Learning Objectives

1. Understand the physiology of visual-perception.

2. Recognize the signs & symptoms of common visual-perceptual deficits post TBI.

3. Understand the screening & treatment strategies for common visual-perceptual deficits post TBI.
Prevalence

- TBI is one of the major causes of death and disability in the U.S \(^{(\text{CDC}, 2017)}\)

- 90\% of TBI patients have visual-perceptual dysfunction \(^{(\text{Jacobson & Marcus, 2011})}\)

- Veterans: 50\% of those dx with TBI reported visual complaints \(^{(\text{Radomski et al., 2014})}\)
Why is visual-perception so important?

70% of all sensory processing in the cerebral cortex is directly affected by information coming from the 2 eyes

(Hulse & Dudley, 2010)
As a result....

An injury to the brain WILL have an impact on the visual system regardless of where the legion exists in the brain.
Vision TRUMPS all other senses!

We need our vision to integrate with our other senses for normal sensorimotor integration.
Why is visual-perception so important?
Did you know?

- Deficits are not always recognized because:
  - Patients fail to articulate complaints
  - Labeled as confused, clumsy, anxious uncooperative, or unmotivated
  - Clinicians unaware that vision deficits may be the cause of the patient’s behavior
  - Lack of standardized vision screen for TBI
  - Novice clinicians
So where do we start?

1. Basic (really basic) review of anatomy & physiology of the visual system

2. Recognizing common symptoms / deficits

3. Visual – perceptual screening

4. Treatment strategies
Vision vs. Perception

**Vision**
- Defined as the deriving of meaning and directing of action as triggered by light
- Visual acuity
- Visual attention
- Visual field
- Ocular alignment
- Oculomotor control
- Convergence
- Accommodation

**Perception**
- Active processing of sensory input that interacts with higher level processing to interpret the environment
- It’s an aspect of cognition
  - Visual Neglect
  - Depth perception
  - Body part ID
  - R/L discrimination
  - Midline orientation
  - Visual agnosia
  - Color discrimination
  - Spatial relations
Vision & Perception
How does it work?

A very basic review….

1. Light passes through the cornea & lens

2. Combine to produce a clear image of the visual world on the retina - a sheet of photoreceptors

3. The image on the retina is reversed: objects above the center project to the lower part and vice versa
4. Electrical signals from the retina are sent via the optic nerve to the geniculate nucleus to the primary visual cortex which:

- Processes visual information allowing us to see
- Located in occipital lobe
Mary Warren’s visual hierarchy and the 4 circles of vision

Magnacellular
- Ambient (peripheral) vision
- Doesn’t go to occipital lobe
- Visual language processing
- Directs motor movement of eyes/hands
- Gross Motor

Parvocellular
- Focal vision
- Occipital/temporal lobes
- Visual spatial processing
- Object identification
- Fine motor

Visual cognition
Visual memory
Pattern recognition
Scanning
Visual attention
Oculomotor control, visual fields, visual acuity

Centering: Where is it?
Identify: What is it?
Antigravity: Where am I?
Speech/auditory: What do I know about it?

(Hillier and Kawar, 2013)
Capacity of Visual Fields

Focus Vision (Focal)
Visual Lead, Targeting, Signs, Signals

Central Vision
Referencing, Path of Travel, Sightlines

Peripheral Vision
Motion and Color Changes
Common Visual-Perceptual Symptoms & Deficits
Post TBI
Post Traumatic Vision Syndrome (PTVS)

Is a dysfunction in peripheral/ambient visual processing
Most Common Deficits Post TBI

- Visual acuity deficits
- Binocular vision dysfunction
  - Strabismus
  - Convergence insufficiency
  - Accommodation dysfunction
  - Impaired stereopsis
- Visual field deficits and neglect
- Oculomotor dysfunction
  - Nystagmus
- Visual Midline Shift Syndrome
- Photosensitivity
Visual Acuity Deficits

Clarity and sharpness of vision
Binocular Vision Dysfunction: Strabismus

- Eyes are not aligned when viewing an object
- Intermittent or constant
- Caused by muscle imbalance
- Exotropia most common
- Results in loss of depth perception
- Could lead to blindness in affected eye

Strabismus

- Normal
- Esotropia - eye turns inward
- Exotropia - eye turns outward
- Hypertropia - eye turns upward
- Hypotropia - eye turns downward
Binocular Vision Dysfunction: Convergence Insufficiency

Adduction of eyes to view an object at near
Convergence Insufficiency makes the words “move” and look double at times.

When it is mild, it looks a little blur.

When it is moderate to severe, and our eyes do not turn in enough, we see double, and it gives me a headache.
Binocular Vision Dysfunction: Convergence Insufficiencies

- Can lead to suppression of one eye
  - Covers one eye to limit blurring/double vision
  - Brain begins to ignore one eye/shuts down
  - Limits complaints, hard to distinguish
  - Results in loss of binocular vision and depth perception
Binocular Vision Dysfunction:
Accommodation Insufficiency

Inability to focus as object moves closer
Binocular Vision Dysfunction: Impaired Stereopsis

Depth Perception
Binocular Vision Dysfunction

Symptoms

- Eyestrain
- Headaches
- Blurred vision
- Double vision
- Inability to concentrate
- Short attention span
- Incoordination
- Decreased depth perception
- Decreased eye contact
- Squinting, rubbing, closing or covering an eye
- Frequent loss of place
- Trouble remembering what was read
- Sleepiness during the activity
- Motion sickness or vertigo
- Poor posture
  - When completing tasks requiring near vision
  - Head tilt
Binocular Vision Dysfunction
Functional Implications

- Trouble catching balls and other objects thrown in the air
- Avoidance of games that involve depth perception
- Frequency mishaps due to misjudgment of physical distance
  - Trips and stumbles on uneven surfaces
  - Frequent spilling or knocking over of objects
  - Bumping into doors, furniture and other stationary objects
- Sports accidents
- Car parking accidents
Visual Field Deficits

Normal limits of visual field

Classical limits (large, bright targets):
- Superior ~60°
- Inferior ~75°
- Temporal ~100°
- Nasal ~60°
Visual Field Deficits

Homonymous Hemianopia
Visual field “cut”

Visual Field Neglect
Severe inattention
Types of Hemianopia

- Lesion of optic nerve: Ipsilateral monocular visual loss
- Lesion at optic chiasm: Bitemporal hemianopia
- Lesion at optic tract: Contralateral homonymous hemianopia
- Lesion at parietal upper optic radiation: Contralateral homonymous inferior quadrantanopia
- Lesion at temporal lower optic radiation: Contralateral homonymous superior quadrantanopia
- Lesion at occipital visual cortex: Contralateral homonymous hemianopia (macular sparing)
Visual Field Cut
Visual Field Deficits
Which is which?

Homonymous Hemianopia
Visual Field “Cut”
- Typically aware of deficit
- Compensatory strategies are effective
- Visual deficit only
- Postural alignment ok

Visual Field Neglect
Severe Inattention
- Lack of deficit awareness
- Compensatory strategies are tough to comprehend
- Multi-sensory deficit
- Posture misaligned
Oculomotor Dysfunction: Nystagmus

- Repetitive, uncontrolled movements
- Results in reduced vision & depth perception
- Impacts balance and coordination
- Can occur from side to side, up and down, or in a circular pattern

Types of Nystagmus
Visual Midline Shift Syndrome

- Perception of midline is off to the side
  - Symptoms
    - Floor may appear tilted
    - Walls and/or floor appear to shift or move
    - Veering during mobility
    - Leans away from the affected side
    - Imbalance
    - Disorientation
    - Vertigo
Photosensitivity

- Called photophobia
  - An elevated sensitivity to light in the absence of ocular inflammation or infection
  - Generalized to all types of lighting or selective to fluorescent lighting

- Symptoms
  - Fatigue with higher level cognitive tasks, including multi-tasking
  - Fatigue with physical activity
  - Eye strain / fatigue
  - Headache or migraine
  - Malaise / nausea
  - Disequilibrium, dizziness, and possible vertigo
  - Increased sensitivity to motion of visual stimuli (scrolling text, crowded streets, etc.)