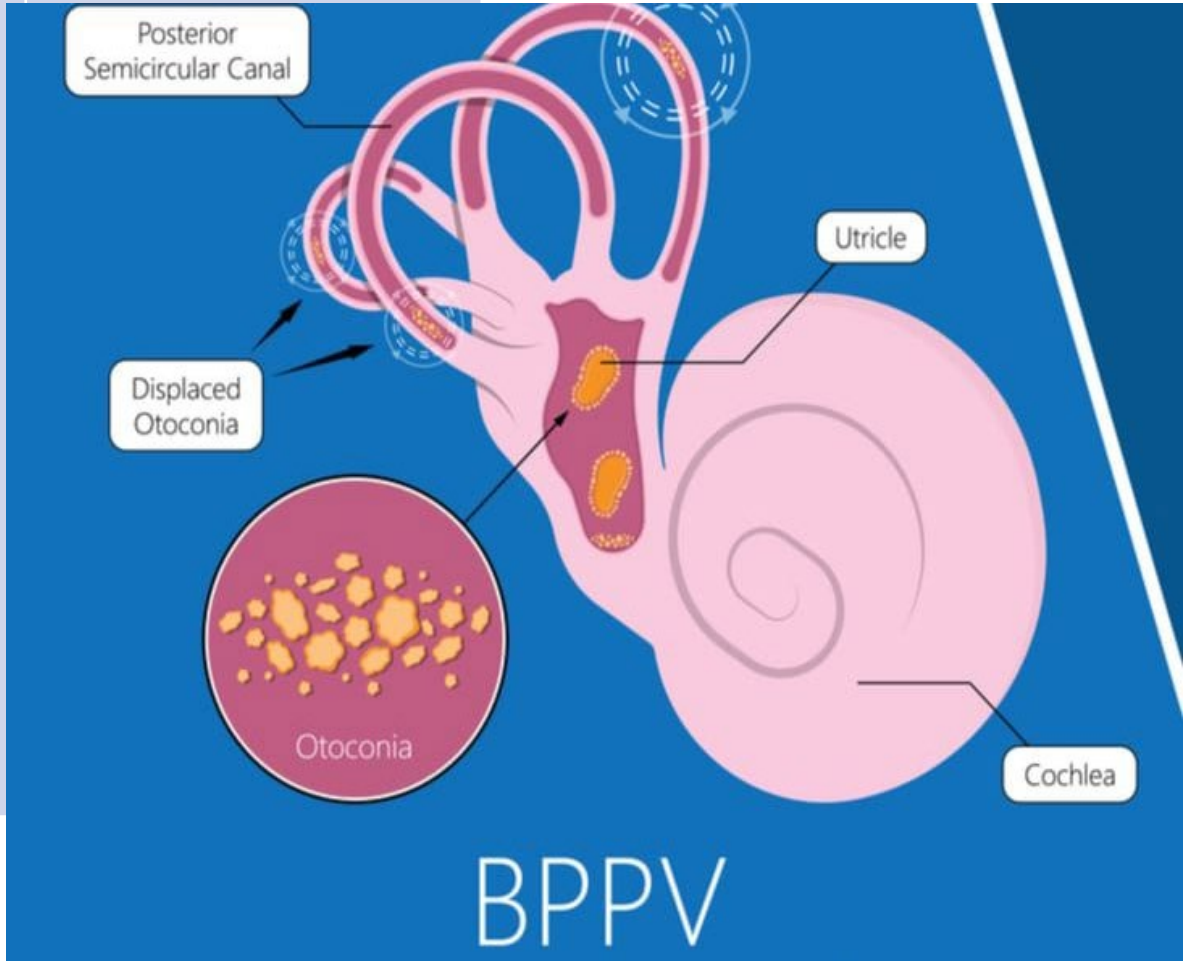
VCR acts to stabilize head as a response to body motion

Red Flag Screening

- Vertebral Artery Test
- Sharp Purser Test
- Transverse ligament test
- Alar ligament test



Diagnosis	Symptoms	Assessment	Treatment
BPPV (peripheral/ mechanical) ~4% following concussion (Alsalaheen, 2010)	• Dizziness with nystagmus •<1-2 min duration •**"room spinning"** •**Dizziness associated with position change or head movement** •Lasting>2 weeks •nausea	**Red flag screening:** 1. **Vertebral A. Test** 2. **Cervical ROM** •Hallpike- Dix • Roll test	Treatment as indicated- PT can usually perform in several sessions



Diagnosis	Symptoms	Assessment	Treatment
Labyrinthine concussion (peripheral)	• Immediate vertigo &/or disequilibrium •Presents similar to uncompensated vestibulopathy	• Balance assessments •mCSTIB •BESS	• PT can address impairments as needed • Vestibular rehab
Secondary endolymphatic hydrops	•Worsening of vertigo/ hearing wks/ months •Mimics Meniere's	•Assess hearing •VEMP	• Dietary changes • Diuretics • symptomatic care of acute episodes
Perilymph fistula (peripheral)	•Sudden Hearing loss •Nystagmus that does not fatigue •Positional vertigo •"fullness" in ear •Sx ↑ w/ change in altitude or Valsalva	•CT scan (temporal) •MOI, pt sx	• Avoid lifting, bending, straining • Rest (1-2 wks) • Surgery
Temporal bone fx	•Hearing loss •Facial paralysis •Vertigo/ imbalance •Bleeding from ear •Battle sign	•CT scan •Hearing assessment •Facial N assessment	• Directly tx PRN • Vestibular PT for persistent sx

Diagnosis	Symptoms	Assessment	Treatment
Central vestibular Impairment	•**Dizziness lasting longer than "minutes"** •May report unsteadiness/ lightheadedness •May report diplopia, dysphagia, dysarthria, dysmetria	•Balance assessments •mCSTIB •BESS •Oculo/ vestibulo- ocular assessment •↓ balance w/ eyes closed	• PT can address impairments as needed • Vestibular rehab

Diagnosis	Symptoms	Assessment	Treatment
Cervicogenic Dizziness	•General imbalance •Neck pain •↓ cervical ROM •HA •Lasts min-hrs •Concurrent whiplash •Related to change in cervical spine position	•**Red flag screening for cervical** •r/o other causes of dizziness •Head-neck differentiation test	PT: • tx of cervical impairments • Vestibular rehab

Vestibular Assessments

Visual Ocular Motor Screening (VOMS)

- Good reliability, valid compared to other concussion measures (Yorke, 2016; Mucha, 2014)

Dix Hallpike Maneuver & Supine Roll Test

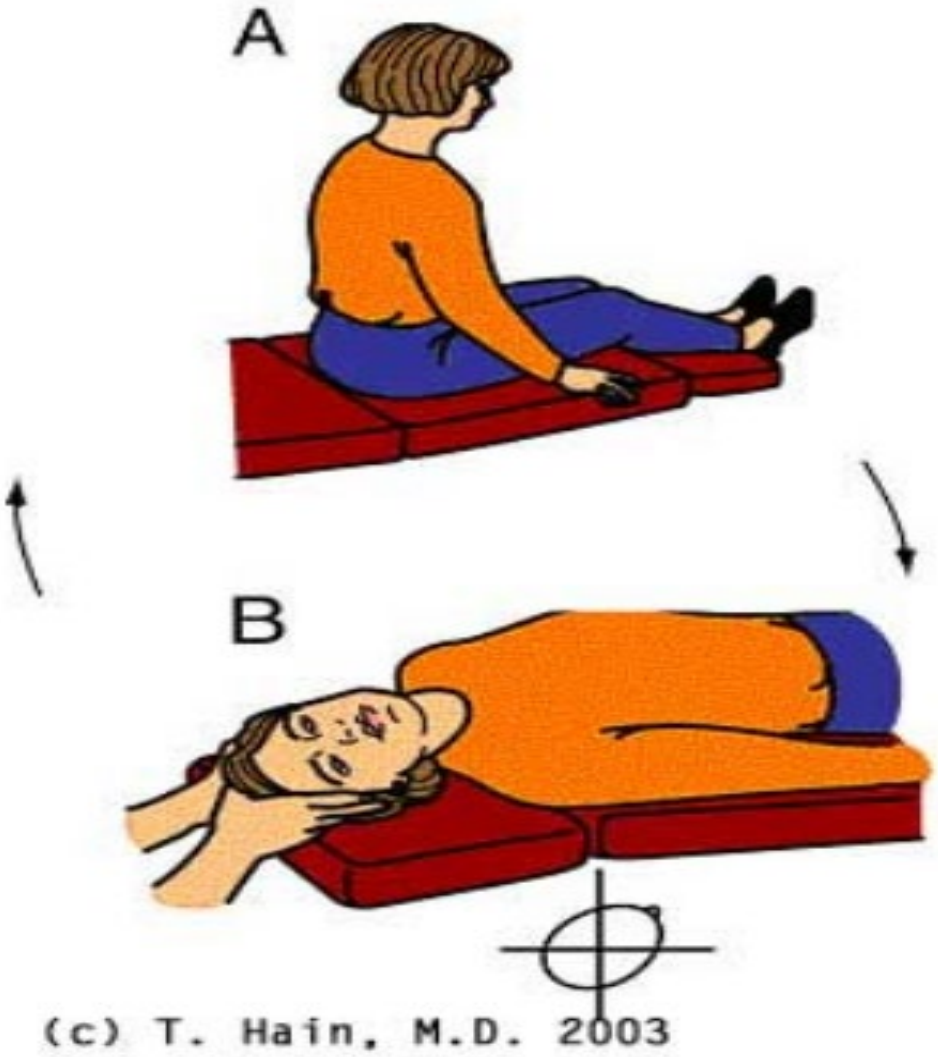
Balance Error Scoring System (BESS)- Stance, SLS, tandem stance on hard surface and foam

- good retest reliability, (Reimann, 1999)
- high specificity, (Giza, 2013)

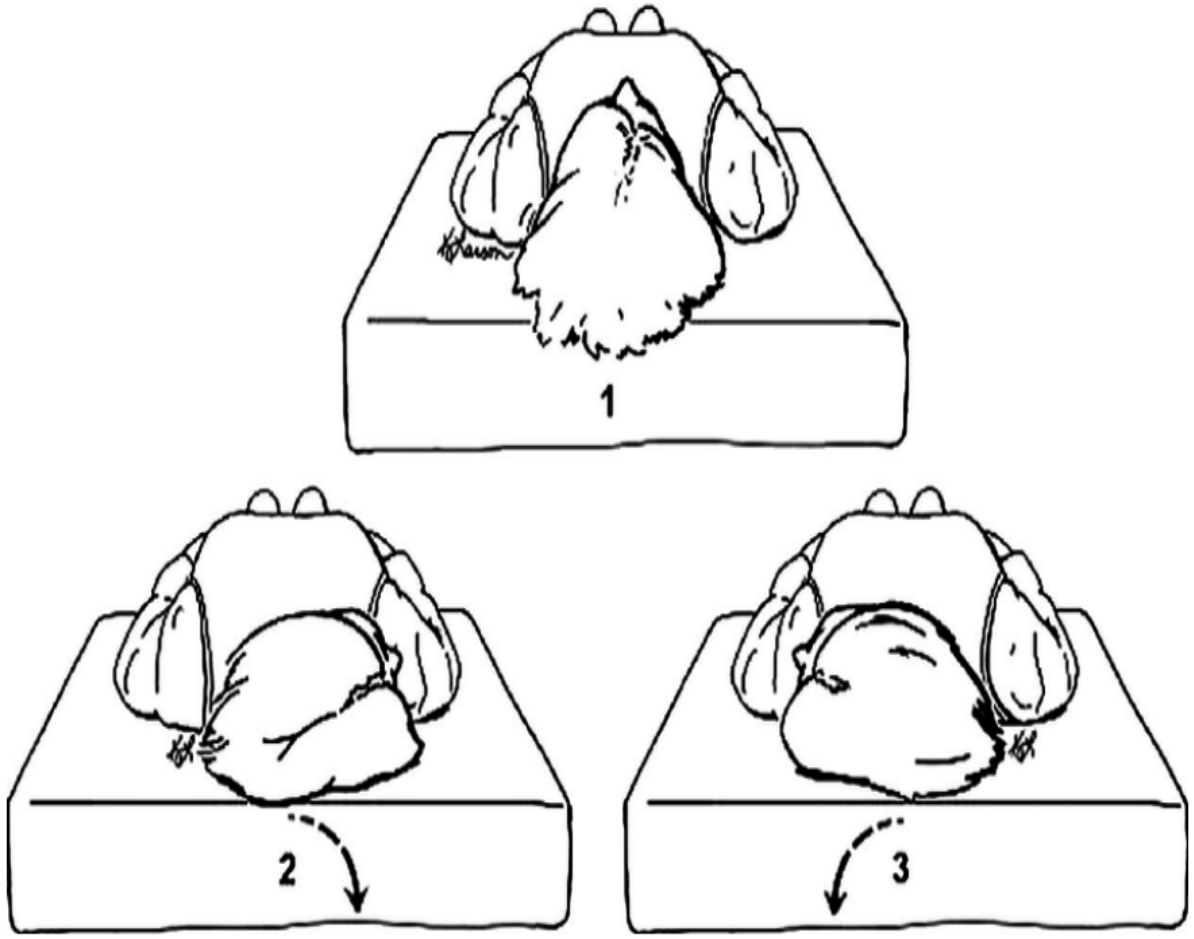
Functional Gait Assessment- 10 item gait assessment

- good retest/ interrater reliability, and validity for vestibular pts, (Wrisley, 2004)

Subjective Assessments: Dizziness Handicap Survey, ABC scale, Visual Vertigo Scale, Post-Concussion Symptoms Scale



Dix Hallpike Maneuver



Supine Roll Test

Clinical Practice Guideline: Benign Paroxysmal Positional Vertigo, Nov. 2008

Balance Error Scoring System (BESS)

Need: foam, timer

- Measures vestibulospinal impairment
- Developed specifically for concussion
- Can be used at sideline or in clinic

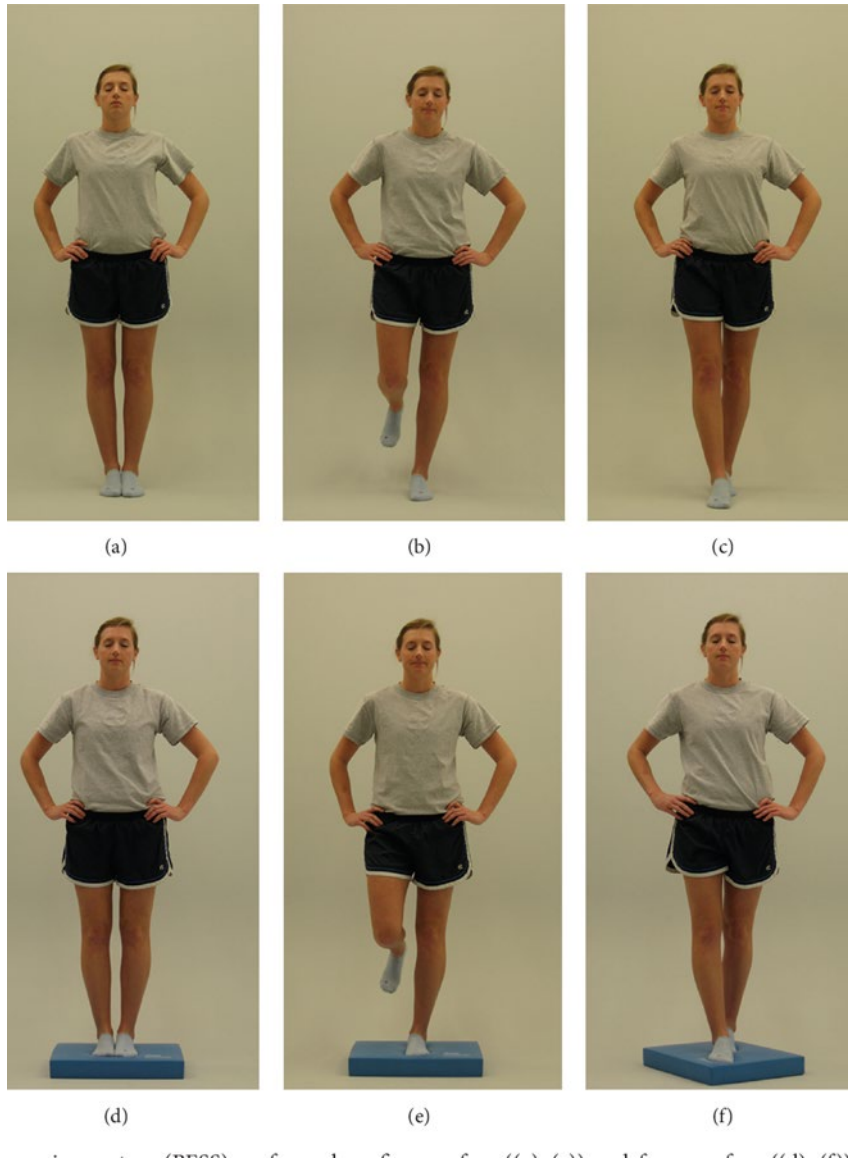
- Current "gold standard" (Bell 2011)
- May be best used as prescreening test for a suspected concussion (Guskiewiez, 2007)
- Most useful 2 days post injury (Giza, 2003; McCrea, 2003)

BESS

- Subject should perform without shoes, hands on hips x 20 sec
- Double Leg Stance= narrow base of support
- Single Leg Stance (SLS)= non dominant foot
- Tandem= dominant foot in back
- Multiple errors at 1 time= 1 error

Scoring: 1-10 errors/ trial

- Move hands off hips
- Opening eyes
- Step, stumble, fall
- Lifting foot/ heel off of surface
- Hip moves more than 35 degrees from midline
- Remain out of proper testing position >5seconds



Effectiveness

- Vestibular rehab is a useful treatment for pts w/persistent dizziness and balance problems not resolved w/ rest

  - significant improvement in subjective reports (Alsalaheen, 2010)

- Cervico-vestibular rehab may dec time to medical clearance for patients with persistent dizziness, head or neck pain (Schneider, 2014)

Table 2 Best evidence synthesis table

Does vestibular rehabilitation postconcussion	Best evidence synthesis statement
1(a) Does vestibular rehabilitation improve reports of dizziness and vertigo postconcussion?	The best evidence synthesis is that currently no level 1 evidence exists to support the statement that vestibular rehabilitation after mTBI/concussion improves dizziness. Level 3 evidence supports improvement in Dizziness Handicap Inventory scores.
1(b) Does vestibular rehabilitation improve balance impairment postconcussion?	The best evidence synthesis is that currently no level 1 evidence exists to support the statement that vestibular rehabilitation after mTBI/postconcussion improves DVA. Level 3 evidence supports improvement in DVA with gaze stabilisation exercises.
1(c) Does vestibular rehabilitation improve balance impairment postconcussion?	The best evidence synthesis is that currently no level 1 evidence exists to support the statement that vestibular rehabilitation after mTBI/postconcussion improves balance. Level 3 evidence supports improvement following a daily home exercise programme of vestibular rehabilitation in balance as measured by the Sensory Organisation Test and in self-efficacy related to balance as measured by the Activities-specific Balance Confidence scale.
1(d) Does vestibular rehabilitation improve gait impairment postconcussion?	The best evidence synthesis is that currently no level 1 evidence exists to support the statement that vestibular rehabilitation after mTBI/postconcussion improves gait. Level 3 evidence supports improvement in gait as measured by the Dynamic Gait Index, Functional Gait Assessment and Timed Up and Go with gait retraining as a component of vestibular rehabilitation.
2. Facilitate early return to sport/work	Level 1 evidence in the form of only 1 RCT supports cervical spine physiotherapy and vestibular rehabilitation in combination after mTBI/concussion. This multimodal intervention statistically improved the odds (3.91 times more likely) to be medically cleared to return to sport at 8 weeks over and above usual care in individuals with vestibular symptoms and cervical spine involvement and/or headache post-mTBI. No evidence currently exists to support the statement that vestibular rehabilitation alone after mTBI improves return to work.

DVA, dynamic visual acuity; mTBI, mild traumatic brain injury; RCT, randomised controlled trial.

Murray DA, *et al*. *Br J Sports Med* 2017;**51**:442–451. doi:10.1136/bjsports-2016-096081

Educate on vestibular system & relationship to balance/ dizziness

Teach grounding techniques (i.e. touch a stable object, focus on a stable object, etc)

Meditation/ breathing techniques

Alcohol can worsen symptoms

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Occupational Therapist's Role in Post Concussion Syndrome

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Disclosures

No disclosures

Learning Objectives

- Understand OT's role in post concussion rehab
- Review prevalence of visual deficits post concussion
- Determine when to refer to OT
- Discuss assessment tools and interventions used to treat oculomotor dysfunction post concussion

OT's Role in Post Concussion Rehab

- In post concussion rehab, occupational therapists address:

Oculomotor Function	Visual/Perceptual Skills	Motion Intolerance & Visual Motion Sensitivity	Appropriate Re-Exposure to Daily Activities	Mindfulness

• Use of the VOMS assessment
• Adult Vision Questionnaire
• Oculomotor Exam
• VOR
	• Motor Free Visual Perception Test (MVPT)
	• Trail Making
	• Letter Cancellation
	• Line bisection
	• Maze Test
		• Motion Sensitivity Quotient (MSQ)
		• Dizziness Handicap Inventory (DHI)
		• Habituation for desensitization
		• Visual Motion Sensitivity – OPK videos; habituation & exposure
			• Habits, Roles, and Routines
			• Return to work, school, and play
			• Fatigue scale
			• Pt education
			  • Activity pacing
			  • Eye ergonomics
			  • Gradually increasing exposure
			  • Organization strategies
				• Meditations
				• Relaxation

OT's always ensure interventions will translate into functional activities. We use a variety of interventions to help patient's reintegrate themselves into daily activities and improve performance and participation with all meaningful occupations.

The Visual and Oculomotor System

- Visual symptoms/deficits are common post concussion, as ~1/2 of the brain's circuits are involved in vision and control of eye movements. [1]
- "The visual system is particularly vulnerable to the effects of brain injury due to its expansive anatomy and physiology throughout the brain (Singman, 2013), as approximately 70% of the brain is used for visual and sensory processing (Suter, 2010)." [3]
- "Posttraumatic vision or oculomotor problems are reported in 30% to 65% of patients with a mild traumatic brain injury and in nearly 30% of patients with a SRC." [2]
- The neural circuits needed to coordinate eye movements efficiently without symptoms are very complex and are still not fully understood pathophysiologically. [3]

When to refer to OT [1, 2, 3, 4, 5]

Symptoms Post Concussion

- Headache
- Nausea
- Dizziness
- Difficulty reading (losing place when reading and with close up work)
- Difficulty using computer and/or phone / screen intolerance (difficulty concentrating or increase in symptoms)
- Difficulty returning to normal, daily activities
- Blurred vision/focus
- Eye fatigue
- Eye strain and/or burn
- Diplopia (double vision)
- Pressure behind eyes
- Photophobia
- Sensitivity to visual stimuli (visual motion sensitivity)
- Difficulty with more visually based academic work (ex: math and reading)
- Anxiety
- Distractibility/attentional concerns
- Inability to shift focus between objects
- Inability to track an object
- Visual field loss

Timeline

- OT is warranted when symptoms linger post concussion.

- Research suggests that the sooner a person receives therapy for visual deficits, the better the outcomes with faster recovery time.
  - If visual symptoms do not recover spontaneously in 2 weeks in adults or 4 weeks in adolescents [1] → refer to therapy
  - Early management is preferable, but majority of vestibular and/or oculomotor dysfunction will self-resolve in 4 weeks. [3]
  - When early intervention is not available, ensure that the patient is referred for a more in-depth clinical evaluation and treatment when symptoms do persist >4 wks. [3]

Assessment Tools:

- Adult Vision Questionnaire
- Dizziness Handicap Inventory
- Oculomotor Exam
- The Vestibular/Ocular Motor Screening (VOMS) assessment tool
- Head Thrust / Impulse Test
- Dynamic Visual Acuity Test
- Visual/Perceptual Testing
- Motion Sensitivity Quotient

Subjective Questionnaires

Adult Vision Questionnaire

Adult Vision Questionnaire:
Directions: please check the answer that best describes your situation. If you wear glasses or contact lenses, answer the questions assuming that you are wearing them.

Never = never
Occasionally = less than 1 time/week
Frequently = at least 1 time/week
Always = everyday

1. Do you have headaches or facial pain?
2. Do you have pain in your eyes with eye movement?
3. Do you experience neck or shoulder discomfort?
4. Do you have dizziness, lightheaded or nausea while performing close up work? (computer work; reading; writing)
5. Do you have dizziness, lightheaded or nausea while performing far distance activities? (driving, tv, movies)
6. Do you experience dizziness when bending down and standing back up, or when getting up quickly?
7. Do you feel unsteady with walking, or drift to one side?
8. Do you feel overwhelmed or anxious while walking in a large department store or walking in a crowd?
9. Do you feel dizzy or off balance when walking down a long hallway or on bold patterned carpeting?
10. Does riding in a car make you feel dizzy or uncomfortable?
11. Do you find yourself with your head tilted to one side?
12. Does your posture tend to be leaning more forward or backward than your used to?
13. Do you experience poor depth perception or have difficulty estimating distances accurately?
14. Do you experience double/overlapping/shadowed vision at far distances?
15. Do you experience double/overlapping/shadowed vision at near distances?
16. Do you experience glare or have sensitivity to bright lights?
17. Do you close or cover one eye with near or far tasks?
18. Do you skip lines or lose your place while reading?
19. Do you use your finger to keep your place on the page?
20. Do you tire easily with close-up tasks?
21. Do you experience blurred vision with far distance tasks? (driving, television, movies, chalkboard at school)
22. Do you experience blurred vision with close up tasks? (computer, reading)
23. Do you experience words running together or appearing to move on the page?

History:
Have you ever been diagnosed with:
Traumatic brain injury (TBI) or concussion?
Reading disability?
Lazy eye?
Have you ever had an eye operation?

Dizziness Handicap Inventory (DHI)

Dizziness Handicap Inventory Date of Birth _____ Today's Date_____

Name _____ **Height** _____ **ft.** _____ **in.** **Weight**_____**lbs.**

Instructions: The purpose of this scale is to identify difficulties that you may be experiencing because of your dizziness. Please check "always", or "no" or "sometimes" to each question. Answer each question only as it pertains to your dizziness problem.

	Questions	Always	Sometimes	No
P1	Does looking up increase your problem?	☐	☐	☐
E2	Because of your problem, do you feel frustrated?	☐	☐	☐
F3	Because of your problem, do you restrict your travel for business or pleasure?	☐	☐	☐
P4	Does walking down the aisle of a supermarket increase your problem?	☐	☐	☐
F5	Because of your problem, do you have difficulty getting into or out of bed?	☐	☐	☐
F6	Does your problem significantly restrict your participation in social activities, such as going out to dinner, going to movies, dancing or to parties?	☐	☐	☐
F7	Because of your problem, do you have difficulty reading?	☐	☐	☐
F8	Does performing more ambitious activities like sports, dancing, and household chores, such as sweeping or putting dishes away; increase your problem?	☐	☐	☐
E9	Because of your problem, are you afraid to leave your home without having someone accompany you?	☐	☐	☐
E10	Because of your problem, have you been embarrassed in front of others?	☐	☐	☐
P11	Do quick movements of your head increase your problem?	☐	☐	☐
F12	Because of your problem, do you avoid heights?	☐	☐	☐
P13	Does turning over in bed increase your problem?	☐	☐	☐
F14	Because of your problem, is it difficult for you to do strenuous housework or yard work?	☐	☐	☐
E15	Because of your problem, are you afraid people may think that you are intoxicated?	☐	☐	☐
F16	Because of your problem, is it difficult for you to go for a walk by yourself?	☐	☐	☐
P17	Does walking down a sidewalk increase your problem?	☐	☐	☐
E18	Because of your problem, is it difficult for you to concentrate?	☐	☐	☐
F19	Because of your problem, is it difficult for you to walk around your house in the dark?	☐	☐	☐
E20	Because of your problem, are you afraid to stay home alone?	☐	☐	☐
E21	Because of your problem, do you feel handicapped?	☐	☐	☐
E22	Has your problem placed stress on your relationship with members of your family or friends?	☐	☐	☐
E23	Because of your problem, are you depressed?	☐	☐	☐
F24	Does your problem interfere with your job or household responsibilities?	☐	☐	☐
P25	Does bending over increase your problem?	☐	☐	☐

Oculomotor Exam

1. **Observation** [6]
   - Test: observe patient's resting position: head tilt, ptosis, sunglasses, squinting
   - Be sure to ask about acuity – does the patient wear glasses/contacts, readers, cataracts repaired, etc.

2. **Spontaneous Nystagmus** [7]
   - Any nystagmus present with primary gaze
   - Test: Observe patient's eyes as they look straight ahead
   - Involvement:
     - Central: vertical, pure torsional, pure horizontal
     - Peripheral: mixed horizontal and torsional (fast phase towards more neurally active side)

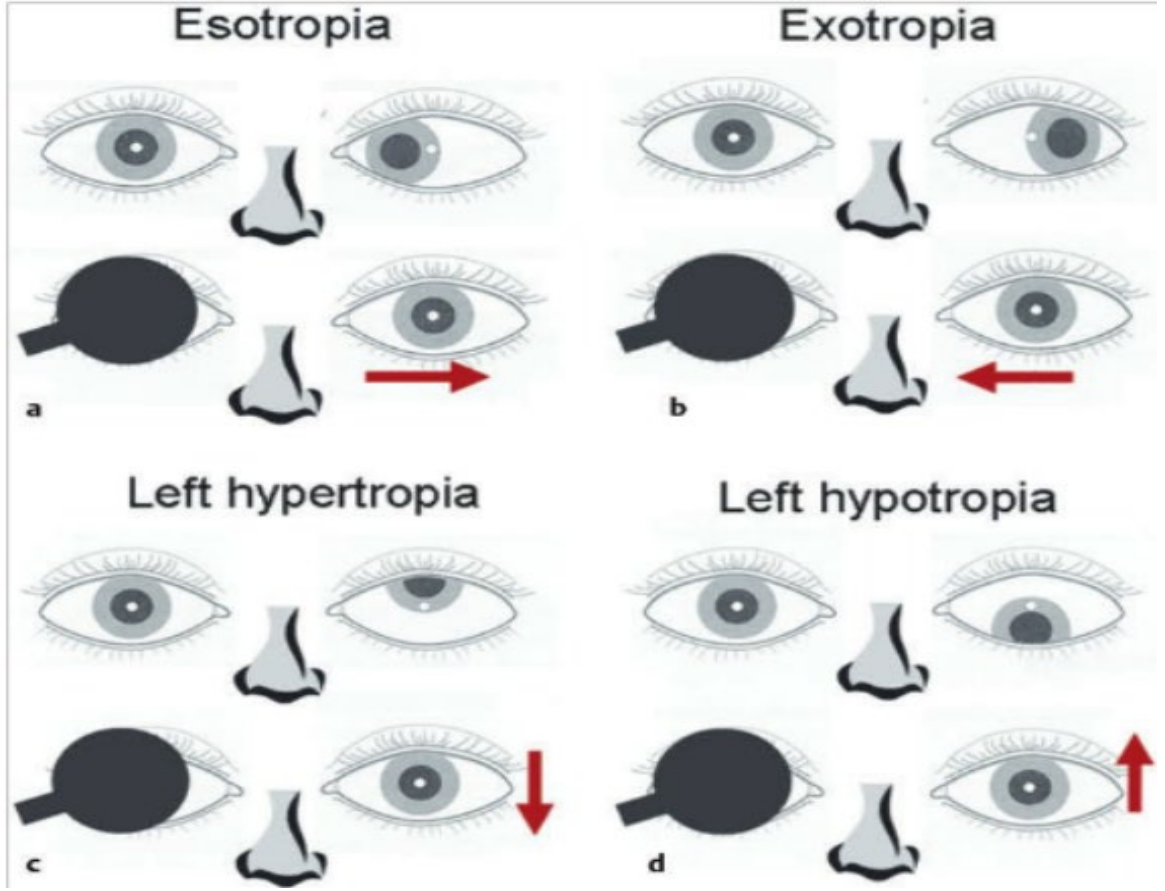
Oculomotor Exam cont.

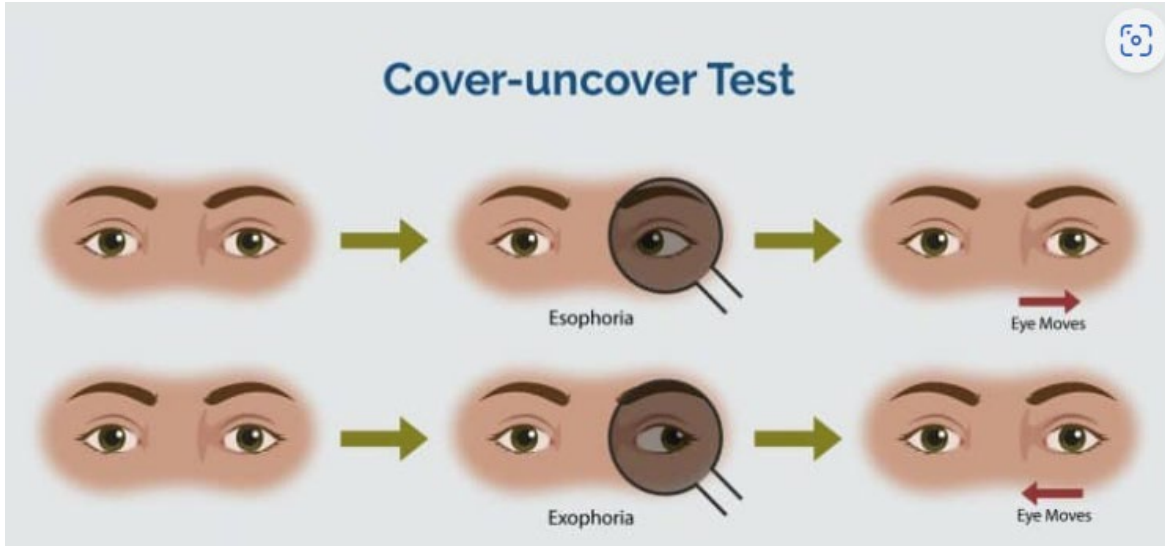
3. **Ocular Range of Motion (Extraocular ROM)** [6, 8]
   - Assess full ocular ROM
   - Test:
     - Patient's head is stationary. Hold finger tip or tip of pen ~18-24 inches in front of the patient and have them follow the point with their eyes only.
     - Move the point left to right, up and down, and diagonal planes.
   - Involvement: possible cranial nerve palsy

4. **Gaze Holding Nystagmus** [6, 7, 8]
   - Assess for presence of nystagmus or inability to hold position
   - Test:
     - Patient's head is stationary. Hold finger tip or tip of pen ~18-24 inches in front of the patient and have them follow the point with their eyes only.
     - Move 30 degrees from center left, right, up, and down.
     - Hold each position to observe for presence of nystagmus and note the direction.
     - Involvement:
       - Non-pathological: nystagmus can occur at ocular end range, especially in older individuals, but should not be persistent
       - Central dysfunction: Direction changing
       - Peripheral dysfunction: Unidirectional; no matter where they gaze, same direction of nystagmus; magnitude may change

Oculomotor exam cont.

5. **Ocular Alignment Considerations** [6, 9, 10]
   - 2 types:
     1. Strabismus / Tropia – Always present; eyes can't focus on the same central point
     2. Phoria – Can be temporary due to fatigue
   - **Cover/Cross Cover Test**: Identifies tropia of the uncovered eye
     - Tests for misalignment during binocular function
     - Looking for movement of the uncovered eye
     - Test Instructions:
       - Occlude vision of one eye while patient focuses on target in midline
       - Observe the uncovered eye for movement
       - Affected eye will move out of resting position to center to maintain focus on target
       - Repeat on other eye
   - **Cover/Uncover Test**: Identifies phoria based on eye movement when cover is removed from eye
     - Tests for misalignment that may be compensated for in binocular function tasks
     - Test Instructions:
       - Occlude vision of one eye while patient focuses on target in midline
       - Observe for refixation movement of occluded eye when cover is removed
       - When occluded, affected eye will move into desired resting position, since not needed to maintain binocular function
       - If phoria present, eye will shift back to straight looking position, once uncovered to maintain fusion with the other eye
       - Repeat on other eye





The Vestibular/Ocular Motor Screening (VOMS) [1, 6, 11]

- Special test for post concussion population
- Standardized assessment tool used to assess common oculomotor and vestibular problems via patient reported symptom provocation after each assessment following concussion
- “Has good sensitivity for identifying concussion and confirming visual dysfunction as a cause for ongoing visual symptoms” [1]
- 5 domains:
  - Smooth pursuits
  - Horizontal and vertical saccades
  - Near point convergence
  - Horizontal and vertical vestibulo-ocular reflex (VOR)
  - Visual motion sensitivity
- Test:
  - At rest, prior to testing, establish patient’s baseline symptoms on a scale from 0 (none) to 10 (severe) for symptoms of headache, dizziness, nausea, and fogginess
  - Each of the 5 domains is performed
  - Patient verbally rates changes in headache, dizziness, nausea, and fogginess symptoms on a scale of 0 (none) to 10 (severe) compared with their immediate pre-assessment state after each domain to determine if each assessment provokes symptoms.
- Identified deficits require more in depth assessment

Vestibular/Ocular Motor Test:	Not Tested	Headache 0-10	Dizziness 0-10	Nausea 0-10	Fogginess 0-10	Comments
BASELINE SYMPTOMS:	N/A					
Smooth Pursuits						
Saccades – Horizontal						
Saccades – Vertical						
Convergence (Near Point)						(Near Point in cm): Measure 1: _____ Measure 2: _____ Measure 3: _____
VOR – Horizontal						
VOR – Vertical						
Visual Motion Sensitivity Test						

Smooth Pursuits [3, 6, 8]

- Tracking – Allows both eyes to simultaneously follow a slow moving target
- Assess ability of eyes to follow a moving target
- Test:
  - Patient's head is stationary. Hold finger tip or tip of pen ~18-24 inches in front of the patient and have them follow the point with their eyes only.
  - Move 30 degrees from center in all directions
  - Move the point at a speed of 20-40 degrees per seconds (it should take 2 seconds to move from 1 side to the other)

Abnormal Findings and Functional Impairments
• Saccadic intrusions • Variability in speed • Increase in symptoms • Reports of visual motion sensitivity, dizziness, and nausea when tracking/following moving targets • Difficulty driving and tracking other vehicles in traffic • Difficulty watching action movies on TV • Difficulty scrolling on screens

- Impaired pursuits range from 43-60% of people with mTBI
- Involvement = central

Saccades [3, 6, 8]

- Gaze shifting – Allow both eyes to move quickly in the same direction, quickly shifting eyes between targets
- Assess quick simultaneous movement of both eyes in same direction
- Test:
  - Patient's head is stationary. Hold finger tip or tip of pen 30 degrees to one side of your nose.
    - 1.5 feet to the side of midline to achieve 30 degree gaze
  - Have patient alternate between looking at your nose and the point with eyes only.
  - Do in all directions

Abnormal Findings and Functional Impairments

- > 2 eye movements to reach target
- Over shooting, undershooting
- Slowed speed
- Increase in symptoms
- Reports of dizziness with eye movements
- Headaches when reading,
- Eyestrain
- Symptom provocation when watching fast moving objects or shifting gaze horizontally or vertically
- Reading: need for re-reading, losing place when reading, issues with reading on screens
- Difficulty with eye contact

- Impaired saccades range from 21.6-30% of people with mTBI
- Involvement = central

Convergence [2, 3, 6, 8]

- Vergence – Disconjugate eye movements used to track an object moving closer or further away as well as looking at objects that are located at different distances
- Convergence – Ability of eyes to move inwards to focus on close target
- Divergence – Ability of eyes to move outwards to focus on far target
- Test for Near Point Convergence (NPC):
  - Have patient hold point (recommended 14 point font, but may need to be adjusted based on patient's visual acuity) at arm's length away and bring it toward tip of nose while maintaining eyes on target.
  - Note the distance from bridge of nose when patient reports double vision, eyes deviate, or excessive blurriness

Abnormal Findings and Functional Impairments	
• Failure of eyes to converge • Point of convergence >5 cm • Eye deviation away from the target (exophoria) • Double vision (diplopia) • Overlap of images perceived as blurry vision or shadowing • Pressure behind eyes	• Issues with reading and losing place when reading • Eyestrain / fatigue • Headache • Distractibility / attentional concerns • Difficulty with more visually based work (math, reading)

- Impaired convergence range from 30-56% of people post-TBI and is reported as a prevalent deficit in people with hx of TBI
- Reduced NPC is linked to neurocognitive impairment (worse performance with verbal memory, visual motor speed, and reaction time) and gross motor system dysfunction (slowed gait speed, shorter stride lengths, and dual-task average walking speed)
- Involvement = central

Accommodation [3]

- Accommodation – visual clarity or “focus”; the eye needs to increase accommodation the closer an object is
- Accommodation disorders can cause symptoms similar to those of convergence disorders
- Near point of accommodation (NPA) – how much a person is able to engage focus as an object approaches the eye and still perceive the object to be clear
- Accommodative insufficiency (AI) – occurs when NPA is lower than expected norms for the person’s age
- Accommodative spasms (AS) – occurs when the accommodative system over-accommodates for a stimulus; the eye is unable to release focus after looking at a near target for a prolonged period of time
- Accommodative infacility – when the accommodative response is slow in speed

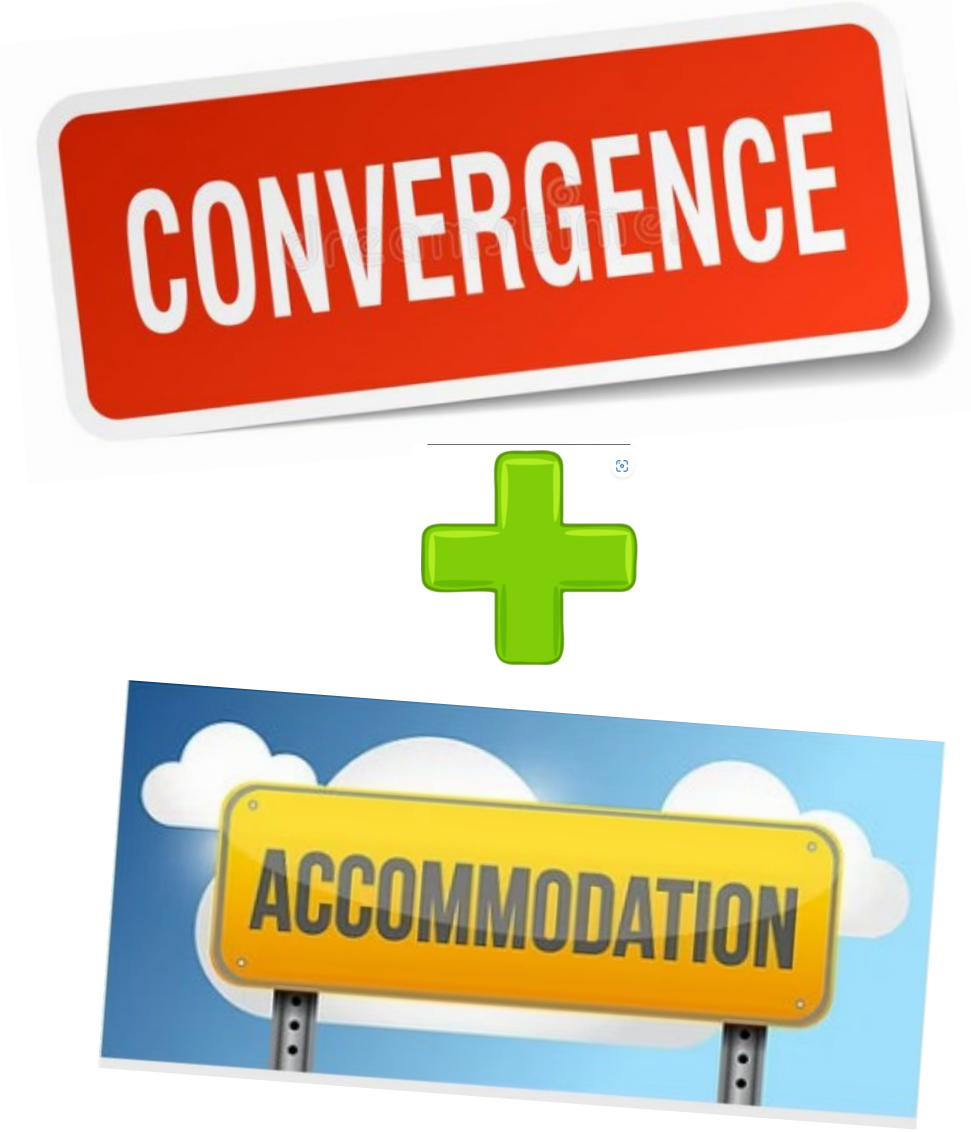
Abnormal Findings and Functional Impairments

- Blurred vision
- Eyestrain
- Headaches
- Changes in focus
- Nausea
- Dizziness
- Headaches with prolonged near work and blurry vision at distance afterwards → symptom of AS

- Accommodative disorders are one of the most common oculomotor problems post concussion occurring in 51% of post concussion adolescents
- Accommodative disorders have been found in up to 41% of people with TBI with reduced NPC

Convergence and Accommodation Relationship [3, 4]

- Convergence and accommodation are closely related and work together
- We need a combination of convergence and accommodation to change viewing distance from near to far objects
- Convergence insufficiency and accommodative insufficiency are two of the most prevalent problems post concussion in adolescents
- Sometimes, the inability to accommodate causes a reduced ability to converge
- When someone has both a convergence and accommodation problem, symptoms may persist for longer
- Convergence issues may not completely resolve with convergence exercises alone due to the underlying accommodation problem



Vestibular-Ocular Reflex (VOR) [3, 6]

- VOR – allows individuals to constantly maintain stable vision even when the head and/or body is in motion
- Assess the ability to stabilize vision on a target while the head is moving
  - Test:
    - Patient is seated. Examiner holds target of ~14 point font in front of patient at midline, ~3 feet away
    - Patient rotates head side to side and maintains focus on target
    - Amplitude of movements: 20-30 degrees to each side
    - Repeat for vertical direction

Abnormal Findings and Functional Impairments	
• Eyes slip off of target and corrective saccade used to reposition eyes on target • Headache • Dizziness • Nausea • Imbalance	• Movement related blurry vision • Unsteadiness • Vertigo • Anxiety in busy environments • Visual motion sensitivity

- Limited research regarding prevalence of VOR specific dysfunction post concussion; studies range from 0-71% of individuals
- Involvement = peripheral

VOR Cancellation (visual motion sensitivity) [3, 6]

- Visual Motion Sensitivity – can occur when an individual becomes overly reliant on the visual system, which results in a heighted awareness of visual motion, specifically when in visually complex/stimulating environments
- In order to shift the direction of gaze in the direction of head movement, VOR mechanism must be overridden – occurs at the level of the cerebellum
- Test:
  - Patient stands, hold arms outstretched and focuses on thumb
  - While maintaining focus on the thumb, patient rotates the head, eyes and trunk together as a unit
  - Amplitude: 80 degrees each direction
  - Speed: 50 bpm on metronome (1 beat each direction)
  - Perform 5 reps; 1 rep = trunk rotates back and forth to starting position

Abnormal Findings and Functional Impairments
• Symptoms of headache, dizziness, nausea ten seconds after test is completed

- Involvement = central

Additional assessments for VOR deficit [7, 12, 13]

Dynamic Visual Acuity Test

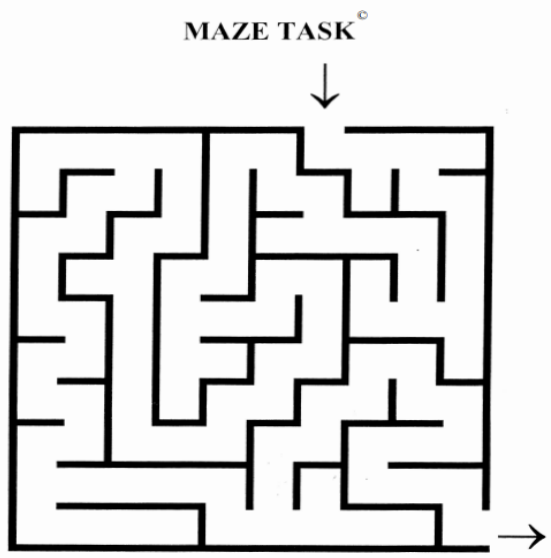
- Indicates deficiency in VOR
- Test:
  - Patient is seated ~20 feet away from traditional Snellen eye chart
  - Have patient recite the lowest line on an eye chart with no head movement.
  - Passively rotate the patient's head side to side at 2 Hz. Have them read the lowest line they can until they make an error.
  - Use metronome to standardize frequency (240 bpm if moving with beat)
  - Note the difference in the number of correct lines read.
  - Greater than a 2-line loss indicates impaired VOR
- Involvement: peripheral

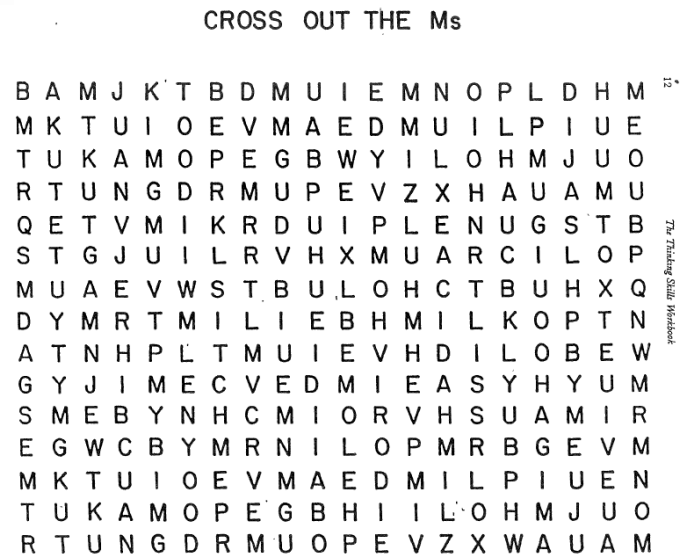
Head Thrust / Impulse Test

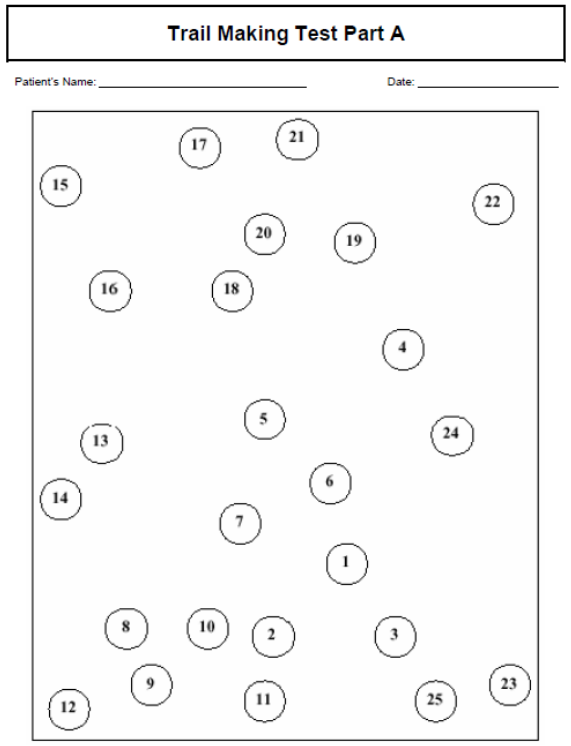
- Indicates VOR deficit
- Test:
  - Patient is seated in front of the tester with eyes fixated on the examiner's nose or distant target
  - Examiner moves head quickly and in unpredictable patterns 10-15 degrees of neck rotation
  - Looking to see if eyes remain on the target of fixation with quick head movements
  - Abnormal findings include: eyes slip off the target with quick head turns followed by a corrective saccade back to the target
- Involvement: peripheral

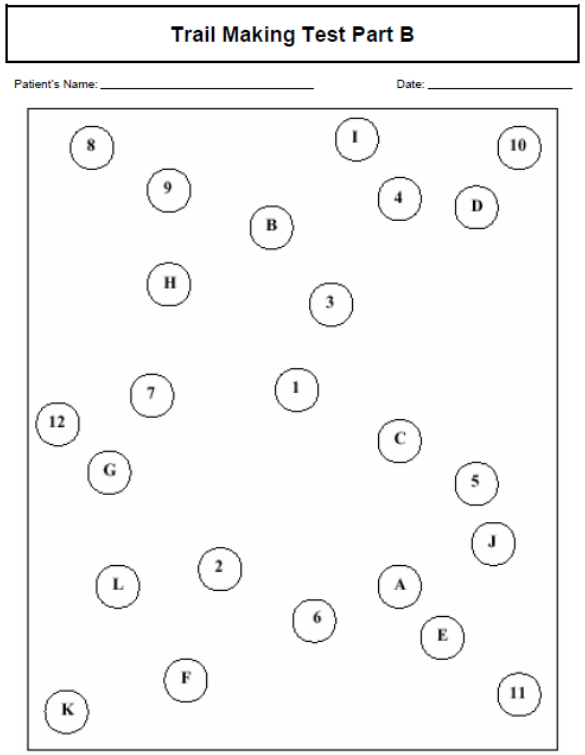
Visual Perceptual Testing

- Motor Free Visual Perception Test (MVPT): assesses figure ground, visual discrimination, spatial relationships, visual closure, and visual memory [14]
- Maze Test: assesses attention, visuoconstructional ability, and executive functions of planning and foresight [15]
- Trail Making: assesses cognitive flexibility, alternating attention, sequencing, visual search, and motor speed [16]
- Letter Cancellation: assesses visual scanning [17]









Motion Sensitivity Testing [18]

Motion Sensitivity Quotient (MSQ)

- "Clinical test designed to measure motion-provoked dizziness during a series of 16 quick changes to head or body positions. May also be used as a guide for developing an exercise program for patients with motion provoked dizziness."

MOTION SENSITIVITY TESTING Date: _____

Intensity 0-5 0 = none 5 = severe

Duration < 5 s = 0 5-10s = 1 11-30s = 2 >30s = 3

Score = Intensity + duration

Baseline symptoms	Intensity	Duration	Score
1. Sitting to supine			
2. Supine to L side			
3. Supine to R side			
4. Supine to sitting			
5. L Hallpike-Dix			
6. Up from L			
7. R Hallpike-Dix			
8. Up from R			
9. Sitting, head tipped to L knee			
10. Head up from L knee			
11. Sitting, head tipped to R knee			
12. Head up from R knee			
13. Sitting head turns (5)			
14.Sitting head pitches (5)			
15. In stance, 180° turn to L			
16. In stance, 180° turn to R			

MSQ = Total score x (# of positions) / 20.48 MSQ = _____

MSQ 0-10 mild
11-30 moderate
31-100 severe

Signature: _____ Designation: _____

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Interventions and Treatment

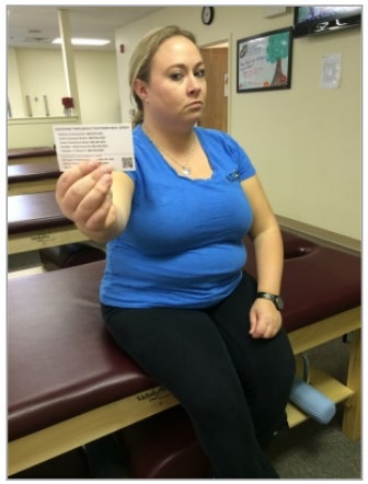
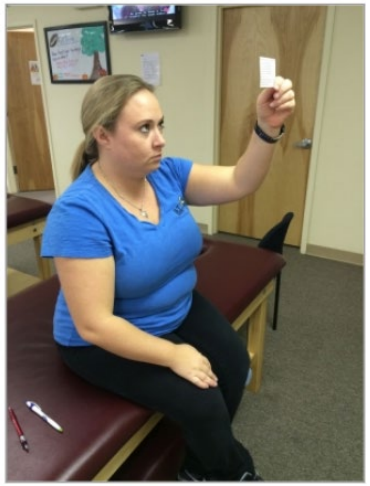
- Oculomotor exercises with progressions
- Motion tolerance/habituation activities for desensitization
- Visual motion sensitivity activities for desensitization
- Pt education
- Activity pacing
- Visual/perceptual activities as indicated
- Mindfulness

Adaptations for Symptom Management

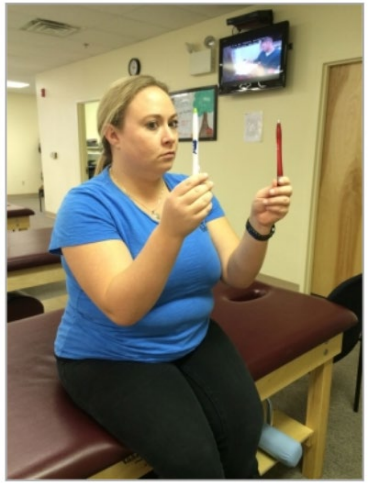
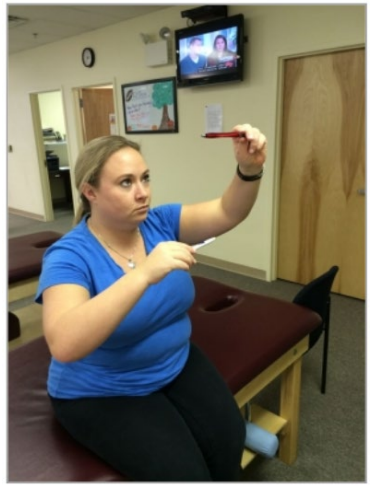
Light Sensitivity	Noise Sensitivity	Other
• Amber polarized sunglasses • Cap with a bill • Blue light blocking glasses- Livho • Fluorescent light covers/diffuser - this is a cover that attaches with magnets to cover lights. It can be colors or decorative patterns. • Dim lights • Blue light blocker on phone • Glare protection screens • Decrease light on computer • Use of reading glasses • Take regular breaks from computer/phone screen- once an hour. This is for when someone is returning to school or work. In acute stages, technology should be avoided.	• Ear plugs • Headphones • Avoid noisy places at first and then gradually start going again choosing less busy times • White noise or fan for sleeping	• Good sleep hygiene • Mental Imagery/Relaxation practice • Plan your day/activities to avoid need to multitask • Allow for periods of rest in daily routine • Activity pacing

Oculomotor exercises with appropriate progressions [19]

Smooth Pursuits

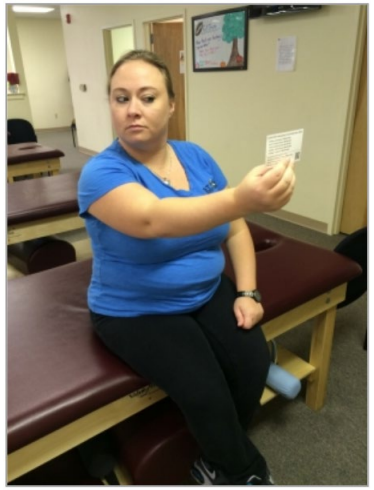
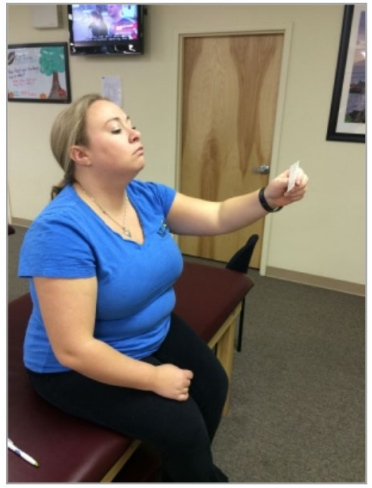



Saccades

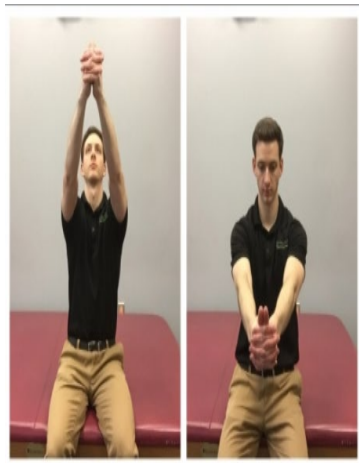



Convergence

VOR

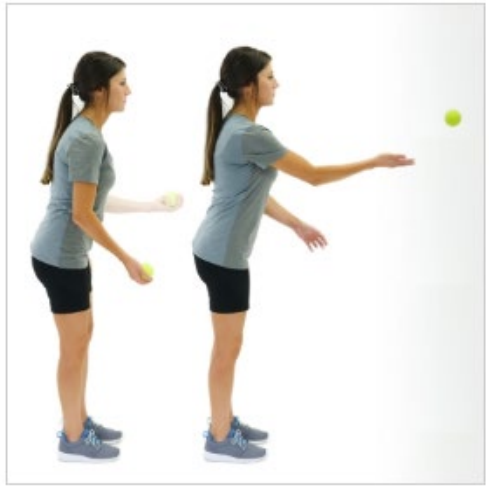
VOR Cancellation

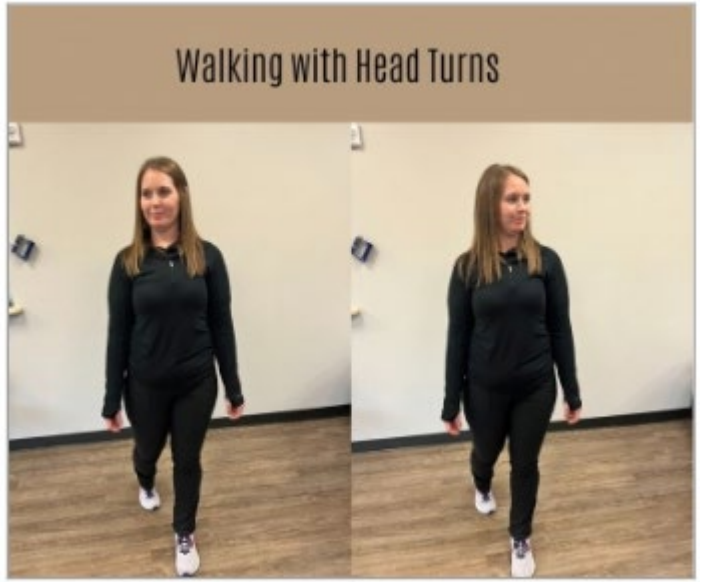



Progressions


Motion Tolerance / Habituation for Desensitization

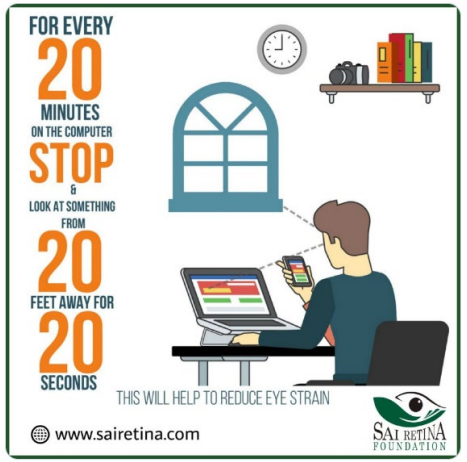
- Perform the exercises, movements, or activities that increase pt's symptoms in a controlled systematic manner
- Activities that involve dual tasking
- Activities that involve work or sport specific movements
- Exposure to visual situations that are bothersome to the patient for desensitization → visual motion sensitivity
  - Optokinetic videos
  - Visual scanning exercises
- Keep in mind symptom elevation





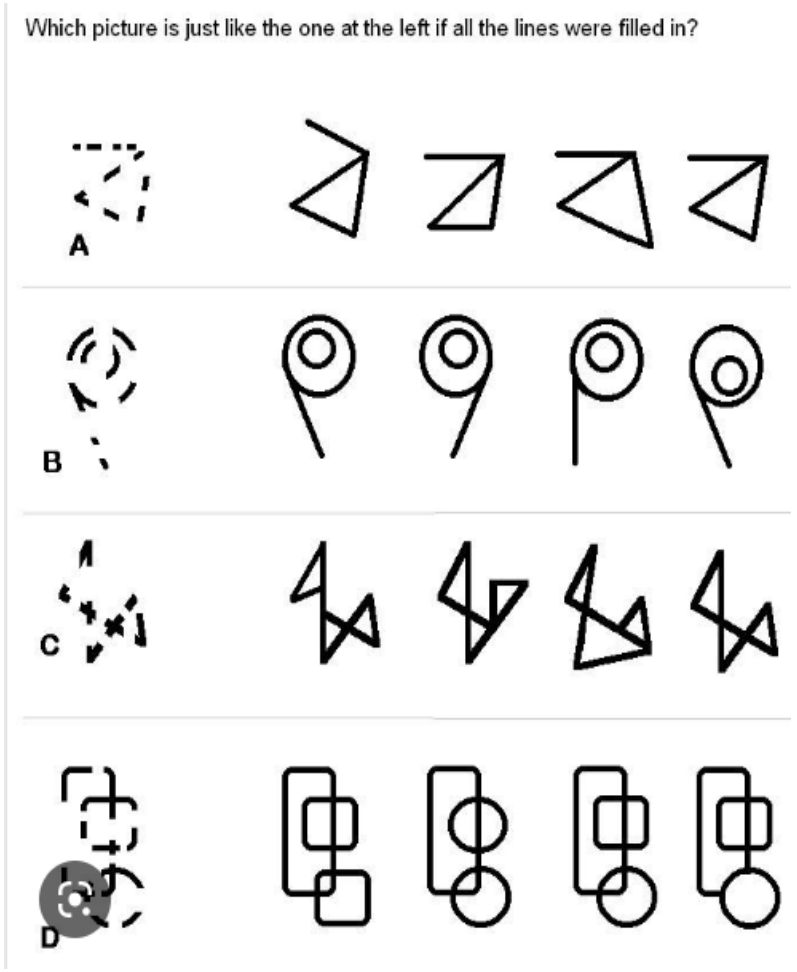
Patient Education

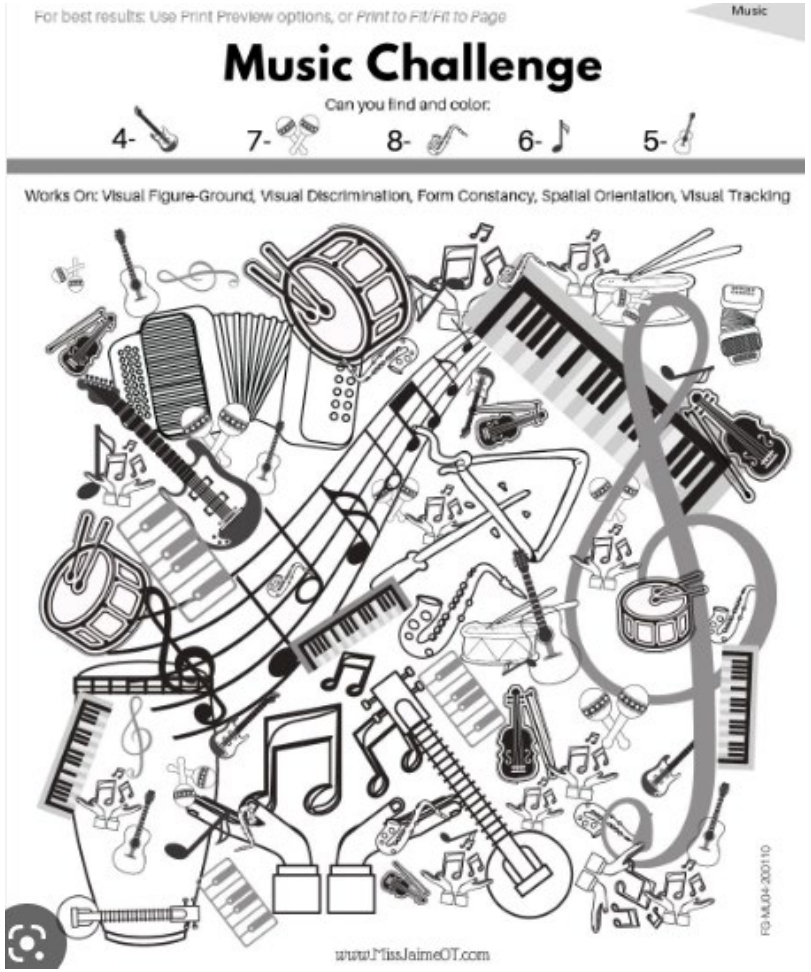
- Activity pacing
  - Pace return to activities
  - Help patients to create a schedule
  - Use of alarms/auditory reminders to take breaks
- Eye ergonomics
  - Blue light glasses
  - Backlighting
  - Palming – warm hands by rubbing them together and place them over eyes
  - Be sure to have computer screens at eye level
- Organization strategies
  - Use of calendars to help with time management
  - Visual reminders/lists

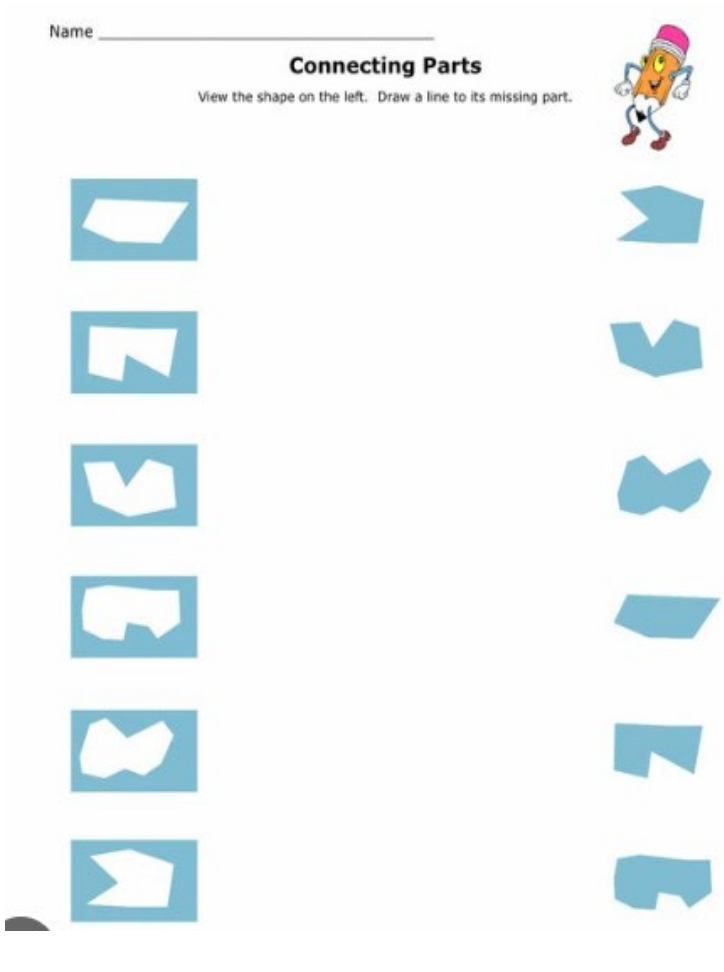


Visual Perceptual

- Use of worksheets to challenge figure ground, visual discrimination, visual closure, visual memory, and spatial relationships







Relaxation / Mindfulness

- Often recommend use of Insight Timer or Head Space app
- Help your patient set up an appointment with a psychologist/psychiatrist to address mental health

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The Role of Speech Therapy in Intervention for Concussion

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Ochsner®
Therapy & Wellness

Disclosures

- No financial disclosures
- I am an Ochsner Health employee

Scope of Practice of Speech Language Pathologists

Articulation	Fluency	Voice	Language
Swallowing	Cognitive Communication	Social Communication	Communication modalities

Role of the SLP With Concussion

Assess	• Determine deficits • Compare patient complaints and standardized assessment scores
Treat	• Using evidenced based practice • Goal-Plan-Action-Review, Time Pressure Management Training, Goal attainment Scaling
Educate	• Cognitive Fatigue • Strategies
Accommodations	• Visual/Auditory supports • Pacing • Notetaking supports

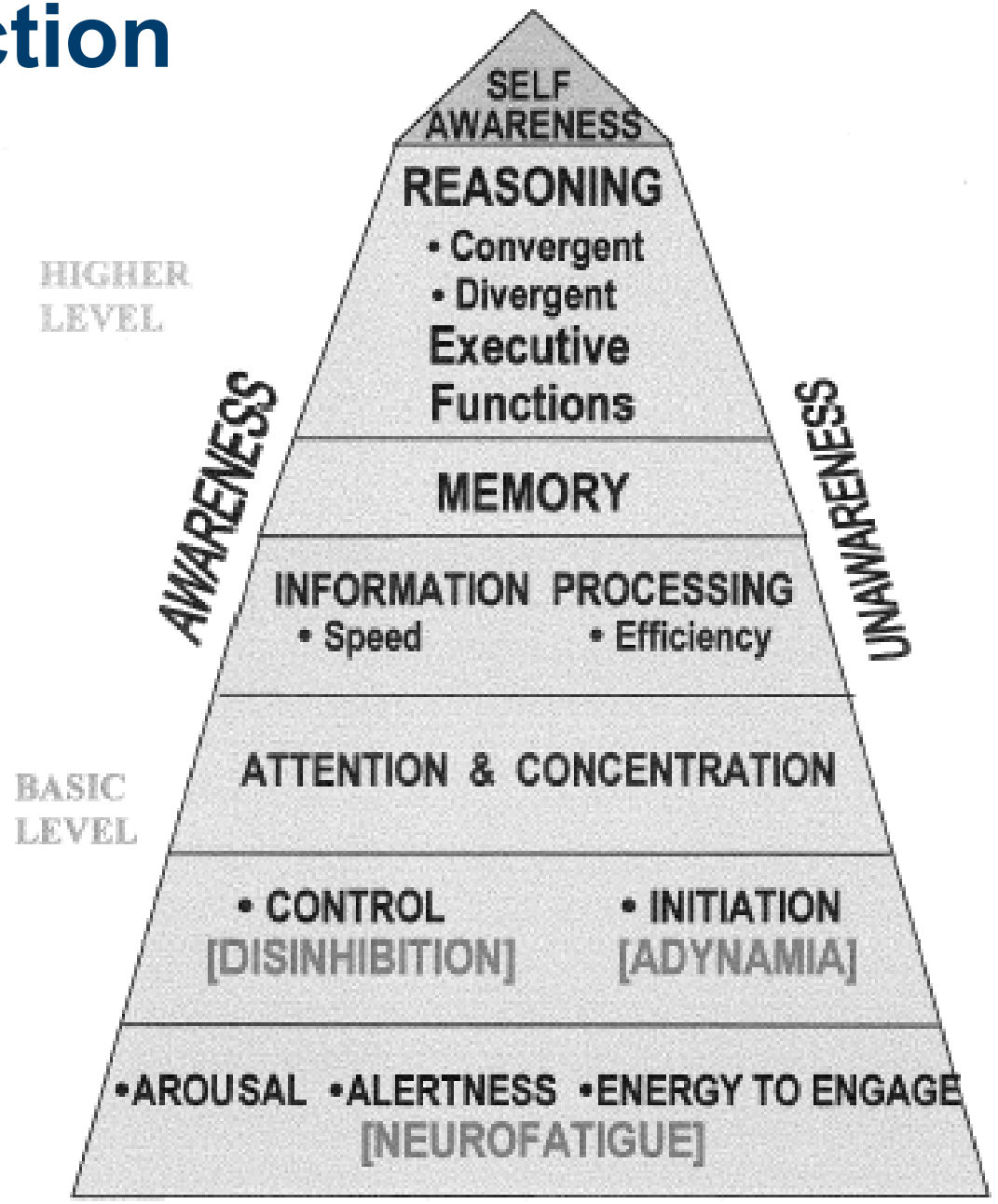
Goal of the SLP

"The goal of SLP engagement is to enable individuals to restore, to the fullest extent possible, their premorbid cognitive communication functioning in order to resume their participation in professional, personal, and community activities."

(Mashima et al, 2021)

Domains of Cognitive Function

- Arousal
- Attention
  - Working memory
  - Sustained
  - Selective
  - Alternating
  - Divided
- Memory
- Executive Functions
  - Problem Solving
  - Deductive reasoning
  - Inductive reasoning
  - Time management
  - Prioritization



Types of Attention

Focused Attention	Sustained Attention	Selective Attention	Alternating Attention	Divided Attention
• Responding to your name as it is being called	• Able to work on a task over a period of time in a quiet environment • Utilizes working memory	• The ability to ignore or "tune out" distracting stimuli • Typical environmental noise is tuned out	• Switching your attention between two tasks • Reading information and responding to given question	• The ability to respond accurately to multiple present stimuli • Taking notes while teacher or colleague is speaking

(Ketcham et al, 2017)

Patient Complaints Indicating Cognitive Dysfunction

When to Refer to Speech Therapy?

Use your tools

- Ask the SLPs on your team and discuss with team members
- The Rivermead Concussion Inventory has questions about fogginess, difficulty concentrating, etc

Ask questions

- How is school going?
- Are you able to complete your homework?
- How far into the school day do you get without having a headache?
- Tolerance within the session?
- Have they returned to work? Why not or how is it going?

It is always better to address cognitive based changes early to prevent following behind in school or work.

Assessment

Purpose of the SLP Assessment

01

Determine cognitive communication deficits

02

Find their baseline prior to creating goals

03

Understand what may be causing difficulty in everyday life

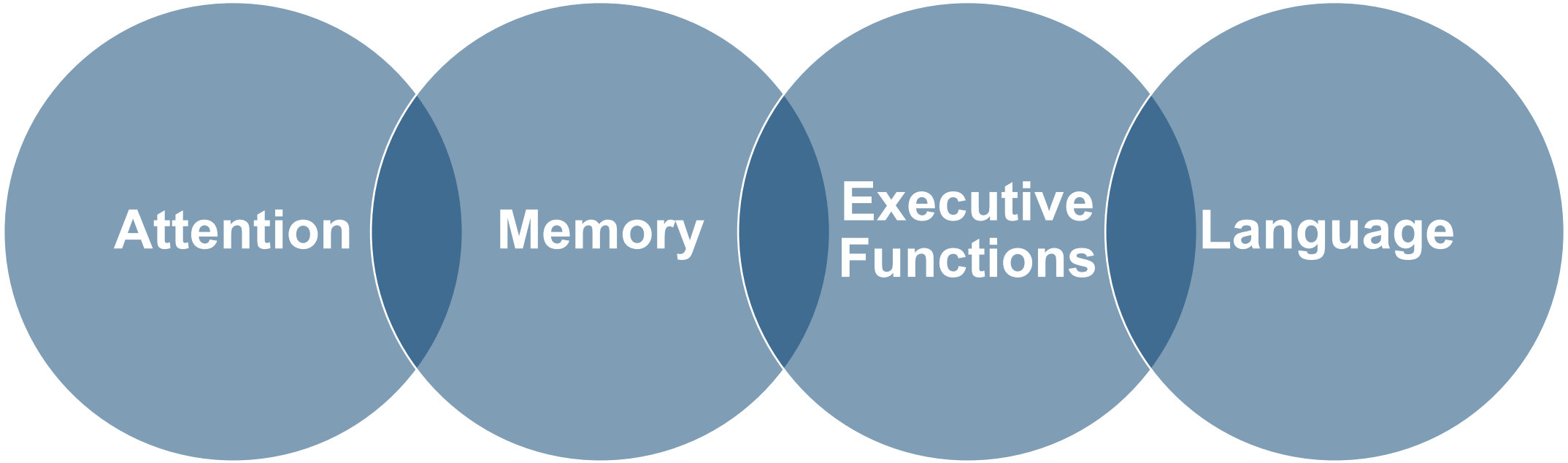
04

Aid in establishing return to learn accommodations

05

Assess how to make treatment specific and functional

Domains to Assess



Formal Assessments & Domains

Modality	Assessments
Multiple Modalities	**Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)** Cognitive Linguistic Quick Test (CLQT) Scales of Cognitive and Communicative Ability for Neuro Rehab (SCCAN)
Attention	Test of Everyday Attention
Information Processing	California Verbal Learning Test (CVLT-II)
Executive Functions	**Functional Assessment of Verbal Reasoning and Executive Strategies (FAVRES and FAVRES-S)**
Memory	Rivermead Behavioral Memory Test-Version 3
Language	Language Sample Reading and Writing can also be assessed from the FAVRES

(Hardin et al, 2021)

Informal Assessment

- Cognitive Communication Checklist for Acquired Brain Injury (CCCABI)
- Multifactorial Memory Questionnaire
- Rivermead Concussion Inventory
- Behavior Rating of Executive Functions (BRIEF questionnaires)

(Hardin et al, 2021)

Auditory Comprehension & Information Processing Possible factors: hearing, attention, memory, receptive language; comprehension, integration, reasoning, and speed of information processing	6. ☐ Hearing what is said, sensitivity to sounds, ringing in ears – Refer to Audiologist 7. ☐ Understanding words and sentences 8. ☐ Understanding long statements (discussions, lectures, news, TV) 9. ☐ Understanding complex statements (humour, subtle, implied information) 10. ☐ Integrating information – Cannot 'glue' information together to draw a conclusion or get the gist 11. ☐ Tendency to misunderstand or misinterpret discussions 12. ☐ Focusing attention on what is said (distraction, fatigue, interest) 13. ☐ Shifting attention from one speaker to another 14. ☐ Staying on track with the conversation, staying on topic 15. ☐ Holding thoughts in mind while talking or listening 16. ☐ Remembering new conversations, events, new information
Expression, Discourse & Social Communication articulation, word finding, language, memory, attention social communication, fatigue, fluency, reasoning, executive functions, social cognition, perception, self-regulation	17. ☐ Speech sounds, muscle movements, voice, fluency, stuttering 18. ☐ Word finding, word retrieval, thinking of the word, vocabulary, word choice 19 ☐ Sentence planning, sentence construction, grammar 20. ☐ Initiating conversation 21. ☐ Generating topics of conversation, thinking of what to say, elaborating, adding 22. ☐ Vague, nonspecific, disorganized conversation 23. ☐ Overly talkative, rambling, verbose conversation 24. ☐ Socially unsuccessful comments (impulsivity, anger, swearing, joking, topic selection) 25. ☐ Nonverbal skills (eye contact, personal space, facial expression, tone of voice, mannerisms, gestures) 26. ☐ Perceiving or understanding conversation partner cues, emotions, context, views
Reading Comprehension any written materials, print or electronic	27. ☐ Physical difficulties (vision: double, blurred, field, tracking, pain, fatigue, dizziness) - Refer to Optometrist, Opthalmologist 28. ☐ Decoding letters or words, reading aloud fluently 29. ☐ Comprehending read sentences, paragraphs, text 30. ☐ Retaining read information over time, remembering, organizing 31. ☐ Attending to what is read, need to read everything twice 32. ☐ Reduced stamina for reading (Reads for ____min now; ____min prior to onset)
Written Expression any written materials, print or electronic	33. ☐ Physical aspects of writing, hand movements – refer to Occupational Therapist 34. ☐ Writing words 35. ☐ Constructing sentences, formulating ideas for writing (sentence formulation) 36. ☐ Organizing thoughts in writing (written discourse) 37. ☐ Spelling difficulties relative to pre-injury abilities
Thinking, Reasoning, Problem Solving, Executive Functions, Self-Regulation (required for communication)	38. ☐ Insight, awareness, recognizing there is a problem 39. ☐ Making & expressing decisions (getting facts, weighing facts, pros & cons, deciding) 40. ☐ Discussing without being overwhelmed, upset, withdrawn 41. ☐ Filtering out less relevant information, focusing on priorities, main points 42. ☐ Organizing, integrating, analyzing, inferring, seeing the whole picture 43. ☐ Summarizing, getting the gist or the bottom line, drawing conclusions 44. ☐ Brainstorming, generating ideas, alternatives, thinking creatively 45. ☐ Planning, prioritizing, implementing, following through, evaluating, self-monitoring of communication

Stuttering & Other Speech Disturbances

- Stuttering post-concussion is not a common presentation
- We do not have a link established in the research
- However, according to 17 case reviews, stuttering is most common in concussion that are:
    - Female (64%)
    - Sports or fall related (as opposed to car accidents) (71%)
    - Stuttering onset within 24 hours (100%)
        - Within 1 hour (50%)
        - Between 1 and 24 hours (50%)

(Cherry & Gordon, 2017)

Strategies for Speaking to Someone Who Stutters

Pause between conversational turn taking

Maintain eye contact

Use positive non-verbal behaviors

Don't try to guess the word they are saying

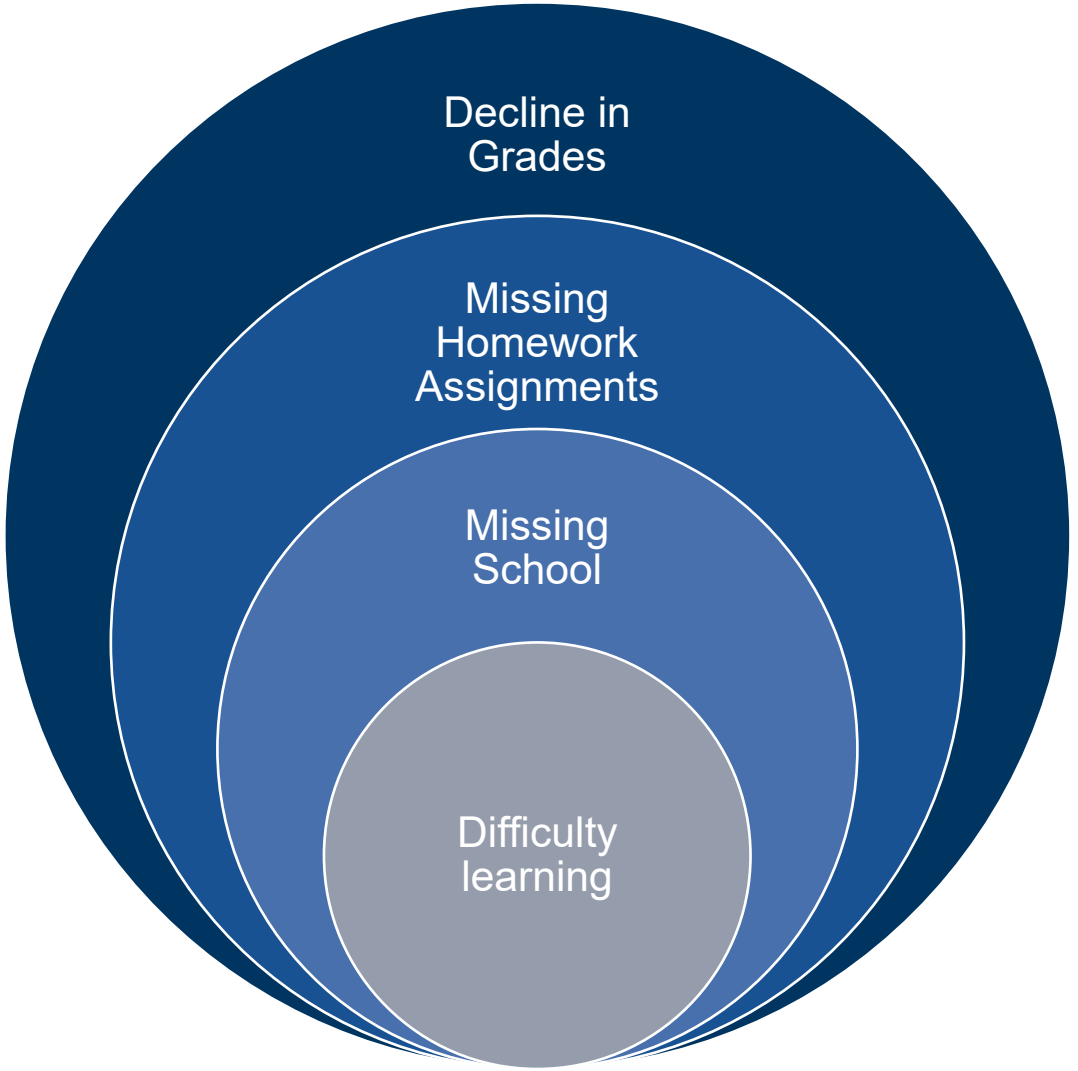
Give extra time for communication

Return to Learn and Return to Work

The Role of the SLP

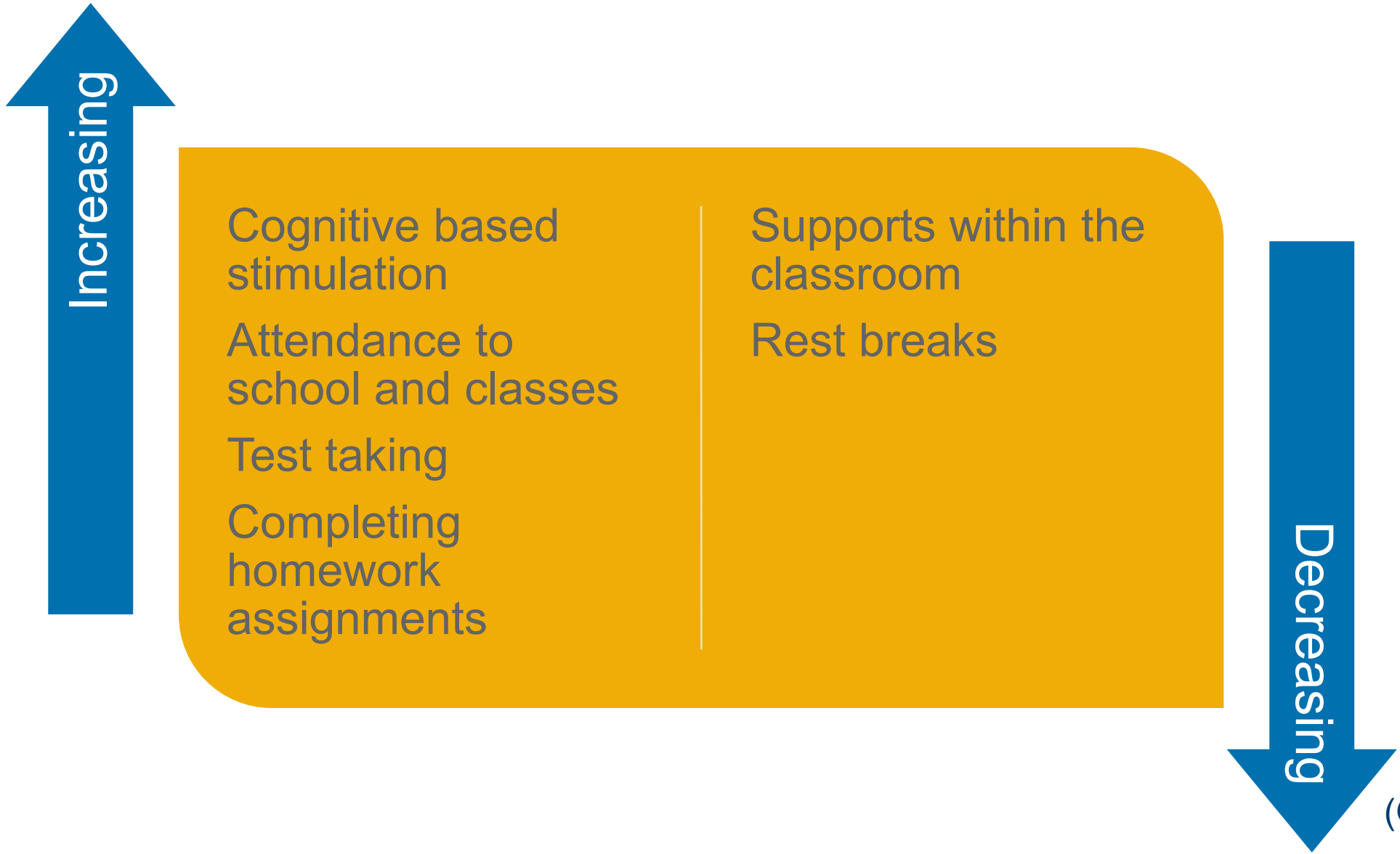
Ochsner

Return to Learn Considerations



(Gioia, 2016; Ketcham et al, 2017)

Return to Learn Considerations



(Gioia, 2016)

Return to Work Considerations

Increasing

- Cognitive based stimulation tasks the patient enjoys
- Work related tasks
- Computer screen tolerance

Decreasing

- Supports
- Rest breaks
- Restricted schedules at work

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