VISION!
How it’s processing changes after mild traumatic brain injury
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About US
- Hennepin County Medical Center: Hennepin Healthcare
- TBI Outpatient Program
- Developmental Optometrist
- Occupational therapist
- Multidisciplinary clinic

Ophto—what?
- Optometrist (OD)– evaluate health of eye and prescribes glasses
- Ophthalmologist (OMD) – above plus surgery
- Neuro Ophthalmology – diagnoses neurological eye conditions
- Developmental/Neuro OD – treats functional effects of neurological conditions
- Communicates treatment plans to occupational therapists

OT—what?
- Occupational therapists (OT)– evaluate and treat dysfunction in ADLs/IADLs
- OT in neuro vision rehabilitation
  - Treat visual processing deficits
  - Emphasis on functional activities
  - Addresses patient return to driving, work, reading, community navigation
- Neuro Vision Rehabilitation (NVR)
  - Visual motor, sensory motor and visual perceptual therapy to treat vision deficits arising from central nervous system injury

Eye Sight vs. Vision
- Eyesight is 20/20
- Generally OD and OMD treat only one aspect of vision—see next slide
  - Under 40: Single vision glasses to see 20/20
  - If you see 20/20 without glasses, then you don’t need them.
  - If your eye obviously look misaligned refer to surgery

Vision disorders that affect function are usually not detected or treated by general OD/OMD.

COMPONENTS OF VISION
- VISUAL ACUITY
- ACCOMMODATION
- OCULAR MOTILITY (FIXATION/PURSUITS/SACCADES)
- BINOCULARITY
- VISUAL SPATIAL INTEGRATION
- NORMAL PUPILLARY & RETINAL FUNCTION
SYMPTOMS OF VISUAL DYSFUNCTION

- Blurry vision
- Difficulty transitioning between distance and near
- Pressure or pain behind or around eyes
- Covering/closing one eye to see more clearly
- Double Vision
- Fatigued eyes feel tired with reading or computer use
- Headaches when reading or performing visual tasks
- Loss of balance or unsteadiness
- Poor eye hand coordination/clumsiness
- Sensitive to movement in environment
- Restricted field of vision/reduced peripheral vision
- Sensitivity to light

Hierarchy of Vision Therapy

VISUAL ACUITY

- Always measured in an eye exam
- Normal vision is 20/20: formal definition, at 20 ft a person can see a letter that subtends an angle of 5 minutes of arc.

ACCOMMODATION

- The process by which the eye changes optical power to maintain a clear image or focus on an object as its distance varies.
  - Central Process
  - Local Process
    - Ciliary Body controls the lens of the eye
    - This muscle naturally weakens by mid 40's

ACCOMMODATIVE DYSFUNCTION

- Accommodative Insufficiency - blurry vision at near
- Accommodative infacility - blurry vision when changing distances
- Accommodative excess, blurry vision at distance
- Accommodative spasm - blurry vision everywhere
ACCOMMODATIVE TESTING

- Amplitude of accommodation
- Minus lens
- Push up
- Pull away
- Accommodative facility
- Accommodative翻力
- Lead or Lag of accommodation
- Fused cross cylinder
- Monocular estimation method

- Lens rack for accommodation testing

ACCOMMODATION TREATMENT - LENSES

- Patients who are farsighted are prescribed plus lenses for full time wear
- Other patients are prescribed plus lenses for reading
- TBI patients generally have difficulty adapting to Bifocals and PALS
- Separate reading / computer glasses
- Stabilizes accommodation in pre-presbyopes
- Wider viewing area for nerve palsies and patients with poor peripheral awareness

ACCOMMODATION TREATMENT

- Near far Hart Chart – to develop proprioceptive feeling of accommodation
- Monocular/Binocular Accommodative Rock
  - Lenses to use with a visual-motor activity i.e. Michigan tracking

ACCOMMODATION TREATMENT

- Lighting, posture and font size affect patient performance in the exercises

- Functional deficits:
  - Reading/computer use
  - Looking near/far during daily activities
  - Clarity of driving
  - Shifting focus between notes/whiteboard

Oculomotor Function

OCULAR MOTILITY

- FIXATION : Ability of the eye to hold a steady image
- PURSUIT : Ability for the eye to hold a steady image as it slowly moves
- SACCAD : Ability for the eyes to move/jump from one point to another
OCULOMOTOR DYSFUNCTION
- Saccadic Intrusions - disorder of fixation and pursuit
- Nystagmus - disorder of fixation
- Hypermetric saccades
- Hypometric saccades
- Slowed saccades

OCULOMOTOR TESTING
- Fixation
  - Cover one eye & have patient look at medium sized target 18 in away from eyes for 10 seconds
- Pursuits
  - H pattern or clockwise/counterclockwise movement
- Saccades
  - 2 different fixation targets 18 in apart
  - Have patients track horizontally, diagonally and vertically

OCULAR MOTOR EXAMPLES
- Smooth Pursuit
- Saccadic eye movements

OCULOMOTOR TESTING: Visagraph
- Infrared eye tracking instrument

OCULOMOTOR TESTING: King Devick
- Paper-based saccadic assessment, looks at reading strategies, short and long angle saccades

OCULOMOTOR TREATMENT
- Goal of oculomotor treatment: Improving the efficiency and accuracy of eye movements
- Fixation/pursuit therapy
  - R/G flashlight tag
  - Spoon/Pursuits
  - Feed/Feed
- Saccadic therapy
  - Pool it saccades
  - Hart/Chart
  - Michigan tracking
OCULOMOTOR FUNCTION
- Tracking in daily environment
- Navigating space & movement
  - Walking, Running, Driving
- Close visual activities
  - Reading, computer
- Foundation for binocular vision

Binocular Vision

BINOCULAR VISION
- Using two eyes together, to view a single 3-D image
- Allows us to accurately judge distance
- Useful with navigating busy environments, driving, playing sports

BINOCULAR VISION (BV) DYSFUNCTION
- Convergence Insufficiency
- Convergence Excess
- Divergence Insufficiency
- Divergence Excess
- Cranial Nerve Palsy

(BV) DYSFUNCTION: Exophoria
- Eyes appear straight when both eyes are open
- When one eye is covered, that eye turns OUT
- Although this person’s eyes appear normal, they have to exert much more effort to keep their eyes straight
*These patients tend to have convergence insufficiency

(BV) DYSFUNCTION: Esophoria
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(BV) DYSFUNCTION: Hyperphoria
- 4th cranial nerve palsy
- Skew deviation (brain stem)
- Vertical diplopia
- May have compensating head tilt

(BV) DYSFUNCTION: Suppression
- An adaptation that the brain develops to deal with problems with binocular vision
- Can occur in childhood and adulthood
- Some binocular problems that lead to suppression
  - Strabismus (eye turn)
  - Amblyopia (lazy eye)
  - Convergence insufficiency
- The brain learns to "ignore" part of the vision of one of the eyes
- Suppression can be primarily one eye, or can alternate between both eyes
- Suppression can be constant or intermittent

BINOCULAR TESTING
- Horizontal and vertical cover test
- Horizontal vergence ranges at distance and near
- Suppression
- Near Point of Convergence
- Vergence facility

BINOCULAR TREATMENT - PRISMS
- Prisms
  - Compensating prisms for strabismus and phoria
  - Yoked prisms for spatial/postural imbalances

BINOCULAR TREATMENT
- Improving the ability for the eyes to stay aligned when focusing on a target near or far
  - Anti-suppression
  - Convergence
  - Divergence
  - Vertical Vergence

BINOCULAR: Anti-suppression Treatment
- GTVT
- Polaroid Fusion Sheet
- BARK reader
BINOCULAR: Vergence Treatment

Motor based activities/proproprioceptive awareness
- Two finger jump ductions
- Pointer in the straw
- Barrel card

Vergence facility: The ability for the eyes to make large accurate jumps from a near target to a distance target and vice versa
- Aperture rule
- Eccentric circles (EC)
- Lifesaver cards (LS)
- Brock’s string/vectogram jump ductions

Integration of balance, vestibular, auditory systems
- Add balance board
- Head rotation / chair spins
- Metronome

BINOCULAR FUNCTION

- Seeing objects near/far as one image (stereopsis)
- Depth perception
- Walking, Running
- Playing sports
- Reading/using a computer
- Driving

VISUAL-SPATIAL INTEGRATION

- Visual processing works in two main streams
- Central/Focal processing is a slower process
- Peripheral/ambient processing is a faster process
- Example: a cup falls off the edge of the table, you reach to grab it before it hits the ground, your reaction occurred before you were aware of what was happening

Visual Spatial
VISUAL-SPATIAL DYSFUNCTION
- Tend to be very symptomatic
- Main Complaints: vertigo, lightheadedness with position changes or head turns, loss of balance, bothered by movement in the environment (visual motion sensitivity), difficulty in busy visual environments, reduced peripheral vision, sensitivity to light
- Examination findings: nystagmus, vertical phoria, divergence insufficiency with convergence insufficiency

VISUAL-SPATIAL ASSESSMENT:
Yoked Prism Test
- This test evaluates:
  - Spatial orientation
  - Balance
  - (subcortical reflexive level)
  - Spatial organization & perception
  - (cortical level)

VISUAL-SPATIAL TREATMENT:
Therapeutic Occlusion
- Bangerter foil
- Temporary occlusion
- Can apply directly onto glasses
- Immediate relief in symptoms

VISUAL-SPATIAL TREATMENT:
Peripheral awareness therapy
- Often focus on hand eye coordination, spatial processing – Where am I in space?
  - McDonald Chart
  - Dynavision / Vision coach

VISUAL-SPATIAL TREATMENT:
Visual motor/spatial activities
- Yoked prism with dynavision / vision coach
- Multi-matrix game
- Visual Motor Forms

Photosensitivity
PHOTOSENSITIVITY - LIGHT SENSITIVITY

- Main complaint: light sensitivity, difficulty working on the computer, watching TV, difficulty with glare at night
- May be associated with headaches, pain behind the eyes, difficulty sustaining focus on computer or TV screens
- Alpha-Omega Pupil – fail to constrict, or fail to hold the constriction (video)

PHOTOSENSITIVITY - LIGHT SENSITIVITY

- Comorbidity of migraine-like headaches after TBI
- Trigeminal nerve can activate the parasympathetic system, which can cause tearing, and periorbital pain
- Short ciliary nerves carry sympathetic supply to the blood vessels of the eye
- Long ciliary nerves carry sympathetic supply to the pupil

NORMAL PUPILLARY & RETINAL FUNCTION

- Light enters the eye through the pupil
- Light is received by the retinal ganglion cells
- Exit the retina via the Optic Nerve

NORMAL PUPILLARY & RETINAL FUNCTION

- Intrinsically photosensitive retinal ganglion cells
  - These cells are in the retina, detect light and the signal travels to the pretectal and suprachiasmatic nuclei
  - More important than rods and cones for circadian rhythm.

TINTS

- Can be very helpful in reducing the patient’s symptoms indoors, with use of screens, and night time driving
- XTRActive transitions

TINTS

- Mercury Reader/Visor (Chrome extension)
- F.Lux or blue light filters for the screen
- Yellow tinted glasses (non-rx) for night driving
- Irlen overlays
- Hat/sunglasses
  - *Recommend to use sunglasses in moderation to avoid over-reliance

Strategies to use at home
How common are visual issues post mTBI?

- Convergence Insufficiency 11-63%
- Accommodative Insufficiency 3-67%
- Saccadic dysfunction 23.4-30%
- Peripheral vision defects 48-51%

CONCLUSIONS

It is important to test all aspects of visual processing, and to work on all areas that are deficient.

Often, binocular problems are the most apparent, but usually should be addressed after treating foundational skills.

Vision and visual processes have a large role in daily activities and processing/interpreting our surroundings. Deficits can drastically limit a person’s ability to be independent.