Navigating Visual Dysfunction: A Multifaceted Approach (Part 1)

Marnie Deardorff, MS, OTR/L
Laura Lizotte, MS, OTR/L
Lauren Mazel, OTD, OTR/L
Kara Robinson, MS, OTR/L
Disclosure

- Marnie Deardorff has no relevant financial or nonfinancial relationships to disclose
- Laura Lizotte has no relevant financial or nonfinancial relationships to disclose
- Lauren Mazel has no relevant financial or nonfinancial relationships to disclose
- Kara Robinson has no relevant financial or nonfinancial relationships to disclose
Objectives

Participants will be able to:

- Identify environmental modifications and compensatory strategies for symptom management
- Identify common visual impairments associated with concussion
- Identify effective screening and evaluation procedures for visual dysfunction associated with concussion
- Identify treatment strategies for visual dysfunction associated with concussion
Vision and the Brain

- 90% of sensory input comes from our vision
- Over 50% of our brain is directly or indirectly involved in visual processes
- Vision is used for:
  - Executive functioning
  - Reading/Writing/Driving
  - Social interactions
  - Motor control
  - Posture
Visual Pathway

Optic Nerve → Optic Chiasm → Temporal lobe → Lateral Geniculate + Superior Colliculus → Occipital lobe → Cerebellum (Ventral Stream) → Parietal lobe (Dorsal Stream)

Right visual field

Right eye → Optic nerve → Optic chiasm → Left visual field

Left eye → Lateral geniculate nucleus → Primary visual cortex

Emerson Hospital

Dr. Robert C. Cantu Concussion Center
Visual Processing

Dorsal Stream
- THE WHERE
- spatial orientation, balance, posture, spatial mapping

Ventral Stream
- THE WHAT
- object and visual identification and recognition
Cranial Nerves

- **II: Optic sensory (Optic Nerve)**
- **III: Oculomotor Nerve**
  - Superior rectus (moves eyes up)
  - Inferior rectus (moves eyes down)
  - Medial rectus (moves eyes in) *convergence*
  - Inferior oblique's (moves eye out and up)
  - Pupil lens and lid
- **IV: Trochlear Motor**
  - Superior oblique (moves eye in and down)
- **VI: Abducens Motor**
  - lateral rectus (abducts eye)
Treatment Approach

Symptom Management

Return to Function

Rehabilitation

Task Modification

Optometry/Ophthalmology
Treatment Domains

- Symptom Management / Modifications
- Ocular Motor Skills
- Binocular Vision
- Accommodation (“Focusing Ability”)
- Visual Processing Skills
- Functional Training
Treatment Domains

Symptom Management / Modifications

- Ocular Motor Skills
- Binocular Vision
- Accommodation ("Focusing Ability")
- Visual Processing Skills
- Functional Training
Concussion Symptoms

- Headaches
- Dizziness
- Nausea/Vomiting
- Eye strain
- Light sensitivity
- Double vision
- Blurry vision
- Noise sensitivity
- Tinnitus

- Sleep disturbance
- Mood disturbance
- Balance deficits
- Impaired coordination
- Fatigue
- Brain fog
- Cognitive deficits
  - Memory
  - Executive function
  - Attention
Concussion Symptoms

Video
Symptom Management

- General guidelines
- Addressing light, screen, contrast sensitivity
- Task modification / Adapted techniques
- Additional strategies and education
- Community reintegration
General Guidelines

- Maintaining function and quality of life with guidelines and limits
- Understanding triggers
- Graded return approach
- The more acute the injury, the more conservative the approach
- The patients who “do nothing” seem to get stuck
General Guidelines

Video
General Guidelines

- **Symptom Tracking within Activities**
- **Reading**
  - Date: 6/2 ___20___ minutes 4/10 Headache; 3/10 Eye strain
  - Date: 6/5 ___15___ minutes 2/10 Headache; 2/10 Eye strain

- **Computer Use**
  - Date: 8/10 ___20___ minutes 6/10 Headache; 5/10 Eye strain
  - Date: 8/12 ___5___ minutes 3/10 Headache; 3/10 Eye strain
Addressing Light, Screen and Contrast Sensitivity
Addressing Light, Screen and Contrast Sensitivity
Light Sensitivity Management

- The amount of light that a person lives in will affect symptoms. If one lives in darkness all of the time, then light will be sensed as being even brighter.
- Graded return approach
- Use of color tinted glasses, blue light blocking glasses, color filters for reading and computer use, screen brightness software and filters, side or back lighting, overhead light covers
Addressing Light, Screen and Contrast Sensitivity
Addressing Light, Screen and Contrast Sensitivity

- iPhone/Andriod “display accommodations”
  - Reduced white point
  - Color filters/lens
  - Nightshift/blue light filter

- Internal settings
  - Voice dictation
  - Enlarged font
  - Text-to-Speech
  - Reduced motion
Addressing Light, Screen and Contrast Sensitivity

**Color filters**

[Image of a maze with the words 'Stargazing Puzzle #2']

**Color paper**

[Images of mazes printed on orange and blue paper]
Task Modification - Reading

- Color filters
- Tinted glasses
- Blocking strategies
- Visual cues/line guides
- Enlarged font/content
- Print material on colored paper
- Change position of material
- Audiobooks; text to speech
Task Modification - Computer

- Contrast and brightness settings
- Anti-glare filters / Colored filters / Tinting Software
- Tinted lenses
- Changing background color / Shading options
- Changing font size and color
- Enlarging icons and cursor
- Voice-to-text / text-to-speech software
- Printing material to read on paper
- Line guide software
- Using a projector
- Positioning of screen / position of material
Thursday, February 28

Firepaw peered over the brow of a bush-covered slope. Grayspaw and Ravenpaw crouched beside him. Next to them a group of ThunderClan elders, queens, and warriors waited in the undergrowth for Bluestar to give the signal.

Firepaw had not been to this place since his first journey with Lionheart and Tigerclaw. The steep-sided glade looked different now. The rich greenness of the woods had been bleached away by the cold light of the full moon, and the leaves on the trees glowed silver. At the bottom stood the large oaks that marked where the corner of each Clan’s territory touched the other three.

The air was thick with the warm scents of cats from the other Clans. Firepaw could see them quite clearly in the moonlight, moving about below in the grassy clearing that lay between the four oaks. In the center of the clearing, a large, jagged rock rose from the forest floor like a broken tooth.
Apple “reader mode”

Modification Guidelines

- Individualized strategies
- Graded return approach to building tolerance with modifications
- Fading use of modifications as tolerance improves
Additional Education and Strategies

• Use of heat/ice for symptom management
Additional Education and Strategies

Stress management and relaxation strategies

Meditation apps
• Insight Timer
• Headspace
• Calm
• Sounds True

Proper sleep hygiene
Recovery is NOT Linear

Video
Community Reintegration
Community Reintegration

- Shopping at off hours
- Use hat/visors
- Use sunglasses/tinted glasses
- Use ear plugs
- Have an exit strategy/plan
- Position of self
  - At restaurant seating facing wall
  - At a party leaning against a wall
- Know the environment
  - Shopping at a familiar store decreases need to scan for items
Treatment Domains

- Symptom Management / Modifications
- Ocular Motor Skills
  - Binocular Vision
  - Accommodation ("Focusing Ability")
  - Visual Processing Skills
  - Functional Training
Ocular Motor Skills

- Fixation
- Smooth Pursuits
- Saccades
Ocular Motor Dysfunction

- Loss of place or omission of words
- Poor endurance
- Excessive head movement
- Poor attention/distractibility
- Need for tactile/kinesthetic reinforcement
- Increased time to perform tasks

Up to 65% present with ocular motor dysfunction  
(Collins et al, 2013)

21-29% present with saccadic dysfunction  
(Gallaway et al. 2016)
Ocular Motor Skills - Assessment
Abnormal Smooth Pursuits

Video
Ocular Motor Skills - Assessment

Horizontal Saccades
Vertical Saccades
Abnormal Saccades

Video
Ocular Motor Skills – Assessment
King Devick: Test of saccadic eye movement speed and accuracy

Démonstration Card

Test I

Test II

Test III
Ocular Motor Skills- Assessment

King Devick: Normal Video
Ocular Motor Skills- Assessment

King Devick: Abnormal Video
Ocular Motor Skills- Assessment

King Devick Score:
3 minutes 48 S (16 errors)
Fail > 57 S with maximum 1 error

Video
The DEM™
Developed by Dr. Jack Richman, OD and Dr. Ralph Garzia, OD.
Ocular Motor Skills - Treatment
Ocular Motor Skills - Treatment
Ocular Motor Skills - Treatment
Ocular Motor Skills - Treatment

Ann Arbor Tracking Sheets
Ocular Motor Skills - Treatment
Ocular Motor Lab

- **Assessment**
  - Fixation
  - Smooth pursuits
  - Saccades
    - Horizontal
    - Vertical
Symptom Management / Modifications
Ocular Motor Skills
Binocular Vision
Accommodation (“Focusing Ability”)
Visual Processing Skills
Functional Training
Binocular Vision Dysfunction

- Eye strain
- Headaches
- Blurred vision/double vision
- Poor concentration
- Sleepiness during task
- Head tilt or turn
- Frequent loss of place
- Squinting, rubbing eyes, closing one eye
- Words appear to move, jump, swim or float
- Motion sickness/dizziness

47-49% present with convergence insufficiency (Gallaway et al., 2016; Master et al. 2016)
The consumption of soft drinks by American youth is increasing. National dietary surveys show that calibrated soft drink consumption increased from about 5 cans per day in 1977-78 to 112 cans per day in 1994-98, the most recent years for which national data is available. Adolescent boys' soft drink consumption increased more than tripled during these years.
Binocular Vision

- Coordination of both eyes together

- ‘Eye Alignment’ – Positioning of the eyes

- Convergence / Divergence – Functional ability (eyes moving in/out)

Binocular Vision

**Alignment**

**Tropia:** Always present (strabismus)

**Phoria:** Present “some of the time”

Cover / Uncover Test
Maddox Rod / Phoria Cards

Alternate Cover Test
Maddox Rod / Phoria Cards
Binocular Vision - Assessment

Direction of misalignment

Right Esotropia

Right Hypertropia

Right Exotropia

Right Hypotropia
Binocular Vision - Assessment

Cover/Uncover (Tropias)  Alternate Cover (Phorias)
Binocular Vision - Assessment

Binocular Vision: Alignment / Exophoria

Video
Binocular Vision - Assessment

Binocular Vision: Alignment / Esophoria

Video
Eye Alignment Screening
Near Phoria Card
Binocular Vision - Assessment

Convergence

Normal: Break at 4 inches (10cm)
Binocular Vision - Assessment

Video
Children (<age 21) total score = 16 or higher is suggestive of convergence insufficiency.

Adults total score = 21 or higher is suggestive of convergence insufficiency.

(Borsting, Rouse, Mitchel, et al and the CITT group)
Binocular Vision - Treatment

Video
Binocular Vision - Treatment

Brock String
Binocular Vision - Treatment

Lifesaver Card
Binocular Vision - Treatment

Aperture rule picture
Binocular Vision - Treatment
Binocular Vision Lab

PHYSIOLOGICAL DIPLOPIA

https://www.psychologytoday.com/us/blog/eyes-the-brain/200906/you-see-it-is-it-real
Treatment Domains

- Symptom Management / Modifications
- Ocular Motor Skills
- Binocular Vision
- Accommodation ("Focusing Ability")
- Visual Processing Skills
- Functional Training
Accommodation

- Focusing ability of the eye
- Changes in lens shape, pupil size, and position of eyes
Accommodative Dysfunction

- Blurred vision
- Eye strain
- Headaches
- Difficulty reading and concentrating
- Avoidance of near work
- Difficulty taking notes/copying information from board

41.9 - 51% presented with accommodative dysfunction (Gallaway et al., 2016; Master et al. 2016)
Accommodation

- Near/far transitions in gaze
- Subjective report
- Blurred vision more at near than distance
- Age
- Referral to optometry
Accommodation - Treatment

Optometry dx: accommodation insufficiency with recommendation for completion of see-through accommodative rock with bullseye target
Visual Processing Dysfunction

- Lack of coordination and balance
- Clumsiness; falls and bumps into things
- Knocks over objects or misses objects when reaching for them
- Inaccuracy with keys and buttons
- Right vs. left confusion (directionality)
- Poor attention to detail
- Difficulty copying / sloppy handwriting or drawing
- Poor recall of visual material
- Difficulty with activities with high demand on visual processing (driving, reading, writing, sports, mobility)
Visual Processing and Perceptual Skills

- **Visual Spatial Skills**
  - Peripheral awareness
  - Bilateral integration
  - Directionality

- **Visual Analysis**
  - Figure ground
  - Visual discrimination
  - Visual closure
  - Visual memory/visualization
  - Form constancy

- **Visual-Motor Integration**
- Visual processing speed/reaction time
Visual Perceptual Dysfunction in TBI

- Visual and visual-perceptual impairments associated with traumatic brain injury (TBI) are prevalent, with estimates as high as 90% (Jacobsen and Marcus, 2011)
- 31% of people with severe TBI were found to have visual-perceptual impairments one year post injury (Kersel et al, 2001)
- Central and peripheral vision reaction times are prolonged in patients with post concussion visual dysfunction with peripheral visual reaction time being disproportionally prolonged (Clark et al, 2017)
- Reaction times were found to be longer in mild TBI accompanied by an increased variability of response (Piponnier et al, 2016)
- TBI patients exhibited poorer performance on visuo-spatial tasks such as maze learning. (Coetzer and Stein, 2001)
- TBI patients were found to have impairments in verbal and visuo-spatial working memory (Kumar et al, 2013)
Visual Processing - Assessment

- Lafayette Grooved Pegboard
- Developmental Test of Visual Perception – Adult form (DTVP- A)
- Trail Making Test Part A & B
- Functional observations
- Patient report
Visual Processing - Assessment

Lafayette Grooved Pegboard
Developmental Test of Visual Perception (DTVP-A)
Copying Subtest (DTVP-A)

Initial

Re-test
Brain Injury Vision Symptom Survey (BIVSS)

Predictive score of visual dysfunction = > 31

Trail Making Test Part A & B
Visual Processing - Treatment

Dynavision D2™

- Visual processing speed
- Reaction time
- Peripheral awareness
- Visual motor integration
- Saccadic eye movement
Visual Processing - Treatment

Video
Visual Processing - Treatment

Video
Visual Processing - Treatment

Videos
Visual Processing - Treatment

Videos
Treatment Domains

- Symptom Management / Modifications
- Ocular Motor Skills
- Binocular Vision
- Accommodation ("Focusing Ability")
- Visual Processing Skills

Functional Training
Functional Training

Assessment
- Prior level of function
- Current functional performance
- Canadian Occupational Performance Measure

Approach
- Reintegration
- Graded return
- Endurance building
- Desensitization
- Adaptive strategies/task analysis
<table>
<thead>
<tr>
<th>Activity limitations</th>
<th>Importance</th>
<th>Performance</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reading</strong></td>
<td>Baseline: 10</td>
<td>Baseline:2 (5 min)</td>
<td>Baseline: 2</td>
</tr>
<tr>
<td></td>
<td>Discharge: 10</td>
<td>Discharge: 8 (45-60 min)</td>
<td>Discharge: 8</td>
</tr>
<tr>
<td><strong>Computer use</strong></td>
<td>Baseline: 10</td>
<td>Baseline:2 (30 min)</td>
<td>Baseline: 2</td>
</tr>
<tr>
<td></td>
<td>Discharge:10</td>
<td>Discharge: 8 (60 min increments)</td>
<td>Discharge:8</td>
</tr>
<tr>
<td><strong>Grocery shopping/Out with friends in community</strong></td>
<td>Baseline: 10</td>
<td>Baseline:2</td>
<td>Baseline: 2</td>
</tr>
<tr>
<td></td>
<td>Discharge:10</td>
<td>Discharge: 7</td>
<td>Discharge: 7</td>
</tr>
<tr>
<td><strong>Driving</strong></td>
<td>Baseline: 10</td>
<td>Baseline:1</td>
<td>Baseline: 1</td>
</tr>
<tr>
<td></td>
<td>Discharge: 10</td>
<td>Discharge: 6</td>
<td>Discharge: 6</td>
</tr>
<tr>
<td><strong>Baseline:</strong></td>
<td>Average Performance: 1.75</td>
<td>Average Performance: 7.25</td>
<td>Average Satisfaction: 7.25</td>
</tr>
</tbody>
</table>
Functional Training

Picture
Functional Training

Video
<table>
<thead>
<tr>
<th></th>
<th>lbs beef</th>
<th>lbs turkey</th>
<th>lbs salmon</th>
<th>cheese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue-rugula burgers</td>
<td>1.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Philly Cheese Steak Sloppy Joes</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.1 cup</td>
</tr>
<tr>
<td>South by Southwest sliders</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0.6 slices</td>
</tr>
<tr>
<td>Welsh Rarebit</td>
<td>1.5</td>
<td>0</td>
<td>0</td>
<td>1 lb</td>
</tr>
<tr>
<td>Cobb Salad Turkey Burgers</td>
<td>0</td>
<td>2</td>
<td>0.5 to 6 ounces</td>
<td>0</td>
</tr>
<tr>
<td>Everything Salmon Burgers</td>
<td>0</td>
<td>0</td>
<td>1.5/2 cup</td>
<td>0</td>
</tr>
<tr>
<td>Audacious Herbaceous Beef Burgers</td>
<td>1.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gaucho Burger</td>
<td>1.5 to 2</td>
<td>0</td>
<td>0</td>
<td>0.5 to .75 cups</td>
</tr>
<tr>
<td>Steak Pizzaiola Burger</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Functional Training

Video
Functional Training

Picture
Functional Training
**Form 1040**  
Department of the Treasury—Internal Revenue Service  
U.S. Individual Income Tax Return  
2011

For the year Jan. 1-Dec. 31, 2011, or other tax year beginning , 2011, ending , 20

### Your first name and initial  
Last name

### If a joint return, spouse’s first name and initial  
Last name

Home address (number and street). If you have a P.O. box, see instructions.

City, town or post office, state, and ZIP code. If you have a foreign address, also complete spaces below (see instructions).

<table>
<thead>
<tr>
<th>Foreign country name</th>
<th>Foreign province/county</th>
<th>Foreign postal code</th>
</tr>
</thead>
</table>

### Filing Status

1. Single
2. Married filing jointly (even if only one had income)
3. Married filing separately. Enter spouse’s SSN above and full name here.
4. Head of household (with qualifying person). (See instructions.) If the qualifying person is a child but not your dependent, enter this child’s name here.
5. Qualifying widow(er) with dependent child

#### Exemptions

- 6a. Yourself. If someone can claim you as a dependent, do not check box 6a.
- 6b. Spouse

If more than four dependents, see instructions and check here

<table>
<thead>
<tr>
<th>First name</th>
<th>Last name</th>
<th>Social security number</th>
<th>Relationship to you</th>
</tr>
</thead>
</table>

### Income

7. Wages, salaries, tips, etc. Attach Form(s) W-2
8a. Taxable interest. Attach Schedule B if required
8b. Tax-exempt interest. Do not include on line 8a
9a. Ordinary dividends. Attach Schedule B if required
9b. Qualified dividends

### Attach Form(s)

W-2 here. Also attach Forms

---

Emerson Hospital
Functional Training

Picture
THANK YOU!

- Questions?
References

- Centers for Disease Control and Prevention, National Center for Injury Prevention and Control, Division of Unintentional Injury Prevention Jan 2017.


References

- Molloy, J., Murphy, I., & Gissane, C. (2017). The King-Devick (K-D) Test and concussion diagnosis in semi-professional rugby union players. Journal of Science and Medicine in Sport, 20(8), 708-711
References

References