TERMS and DEFINITIONS

What is the Vestibular system? The vestibular system is the sensory system that provides the leading contribution about the sense of balance and spatial orientation for the purpose of coordinating movement with balance.

The vestibular system includes the peripheral receptors in the inner ear. The vestibular pathways including the vestibular nerve, the brain stem vestibular nuclei and the older parts of the cerebellum. *Suchoff, O.D., D.O.S., Ciuffreda, O.D., Ph.D., Kapoor, O.D.,M.S. Visual & Vestibular Consequences of Acquired Brain Injury*

Vestibular system, three main functions:

1. Provides posture and balance control via the vestibulospinal tract (VSR). This includes orientation to gravity through the otoliths.
2. Provides a mechanism to distinguish movement in the environment from self-motion.
3. Maintains visual fixation during head and eye movement via the VOR.
   The vestibular system alone is unable to distinguish body tilt or body motion from head motion. *Suchoff, O.D., D.O.S., Ciuffreda, O.D., Ph.D., Kapoor, O.D.,M.S. Visual & Vestibular Consequences of Acquired Brain Injury*

Ocular motor system – the shared goal of all components of the ocular motor system is to maintain clear, single vision by placing and maintaining an object of visual interest on the fovea, the retinal region with the highest density of photoreceptors and the best visual acuity. Several functional classes of eye movements coexist to meet this shared goal. These include saccades, smooth pursuit, vergence, optokinetic responses, and vestibular reflexes. *Handbook of Clinical Neurophysiology, 2010, Vertigo and Imbalance: Clinical Neurophysiology of the Vestibular System*.

The Visual System - provides vertical orientation, detects optic array movement and provides depth perception of objects moving towards/away from the individual. The visual system alone is inadequate in distinguishing movement of the environment from movement of the body. (*Suchoff, O.D., D.O.S., Ciuffreda, O.D., Ph.D., Kapoor, O.D.,M.S. Visual & Vestibular Consequences of Acquired Brain Injury*

Visual input affects sensorimotor systems via connections to the superior colliculus. This brain area receives only peripheral vision. Thus, if minimal peripheral visual input is perceived, all sensorimotor systems must accommodate in some fashion. That includes the movement system.

Efficient system functioning requires balanced, accurate neural firing from the right and left ears, the right and left eyes, and the left and right brain. When the system isn't balance it must compensate to survive, despite the inefficiencies. When the amount of system compensation required becomes to to great secondary to stress, injury or disease, we start to see symptoms (decompensation) i.e. double vision, dizziness, headache etc.

The visual system is composed of two separate processes - The focal system (central vision) and the ambient system. The system that we are all most familiar with is the focal process (7). The focal system is what the optometrist examines during routine eye health check up's, "which is clearer, this or this." The ambient process (peripheral vision) lets you know where you are in space and provides general information used for balance, movement, coordination, and posture. The ambient process serves to permit focalization to occupy attention while the preconscious nature of the ambient process allows for spatial and temporal change. (7)

Ear Anatomy (brief) -The human inner ear contains two divisions: the hearing (auditory) component — the cochlea, and a balance (vestibular) component—the peripheral vestibular system. Peripheral in this context refers to a system that is outside of the central nervous system (brain and brainstem). The peripheral vestibular system sends information to the brain and brainstem. The vestibular system in each ear consists of a complex series of passageways and chambers within the bony skull. Within these passageways are tubes (semicircular canals), and sacs (a utricle and saccule), filled with a fluid called endolymph. Around the outside of the tubes and sacs is a different fluid called perilymph. Both of these fluids are of precise chemical compositions, and they are different. The mechanism that regulates the amount and composition of these fluids is important to the proper functioning of the inner ear. Each of the semicircular canals is located in a different spatial plane. They are located at right angles to each other and to those in the ear on the opposite side of the head. At the base of each canal is a swelling (ampulla) and within each ampulla is a sensory receptor (cupula).

Movement and balance (pertaining to the inner ear) - With head movement in the plane or angle in which a canal is positioned, the endolymphatic fluid within that canal, because of inertia, lags behind. When this fluid lags behind, the sensory receptor within the canal is bent. The receptor then sends impulses to the brain about movement. When the vestibular apparatus on both sides of the head are functioning properly, they send symmetrical impulses to the brain. That is, the impulses coming from the right side conform to (agree with) the impulses coming from the left side. In response to the nerve impulses from the peripheral vestibular system, the brain sends commands to the eyes—enabling clear vision during movement and to the muscles of the body—so that balance is maintained during position changes and movement. *Vestibular Disorders Association ◦ vestibular.org*

Specialized Optometry - Optometrist can receive specialized training. Certification in the testing and training of all aspects of the visual system and how the visual system relates to learning and motor function is done through the College of Optometrist in Vision Development (COVD). Optometrists with this specialization and certification are called Behavioral Optometrists.

Find a Behavioral Optometrist in your area who may specialize in concussion rehab by visiting:
https://nora.cc/healthcare-locator.html?search=1&page=1
http://www.covd.org/

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YouTube How-To Video links

1. VOMS UMPC Medical Center https://www.youtube.com/watch?v=S66o9ODhmIk
2. Brock String (vergence control) https://www.youtube.com/watch?v=EGlCVTdNqfw
3. Space Fixator (tracking and ambient vision) https://www.youtube.com/watch?v=THyL81Ecg6Y
4. Left Right Discrimination http://www.noigroup.com/Recognise

ADL's Little Things Make a Big Difference – Introductory Activities

1. Move and do light exercises that don't increase your symptoms (unless otherwise directed by your physician or athletic trainer).
2. Be aware of your environment in regards to place in space, as well as symptom responses.
3. Monitor and control graded exposure to activity and symptom-provoking stimuli.
4. Don't exercise while reading a book, staring at the TV or listening to music wearing ear buds.
5. Do look forward with a soft gaze when you're walking.
6. Walk with proper arm and leg swing without staring at the ground.
7. While walking forward be aware of the walls moving (backward).
8. Do practice good visual hygiene while studying or reading.
9. Do practice relaxed breathing 10-20 minutes daily (biofeedback breathing app).
10. When texting or using your phone, be aware of the visual space beyond the phone.
11. Focus on the positive – you will have pain when your brain concludes that there is more credible evidence of danger related to your body than there is credible evidence of safety related to your body. (Moseley & Butler, Explain Pain, NOI 2015)