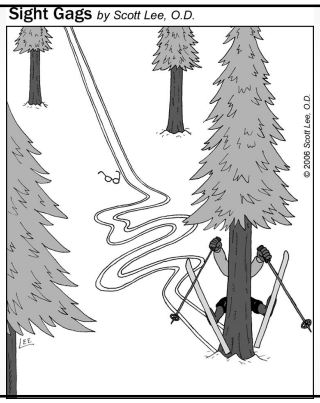
The Optometrist's Role in TBI Prevention and Treatment

Jennifer Simonson OD, FCOVD
Boulder Valley Vision Therapy
1790 30th Street, Suite 311
Boulder, CO 80301
303.443.2257
bouldervt@yahoo.com

Sight Gags *by Scott Lee, O.D.*



Learning Objectives:

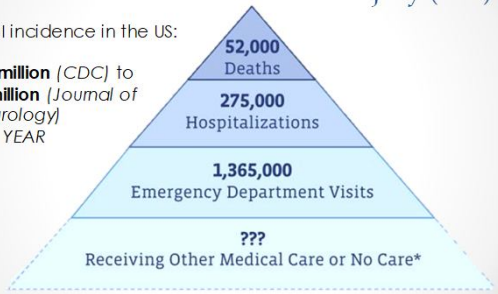
- To understand the impact of Traumatic Brain Injury (TBI) on patients' neurological and visual performance
- To diagnose post-concussive vision syndrome
- To gain insights in how to best treat visual deficits related to TBI

Neuropathology of Traumatic Brain Injury (TBI)

Incidence of Traumatic Brain Injury (TBI)

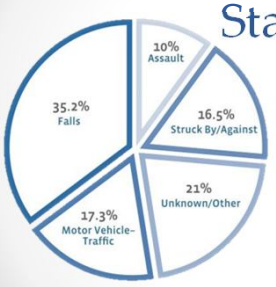
- TBI incidence in the US:

1.7 million *(CDC)* to **4 million** *(Journal of Neurology)* *PER YEAR*



http://www.traumaticbraininjury.com/understanding-tbi/what-are-the-causes-of-tbi/

ER and Hospital Stats



Males >> Females

Most at risk: ages 0-4, 15-19, >65 years

Highest rate of TBI-related ER visits, hospitalizations, and deaths is Males 0-4

TBI in Sports

- High school football accounts for 47% of all reported sports concussions.
- 33% of concussions occur during practice.
- Ice hockey and soccer are shortly behind football on TBI incidence.
- 1 in 5 high school athletes will sustain a sports concussion during the season.

References: www.cdc.gov/TraumaticBrainInjury

TBI in Sports

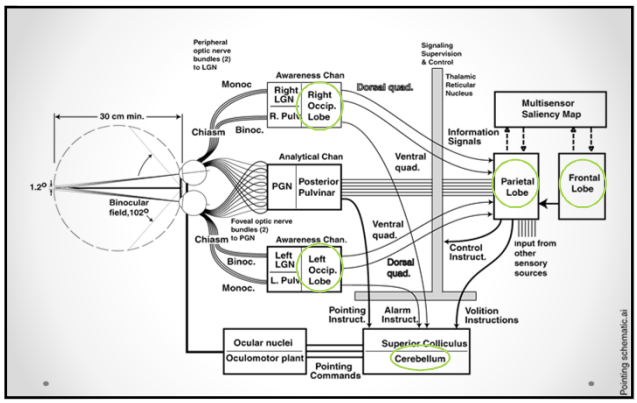
- 33% of high school athletes who have a sports concussion report two or more in the same year.
- 90% of most diagnosed concussions do not involve a loss of consciousness.

http://www.headcasecompany.com/concussion_info/stats_on_concussions_sports

TBI in Sports

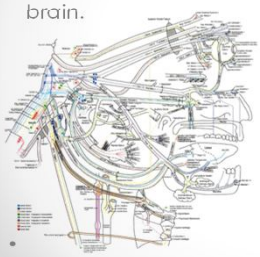
- 39% increase in risk for catastrophic head injury leading to permanent neurologic disability in subsequent concussions.
- An estimated 5.3 million Americans live with a traumatic brain injury-related disability (CDC)

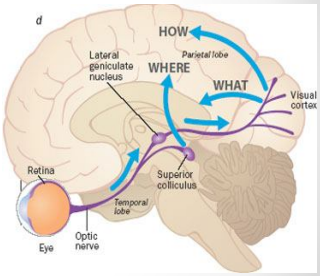
Neurology of the Visual Pathways in the Brain



Far reaching consequences of TBI

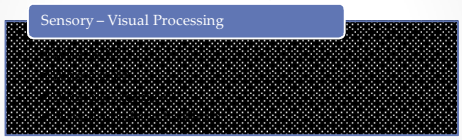
- Visual processing occurs 35 different areas of the brain.



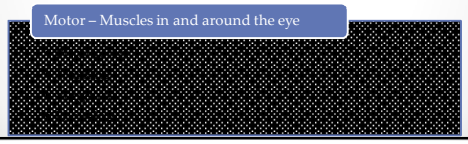


Vision is a SENSORY and MOTOR system.

Sensory – Visual Processing

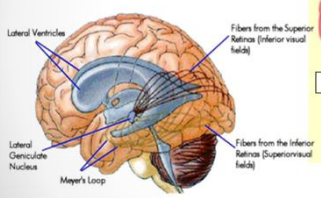


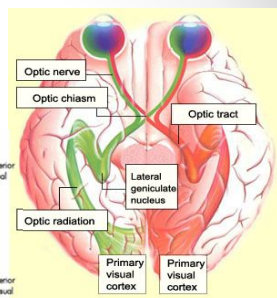
Motor – Muscles in and around the eye



Effects of TBI on the visual system

- Areas of potential injury:





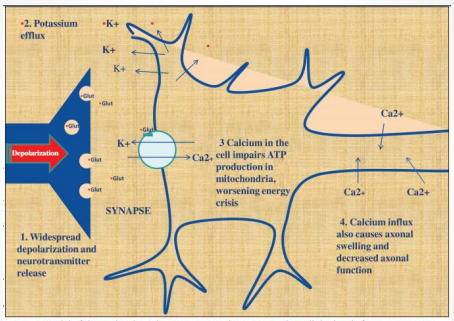


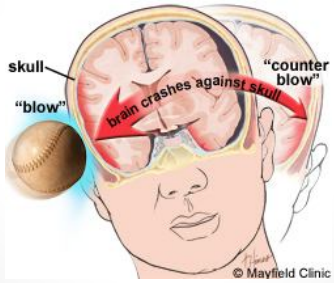
Figure 1. Model of the pathophysiologic processes that occur at the cellular level after a concussion.

Types of TBIs

- **Acceleration** - head is struck by more rapidly moving object, 'coup' lesion, damage occurs at the site of impact
- **Deceleration** - diffuse axonal injury, contrecoup effect, brain moves in the skull, axonal injury occurs at the site and opposite site of impact
- **Left Hemisphere injury** - motor weakness on the right side; Aphasia
- **Right Hemisphere injury** - motor weakness on the left side; visual attention and spatial orientation deficits

Examples:

https://www.youtube.com/watch?v=tdRYV2f6g8



Post-traumatic Vision Syndrome

Visual Deficits Following TBI

- Accommodative Insufficiency
- Oculomotor Dysfunction
- Convergence Insufficiency/Binocular Instability
- Visual-Vestibular Disequilibrium
- Impaired Visual Processing
- Visual Field Loss
- Dry Eyes
- Light Sensitivity

Most commonly reported symptoms (Lovell et all 2004)

	Symptoms	Percent
#1	Headache	71
#2	Feeling slowed down	58
#3	Difficulty concentrating	57
#4	Dizziness	55
#5	Fogginess	53
#6	Fatigue	50
#7	**Visual blurriness/double vision**	49
#8	**Light sensitivity**	47
#9	Memory dysfunction	43
#10	Balance problems	43

Ocular Motor Dysfunction following mTBI

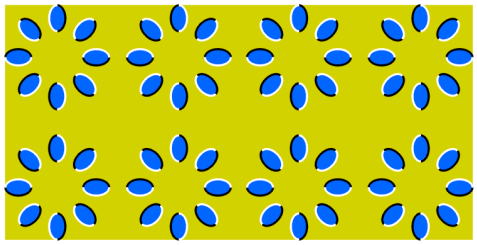
Capo'-Aponte et. Al Military Medicine 2012

Type of visual Impairment	%mTBI	%controls	p
Convergence Insufficiency	**55%**	5%	0.0012
Saccadic Impairment	**30%**	0%	0.0202
Pursuit Impairment	**60%**	0%	0.0001
Ocular Misalignments (vertical phoria)	**55%**	5%	0.0012
Ocular Misalignments (horizontal phoria)	**45%**	5%	0.0084
Accommodative Dysfunction	**65%**	15%	0.0031

After neurological incident

- Stationary objects appear to move
- Seeing words and print run together
- Intermittent blurring
- Having significant difficulties in crowded moving environments
- ***Are told that their eyes are healthy and that this is not in their eyes***
- Anxiety is heightened
- Approximately 90% of people with TBI have visual problems.

Visual Symptoms after TBI



Diagnosis of TBI-related Visual Deficits

Post-traumatic vision syndrome definition

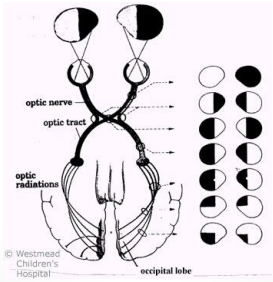
- Dr. William Padula: Insult to the cortex causes stress in the central and autonomic nervous system. It is postulated the disruption occurs at the level of the midbrain, vision is matched with kinesthetic, proprioceptive, and vestibular processes.
- Affects peripheral fusion, pre-planning, and spatial organization

Post-traumatic vision syndrome

Characteristics:

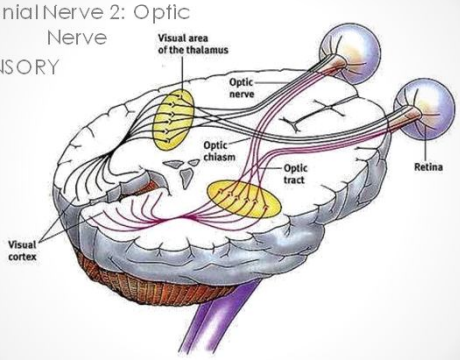
- ❑ photophobia
- ❑ reduced concentration
- ❑ Inattention
- ❑ objects appear to move
- ❑ balance and coordination issues
- ❑ motion sickness
- ❑ difficulty working under fluorescent lights
- ❑ visual-perceptual motor dysfunction

Visual Field Deficits



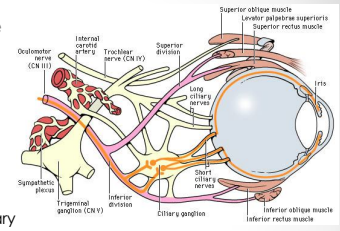
Cranial Nerve 2: Optic Nerve

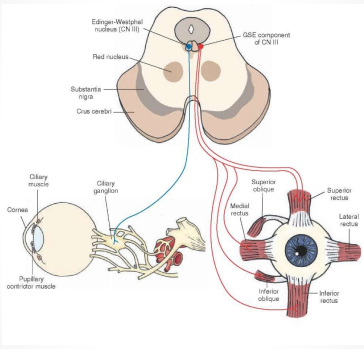
- SENSORY



Cranial Nerve 3: Oculomotor Nerve

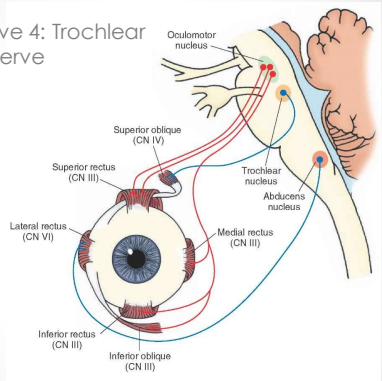
- MOTOR
  - Medial Rectus
  - Superior Rectus
  - Inferior Rectus
  - Inferior Oblique
  - Upper eye lids
  - Pupil constriction
  - Focusing of lens via Ciliary Body Muscle





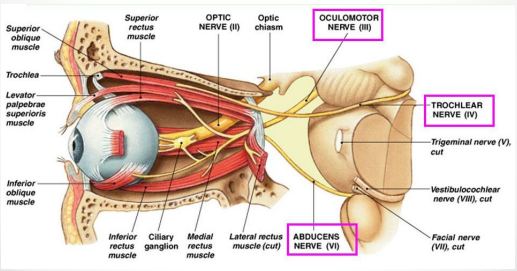
Cranial Nerve 4: Trochlear Nerve

- MOTOR



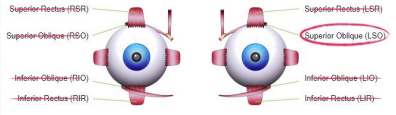
Cranial Nerve 6: Abducens Nerve

- MOTOR



http://www.eyedock.com/parks-3-step

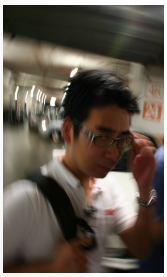
Parks Three Step



Which eye is hyper deviated in primary gaze?	Right Hyper	Left Hyper
Is the vertical deviation greater in right gaze or left gaze?	Right Gaze	Left Gaze
Is the vertical deviation greater with right head tilt or left head tilt?	Right Tilt	Left Tilt

Post-traumatic Vision Examination

OCULAR MANIFESTATIONS OF NEUROLOGICAL INSULT



- Headaches with visual tasks
- Blurred vision
- Double Vision
- Loss of Depth Perception
- Loss of Visual Field
- Aching eyes
- Visual Overload
- Poor Attention/Concentration
- Reading difficulties

Case History

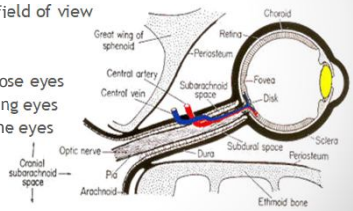
Key questions to ask post-injury *(Goodrich et al, 2013)*

1. What changes have you experienced in your vision?
2. Are you light sensitive, in- or outdoors?
3. Do you experience double vision?
4. Have you noticed a change in your peripheral vision?
5. Do you have blurred vision at distance or near?
6. Has there been a change in reading?
7. Do you lose place while reading?
8. How long can you read before you need to take and break or stop?
9. Do you experience Headaches?
10. Do you have trouble remembering what you've read?

Detailed Questionnaire: *0-3 Scale*

Emergent Visual Conditions
- Flashes of light
- Floaters in field of view
- Restricted field of vision
- "Curtains" billowing into field of view

Urgent Visual Conditions
- Inability to completely close eyes
- Difficulty moving or turning eyes
- Pain with movement of the eyes
- Pain in or around eyes
- Wandering eye
- Double vision



Dr. Allen Cohen at SUNY

Detailed Questionnaire: *0-3 Scale*

Vision Rehabilitation Conditions
- Blurred vision for distance viewing
- Blurred vision for near viewing
- Slow shift of focus from near to far to near
- Difficulty copying or taking notes
- Pulling or tugging sensation around eyes
- Discomfort while reading
- Unable to sustain near work or reading for periods of time
- General fatigue while work/reading
- Loss of place while reading
- Eyes get tired while reading
- Headaches while reading
- Covering, closing one eye
- Easily distracted when reading
- Decreased attention span
- Reduced concentration ability
- Difficulty remembering what has been read

Dr. Allen Cohen at SUNY

Detailed Questionnaire: *0-3 Scale*

- Disorientation
- Loss of balance
- Poor posture
- Face, head turn or head tilt
- Bothered by movement in environment
- Bothered by crowded environments
- Light sensitivity
- A sensation of the floor, ceiling or walls tilting
- Dizziness
- A sensation of the room spinning
- A sensation of not feeling grounded
- Postural shifts/ veering off when walking

Dr. Allen Cohen at SUNY

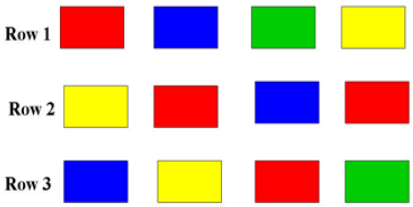
What is tested during an eye examination?

1. Visual Acuity
2. Refractive Status
3. Oculo-motility
4. Accommodation
5. Binocularity
6. Visual fields/peripheral vision
7. Color Vision
8. Pupils
9. Eye Health

- Eye structure
- CN II, III, IV, VI
- Parasympathetic/ Sympathetic Nervous System

Demonstration: Stroop Test

State the colors as fast as you can



From John Gosbee, MD, MS, VA National Center for Patient Safety

Now state the colors as fast as you can

Row 1	Red	Blue	Green	Yellow
Row 2	Yellow	Green	Blue	Red
Row 3	Green	Red	Yellow	Blue

From John Gosbee, MD, MS, VA National Center for Patient Safety

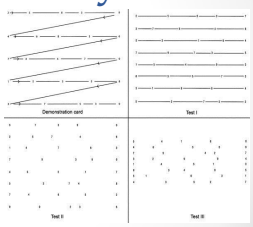
Again, state the colors as fast as you can

Row 1	Red	Blue	Green	Yellow
Row 2	Yellow	Green	Blue	Red
Row 3	Green	Red	Yellow	Blue

From John Gosbee, MD, MS, VA National Center for Patient Safety

Optometric testing - Oculomotility

- Assess range, nystagmus, fatigue
  - Pursuits
  - Saccades
  - Developmental Eye Movement Test
  - King-Devick Test



https://www.oepf.org/sites/default/files/journals/jbo-volume-3-issue-6/3-6%20Maples.pdf

VOMS

- https://www.youtube.com/watch?v=CJF6kJcFGqE

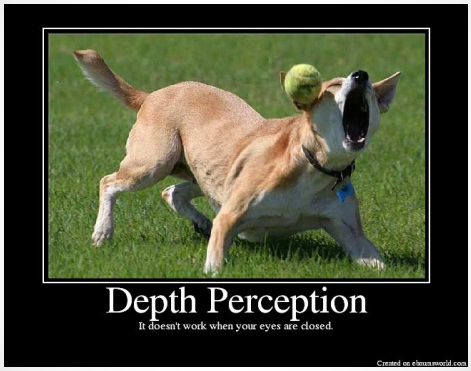
Visual Oculo-motor Screening

Optometric testing - Accommodation

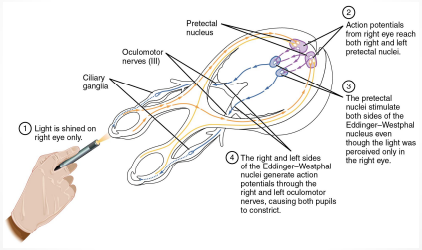
- Nearpoint of Accommodation
- MEM Retinoscopy
- Fused Cross Cylinder
- Amplitude (minus lens or pull away method)
- NRA - PRA
- Facility (+/-2.00 or less depending on age)

Optometric testing - Binocular Vision

- Alignment - Cover testing, Maddox rod, Worth 4 dot, Modified Thorington
- Near Point of Convergence
- Stereopsis: Randot, Stereo Fly
- Vergences
- Risley prism or prism bar - distance and near
- Prism facility (8^BI/BO)



Pupil Testing



Light Sensitivity

Symptoms

- Eyestrain
- Visual fatigue
- Squinting
- Headaches
- Eye pain
- Intolerance to lights
- Alpha/omega pupil(Parasympathetic/sympathetic imbalance)
- Retained Primitive reflexes(Moro)

Causes

- Dry eye, corneal surface
- Blink rate
- Pupil size/reaction
- Uncorrected refractive error
- Inflammation
- Receded NPC, poor fusion
- Cataracts
- Optic nerve problems
- Macular trauma
- Visual field defect

Visual deficits

Visual field loss

Total loss - optic nerve

Homonymous defects

Bitemporal - optic chiasm,

Non-congruous - optic tract, LGN

Hemianopsia - optic radiations

Quadrantanopia - Temporal lobe, optic radiations

Spatial inattention

Also called Unilateral Spatial Neglect

Inability to attend to meaningful sensory stimuli presented in the affected hemi-field

Right parietal lobe lesion, injury, or stroke of the middle cerebral artery

Competitive process with difficulty perceiving certain stimuli

Visual spatial inattention

- "Neglect"

http://slideplayer.com/slide/5279716/

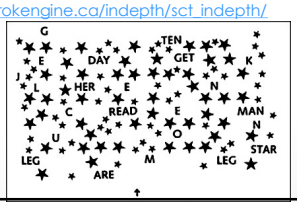
Dr. Carl Garbus

VISUAL SPATIAL INATTENTION

- A deficit in attention to and awareness of one side of space
- The patient's eyesight is fine, but half his visual world no longer seems to matter
- Most common is left sided neglect
- Patient's more prone to bumping into things on one side and won't attend to things on one side

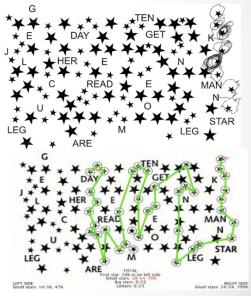
Visual spatial inattention

- The Star Cancellation Test: In the Star Cancellation Test, the stimuli are 52 large stars, 13 letters, and 10 short words interspersed with 56 smaller stars. The patient must cross out with a pencil all the small stars on an 8.5" x 11" piece of paper. Two small stars in the center are used for demonstration. The page is placed at the patient's midline.
- https://www.strokengine.ca/indepth/sct_indepth/



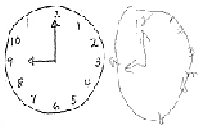
Visual spatial inattention

- **Scoring:** The maximum score that can be achieved on the test is 54 points (56 small stars in total minus the 2 used for demonstration).
- A cutoff of < 44 indicates the presence of USN. A Laterality Index or Star Ratio can be calculated from the ratio of stars cancelled on the left of the page to the total number of stars cancelled. Scores between 0 and 0.46 indicate USN in the left hemispace. Scores between 0.54 and 1 indicate USN in the right hemispace.
- https://www.strokengine.ca/pdf/starcancellation.pdf



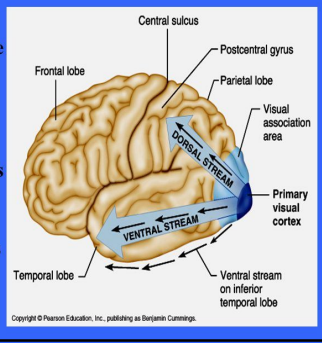
Clock Drawing Test

- ***Free drawn clock:*** the individual is given a blank sheet of paper and asked first to draw the face of a clock, place the numbers on the clock, and then draw the hands to indicate a given time. To successfully complete this task, the patient must first draw the contour of the clock, then place the numbers 1 through 12 inside, and finally indicate the correct time by drawing in the hands of the clock.

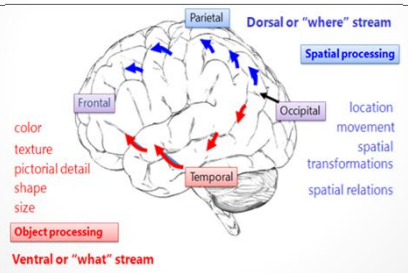


Visual Association Area

- **The dorsal stream extends through the posterior parietal cortex to the postcentral gyrus and perceives spatial relationships among different objects**
- **The "where" things are in space**

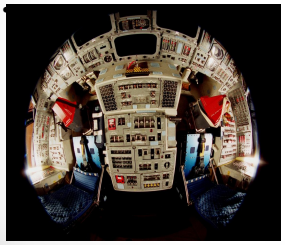


Visual disorders may not be fully expressed or understood by the patient.



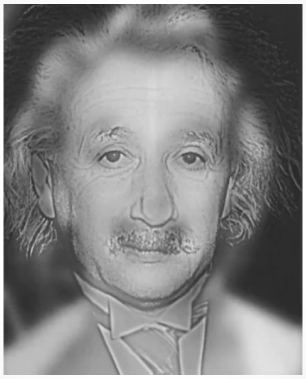
VISION: A TALE OF TWO SYSTEMS

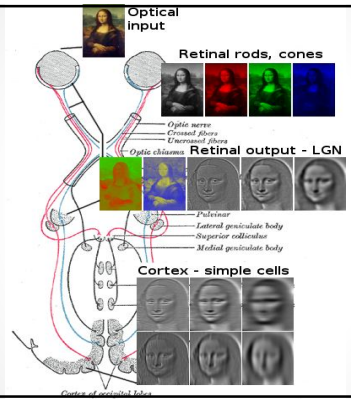
Ambient / Magnocellular System



Focal / Parvocellular System

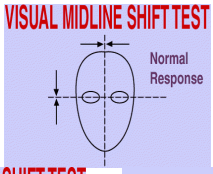
- "What is it?" / Details

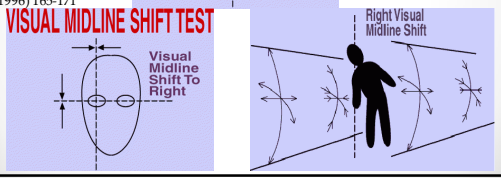




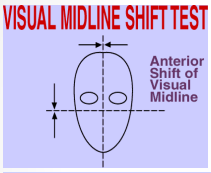
EGOCENTRIC LOCALIZATION ASSESSMENT

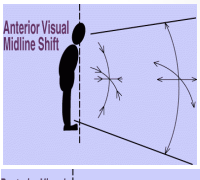
Images courtesy of William Padula's paper: Post Trauma Vision Syndrome & Visual Midline Shift Syndrome. Neurorehabilitation 6 (1996) 165-171

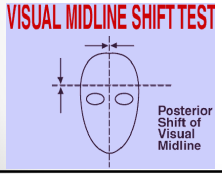


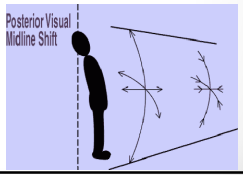


EGOCENTRIC LOCALIZATION ASSESSMENT









EGOCENTRIC LOCALIZATION (AKA: MIDLINE SHIFT)

- Symptoms:
  - Falling over or losing balance
  - "Straight lines aren't straight."
  - "It looks like things are moving."
- Assessment:
  - Check vertical and horizontal planes
- Balance / Posture assessment
  - Walking
  - On a compliant surface
  - Where is the patient's center of balance?

TBI Prevention, Education and Outreach

Outreach

- Athletes
- Coaches
- Athletic Trainers
- Parents
- Recreational activity participants
- Rehabilitation professionals: PT/OT

- Awareness
- Risk Assessment

Concussion Prevention

Screening Tests: King-Devick (K-D) Test

1. Accurate diagnostic test for identifying concussion
2. For use at the sideline and in the office

Pre-season Training Protocols

Vision Screenings
Sports Training

Gains made in:
1. Stereopsis
2. Athletic performance
3. Significant reduction in concussions for the season

Concussion Evaluation:

- Recommend Vision Evaluation 1 month following TBI
- Post-concussion syndrome occurs when symptoms of TBI persist following 1-3 months post-injury

Optometric Treatment and Vision Rehabilitation

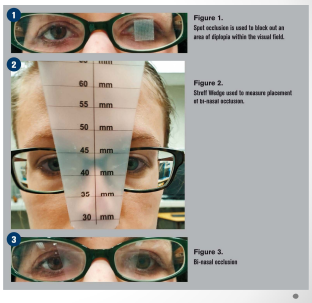
Optometric Treatments for TBI Patients

Spectacle prescription –

- Small refractive errors often make a large difference. Note even small amounts of plus, minus, astigmatism or prism
- Tinted Lenses - indoor and outdoor use
  - Blue
  - Gray
  - Brown
  - Rose (FL-41 anti-migraine)

Lenses

- When treating diplopia consider:
  a) Low plus for near work
  b) Prism - compensating or yoked, Fresnel or ground-in
  c) Bi-nasal Occlusion
  d) Single vision/Standard bifocals vs. PAL designs
  e) Partial or Spot Occlusion - can alleviate double vision



Prism

http://slideplayer.com/slide/10233419/
Dr. Saeed

- Field Loss
  - Prism to increase field awareness
- Yoked prism for shifting body midline

Field Relocation via Binocular Sector Prism	Field Expansion via Peripheral Monocular sector Prisms
Better option for patients with visual neglect.	Better option for patient with HH defect without neglect.

Optometric Treatments for TBI Patients

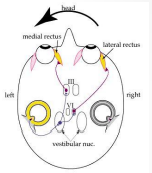
- Environmental and wellness recommendations
  - Lighting – eliminate fluorescent lighting
  - Computer Screens
    - Reduction in screen time and near work often necessary
    - Changing the color spectrum
    - Adjusting brightness
      - F.lux
      - Phone settings

f.lux

20-20-20 RULE
EVERY 20 MINUTES, TAKE YOUR EYES OFF OF YOUR SCREEN AND LOOK AT SOMETHING 20 FEET AWAY FOR AT LEAST 20 SECONDS.

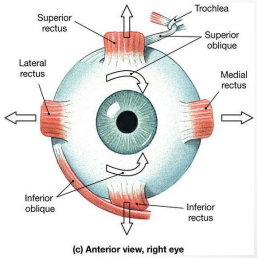
Vision Rehabilitation

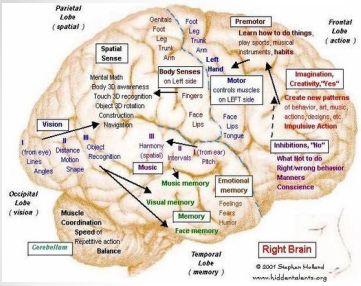
1. Vision therapy designed for patient's diagnosis and goals
2. Visual-vestibular therapy often required
3. Specialized therapy for visual inattention and other visual processing deficits



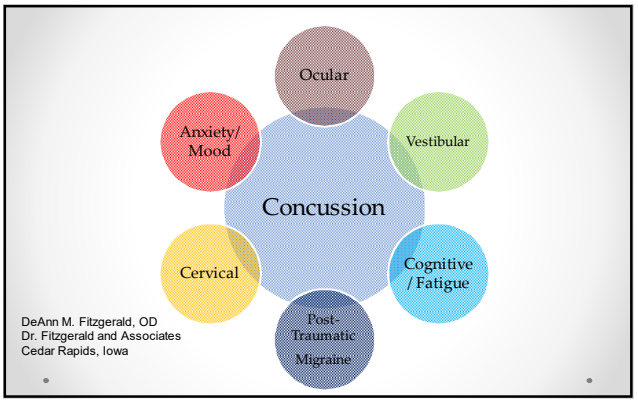
Vision Therapy is Sensory Integration Therapy

Vision Therapy is Neuro-Muscular Therapy





Vision Therapy is Perceptual Therapy



DeAnn M. Fitzgerald, OD
Dr. Fitzgerald and Associates
Cedar Rapids, Iowa

General health considerations

- Nutrition
- Exercise
- Multidisciplinary, team approach
  - Patients may be seeing multiple practitioners

Referral recommendations: Chiropractor, Occupational Therapy (OT), Physical Therapy (PT), Speech Therapy (ST), Psychologist, Cognitive rehabilitation, Physiatry, Acupuncture, Cranio-sacral therapy, Revive Center

Take Away Points:

- You will see patients with a history of TBI.
- These patients will have visual symptoms in most cases.
- You will help identify injury to the eye and neural pathways in the brain.
- You can tremendously help the function of these patients with lenses, prism, selective occlusion and tints.
- You can help relieve visual symptoms of eye strain, headaches, and dry eye syndrome.
- You can help these patients connect with a rehabilitation team which may include referral to low vision specialists or vision therapy.

References

1. Website (retrieved 2/7/2017) http://casemed.case.edu/clerkships/neurology/NeurLrngObjectives/Vision.htm
2. Review of Optometry, "Save a Life, Neuro-Optometry Primer: The Brain" by Mario Gutierrez, OD, FAAO. https://www.reviewofoptometry.com/CMSDocuments/2009/9/Neuro-Optom-Supp_RO-09.02.09.pdf
3. http://cpdailyliving.com/cortical-visual-impairment-cvi-cerebral-palsy-underdiagnosed-undertreated/
4. http://www.perkinselearning.org/videos/webcast/cortical-visual-impairment-and-evaluation-functional-vision
5. http://www.visiontherapysuccess.com/headtrauma.php