• Multi-disciplinary rehabilitation effort is important

• For example, collaboration between Optometry and Occupational Therapy allows integration of assessments of eye/brain impairments (*bottom up approach*) and person-level dysfunction (*top down approach*)

Roberts et al. 2016; Fox, S. et al 2019, Berryman et al. 2020
Many Muscles!

- Six extraocular muscles
  - Superior Rectus
  - Superior Oblique
  - Medial Rectus
  - Inferior Oblique
  - Inferior Rectus
  - Lateral Rectus

http://www.pforflaserandeye.com/anatomy.htm
THE MARY WARREN TRIANGLE (1993)
Bringing it all together....

• Versional eye movements (tracking laterally)
• Vergence eye movements (tracking in depth)
• Accommodation (focus)

...these three subsystems are essential for efficient oculomotor control during reading, and must be precisely synchronized

Thiagarajan et al. 2014
Bringing it all together...

• After brain injury, more effort may be needed for basic oculomotor control to focus/fuse words, which should be automatic
• Higher level actions, such as comprehension, attention, short-term visual memory, and executive function will then be compromised
Important to support and facilitate body awareness/proprioception, peripheral visual awareness, and vestibular processing when addressing focal visual skills (oculomotility, vergence, and accommodation)
How do central and peripheral vision work together?

**Central/focal vision**
- Conscious processing
- The “What”
- Advanced
- Recognition and comparison
- Versional skills
- Vergence skills
- Accommodation

**Peripheral/ambient vision**
- Unconscious processing
- The “Where”
- Primitive
- Detection of movement
- Linked to vestibular
- Provides spatial context info needed for balance, movement, coordination, and posture
- Supports focal vision!
Vestibulo-ocular Reflex (VOR)

- May be affected by TBI (Armstrong, R. 2018)
- Reflexive eye movement that stabilizes image on the retina, by producing an eye movement in the direction opposite to the head movement.
- Since slight head movement is present all the time, the VOR is very important for stabilizing gaze, which is important when trying to focus on anything (reading, watching TV, etc). If the VOR is impaired, objects can look like a photo taken with a shaky hand.
VOR screening

NORMAL VOR
Patient focused on examiner's nose

After sharp turn to patient's right, patient remains focused on examiner's nose

ABNORMAL VOR
Patient focused on examiner's nose

Corrective saccades
• The vestibular and visual systems have mutual interactions and anatomical connections in the brain. In particular, the brain regions responsible for vergence eye movements are closely linked to the vestibular system.

• Dizziness and imbalance are common symptoms of PCS and are likely related to abnormalities in vestibular/cerebellar systems, which are closely linked with the pathways responsible for ocular sensorimotor functions, and particularly with vergence eye movements.

Vision
Proprioception
Vestibular

Visual Motor Integration
- Minimize screen time
- Dimming and/or blue light filtering
- Avoid too much “near viewing” (use 20/20/20 rule)
- Minimize visual “clutter”
- Light print on dark background
- Keep neck/posture/core strong and stable
- Follow therapy team recommendations regarding order of your home program...
- Consider effect of environmental distractions when doing home program
- Consider body position. Maybe laying down helps with a certain vision exercise? How can tapping into other senses help?
- Don’t overdo it with central/focal vision exercises
- Plan out daily activities/pace yourself