Vision Therapy Post Head Injury

Addressing the Root of the Problem

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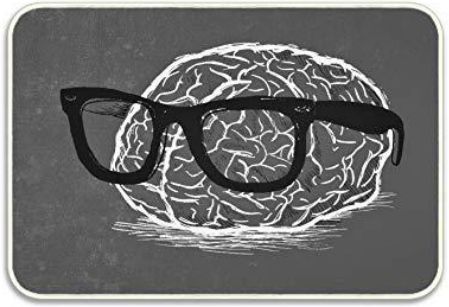
Disclosures

Neither Andrea Lirones, OD, FAAO nor Kara Christy, MS, OTRL, CBIS have any financial disclosures.

Objectives

1. Understand the visual system and prevalence of binocular vision deficits (how vision is impacted) in the post-neurological injury population.
2. Understand clinical signs and symptoms of patients with a binocular vision deficit and how they impact a patient's ADLs.
3. Understand screening techniques and how/when to refer to neuro-visual/behavioral optometry.
4. Understand basic knowledge of vision therapy.



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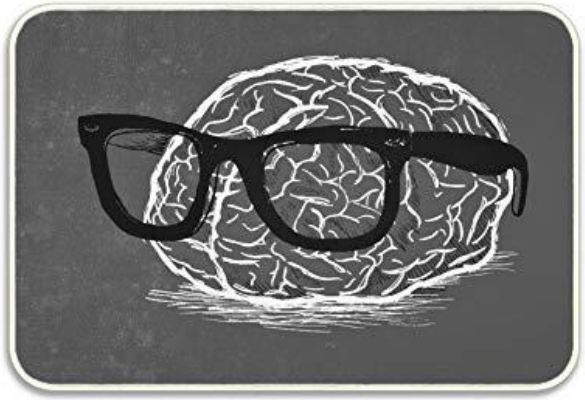


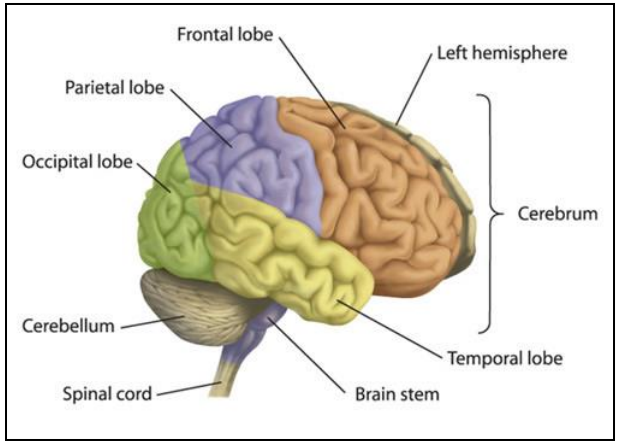
Vision As A Role

- Approximately half of the brain's circuits are involved in vision, binocular vision skills, and visual processing skills (some sources state at high as 60%).
- Every lobe of the brain has some role in the visual system.
- As you can assume, any disruption in this intricate process can cause a disparity between the brain to eye connection.

Vision and the Brain

- Frontal Lobe
  - Pre-Motor Cortex – Motor activity
  - Frontal Eye field – saccades
  - Broca's Area – Speech
  - Personality

- Temporal Lobe
  - Perception
  - Sensory Recognition
  - Processes visual information leading to visual recognition and language
  - Hallucinations
  - Object identification



- Parietal Lobe
  - Locating Objects
  - Pursuits
  - Drawing or Construction of Objects
  - Amnesia for routes and location
  - Difficulty moving through space
  - Neglect

- Occipital Lobe
  - Visual Processing
    - Mapping of the visual world
    - Spatial reasoning
    - Visual memory
    - Identifying visual stimuli
    - Endpoint for the visual pathway/visual field

- Brain Stem/Cerebellum
  - Dizziness
  - Balance

Oculomotor System

Purpose

- Hold images in place on the retina
- Move the eye so that the fovea aligns with an object of interest

Saccades

- “Very rapid, yoked eye movements that move the fovea to an object of interest in the visual field.”

Pursuits

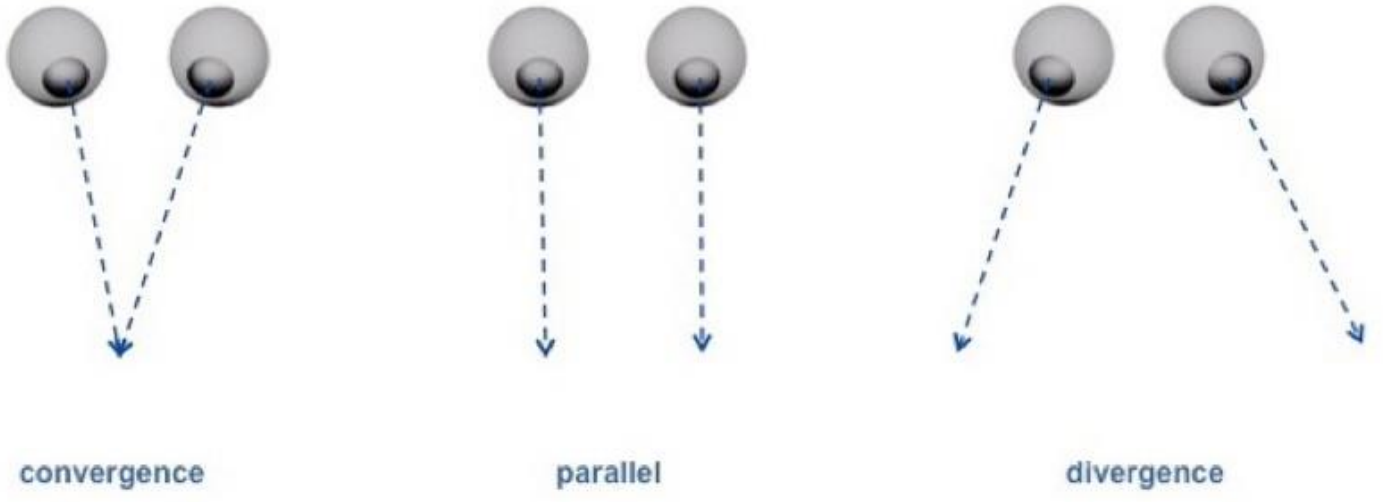
- “Slow, tracking movements that allow continuous fixation of the fovea on a moving object.”

Fixations

- Ability to hold gaze on a target for a period of time

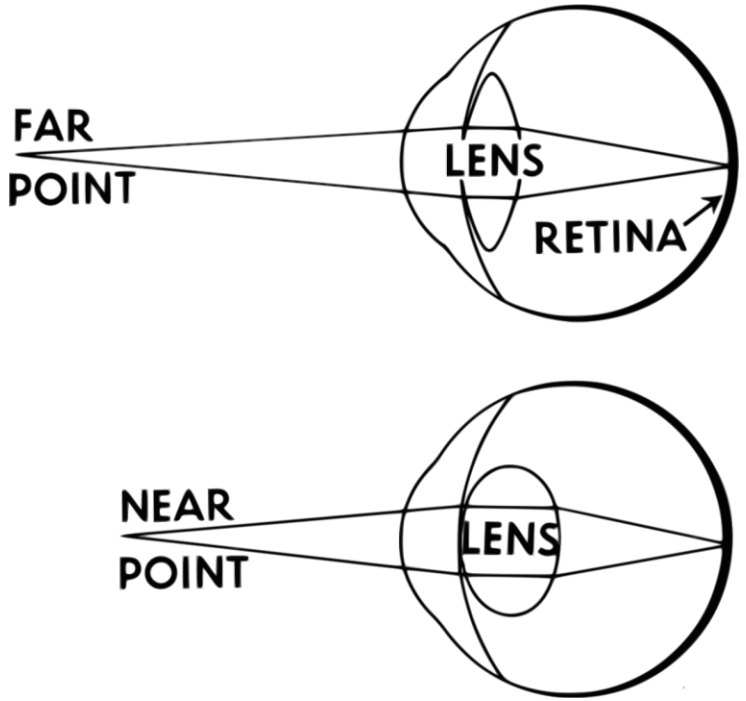
Vergence System

- **Convergence**
  - Ability to cross the eyes to focus on a target
- **Divergence**
  - Ability to uncross the eyes to focus on a target



Accommodation

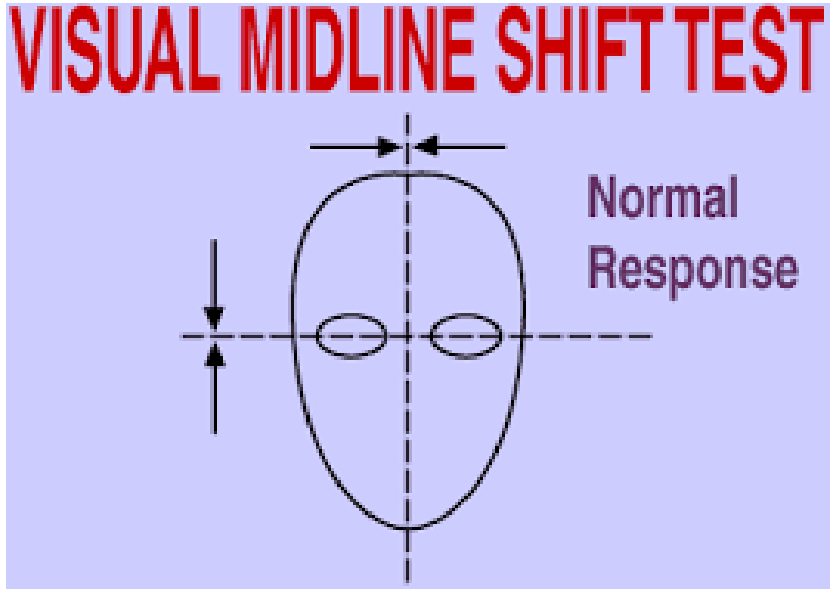
- “Focusing System”
- Ability to change the optical power in the eye to make objects up close clear



Visual Midline Shift Syndrome (VMSS)

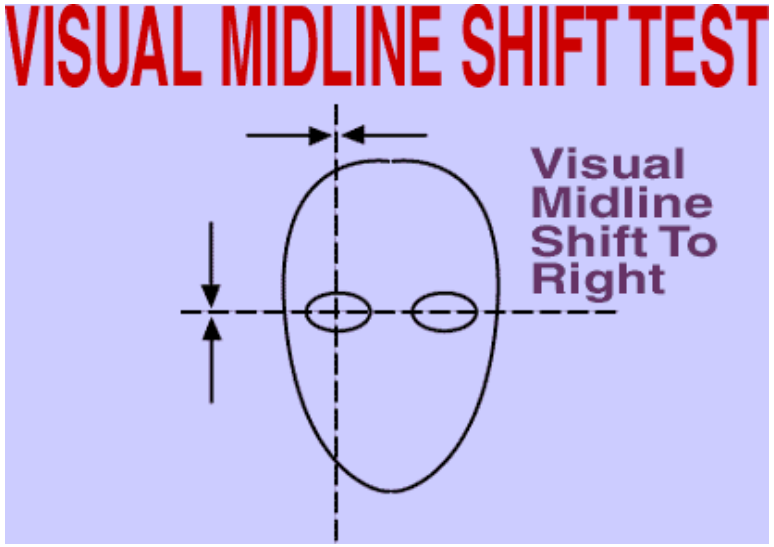
- "Disconnect in the feedback loop between sensory (visual processes) and motor systems."
- Concept of midline is shifted: lateral, anterior or posterior
- Patients **unconsciously** think the center of the body is shifted towards the direction of the midline shift
- The patient will lean **towards** the side of the midline shift
- Imbalance between the ambient and focal systems

Visual Midline Shift Syndrome

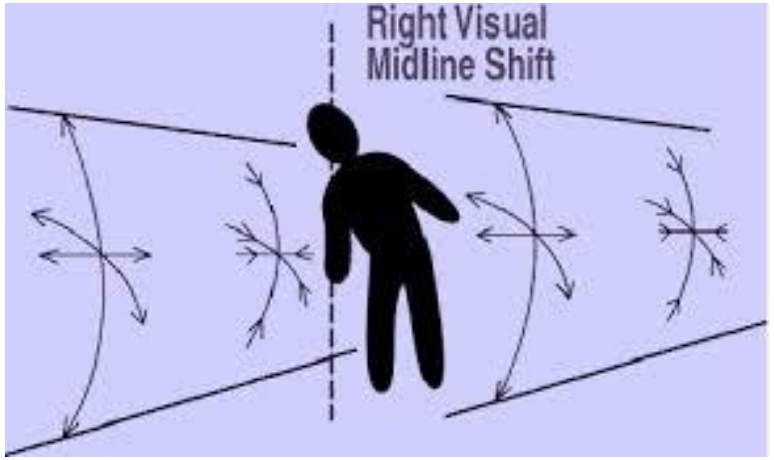


Normal Response

Testing Presentation



Walking/Posture Presentation



Bimodal Visual System

- Two pathways of vision to the brain need to work simultaneously to process these different types of visual information

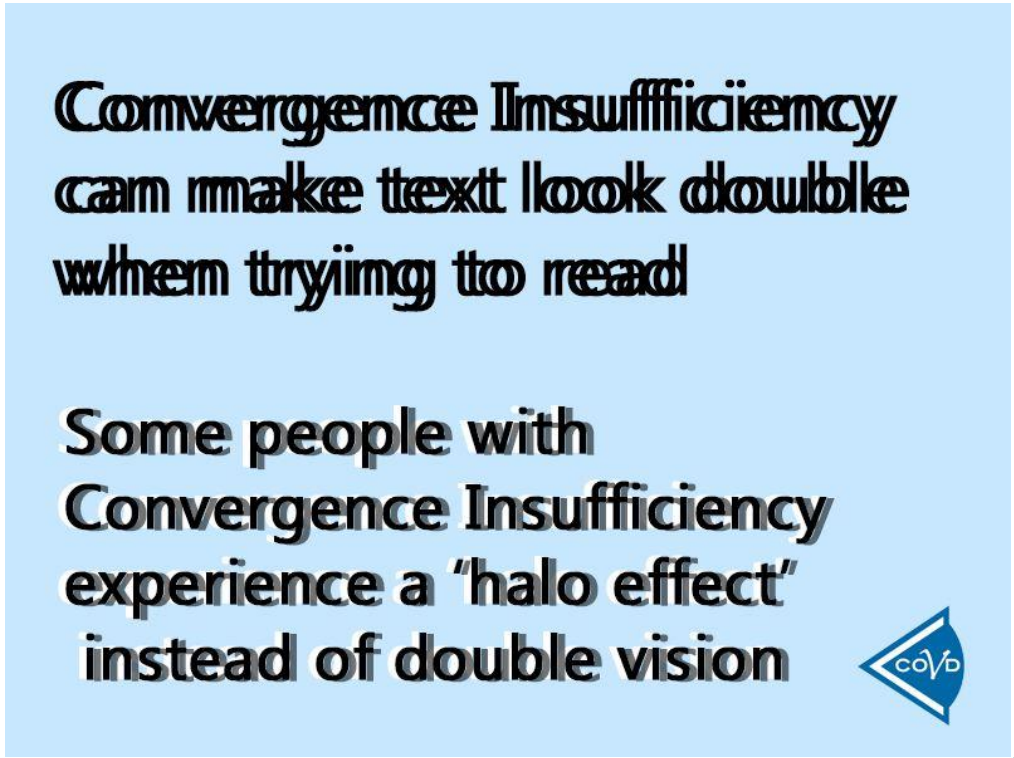
- Focal Vision: The “what”
  - Detail oriented, attention/concentration, identification
  - Central vision, efferent/afferent pathways

- Ambient Vision: The “where”
  - Spatial orientation, posture/balance, movement
  - Peripheral awareness, proprioception

- If acting in isolation, confidence in balance and posture is compromised, leading to a visual midline shift.

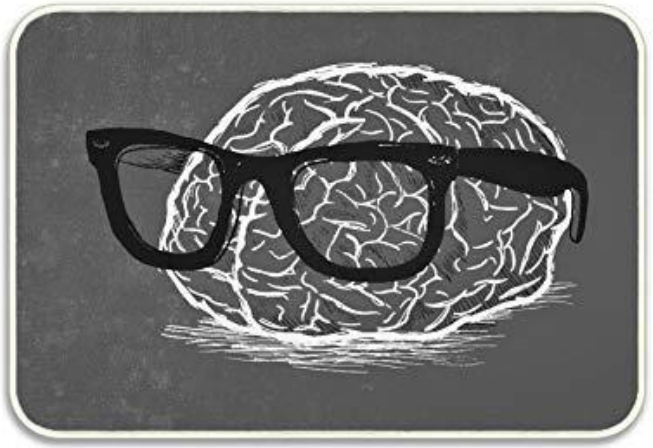
Prevalence

- 10-41% of TBI patients have an accommodative deficit.
- 40-85% of TBI patients suffer form an Oculomotor Dysfunction.
- 40% of TBI patients have vergence dysfunctions.
- At least one visual problem were noted in the following cohorts:
  - 69% of 11-17 year olds with concussion in the outpatient setting
  - 60% hospitalized adults
  - 65% of military personal suffering as a result of blast-induced injury
  - 80% of patients post stroke have one area of their vision impacted
- Visual Midline Shift Syndrome in 40% of patients post TBI.



Objectives

2. Understand clinical signs and symptoms of patients with a binocular vision deficit and how they impact a patient's ADLs.



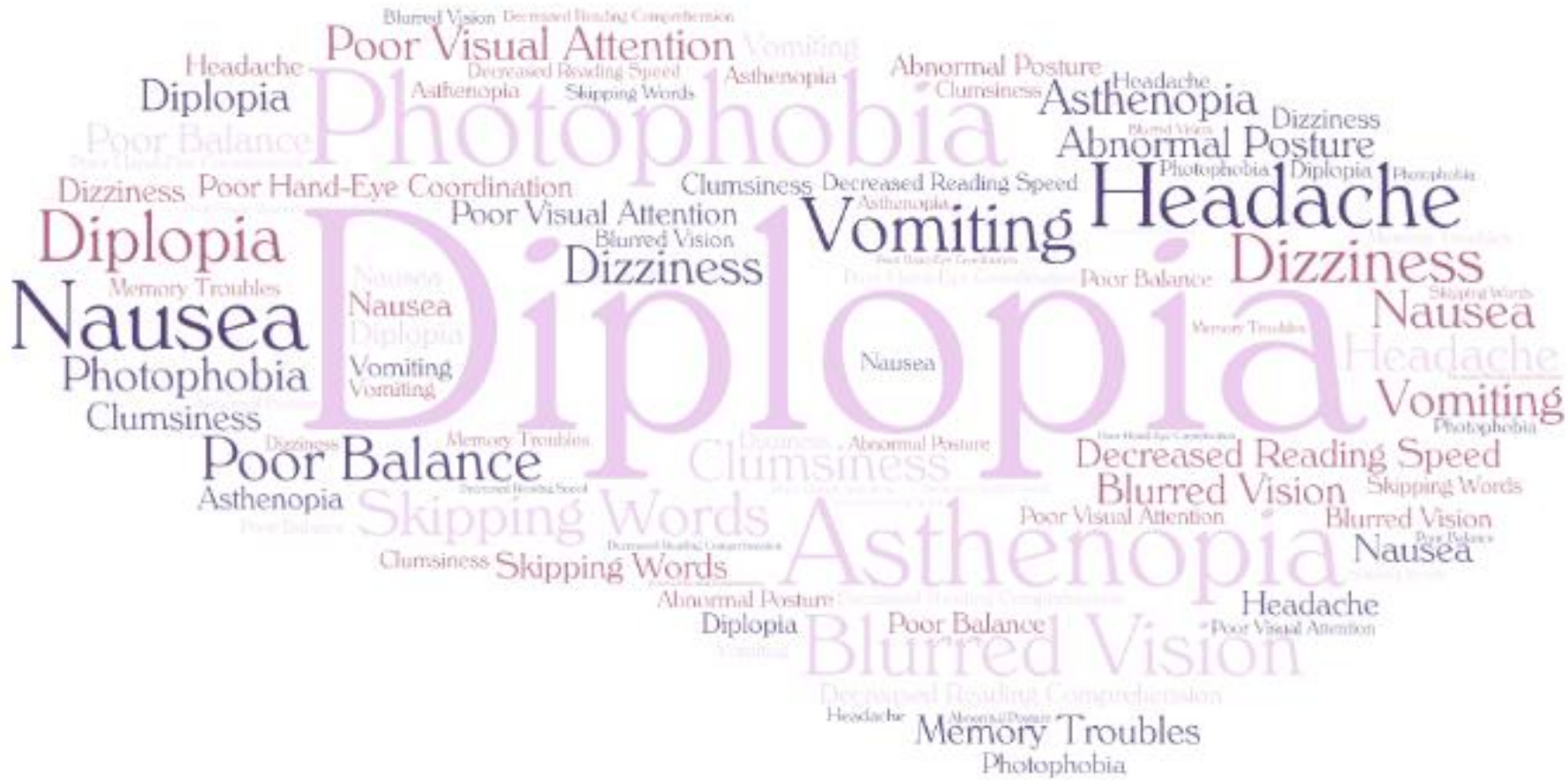
What Can Go Wrong with Vision?

- “Visual difficulties often occur due to an inability to match visual information with proprioceptive, kinesthetic and vestibular stimuli.”

Visual Hierarchy

Warren 1992, 1993

- Impact of vision at each skill level of this hierarchy influences the overall integration of the visual environment.
- The foundation includes ocularmotor control, visual fields, and visual acuity. These are the basic visual skills required to take in information accurately from our visual world.
- Unilateral inattention is represented in this second level, and this deficit would complicate our ability to properly scan and attend to incoming visual information.
- Decreased visual scanning would present difficulties in pattern recognition, which includes (1) form constancy, (2) figure ground perception, (3) visual closure, (4) visual organization, and (5) spatial orientation. Moreover, the optimal functioning of pattern recognition skills are necessary for our ability to retain visual information, also known as visual memory.
- The highest skill level of this hierarchy is visuocognition, in which we are able to integrate visual perceptual information with other sensory input in order to complete executive functioning tasks, such as planning, problem solving, and decision making.
- Determining the cause of a deficit requires an understanding of how brain injury affects the integration of vision at each skill level and how the skill levels interact to produce visual perception.


Blurred Vision
Decreased Reading Comprehension
Poor Visual Attention
Vomiting
Headache
Decreased Reading Speed
Abnormal Posture
Diplopia
Asthenopia
Skipping Words
Clumsiness
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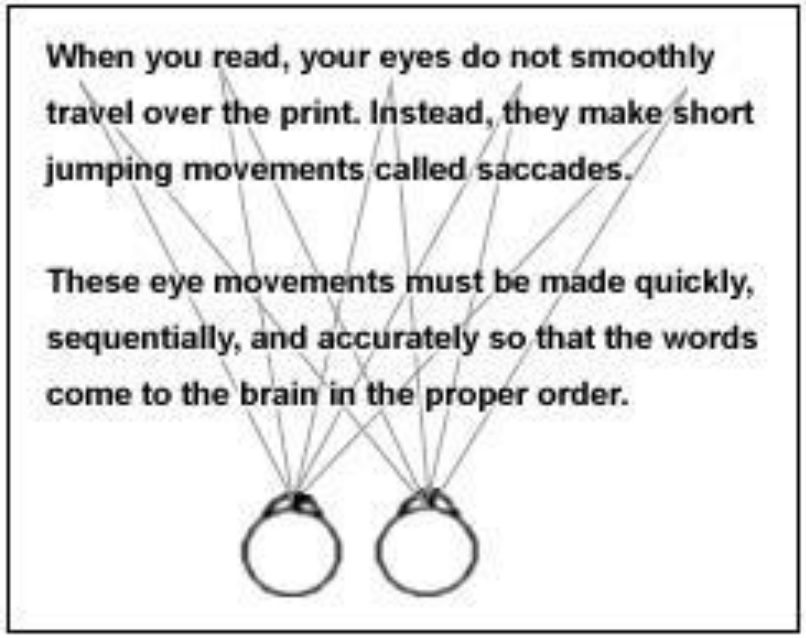
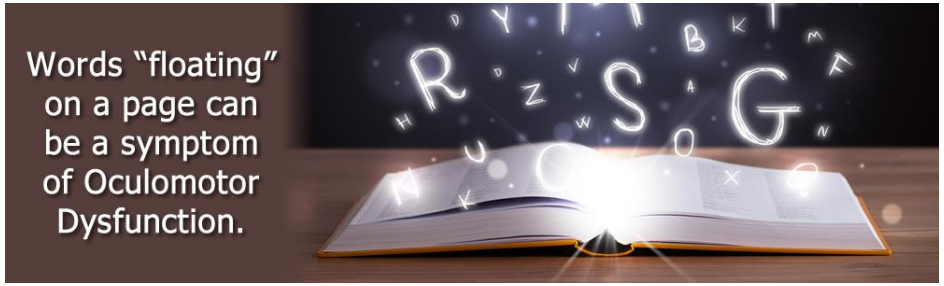
Binocular Vision Dysfunction Symptoms

- Headaches/Eyestrain
- Double Vision
- Words moving around on the page/skipping lines while reading
- Words coming in and out of focus
- Blur
- Poor depth perception
- Poor reading performance/avoidance of reading
- Decreased attention/short attention span

Oculomotor

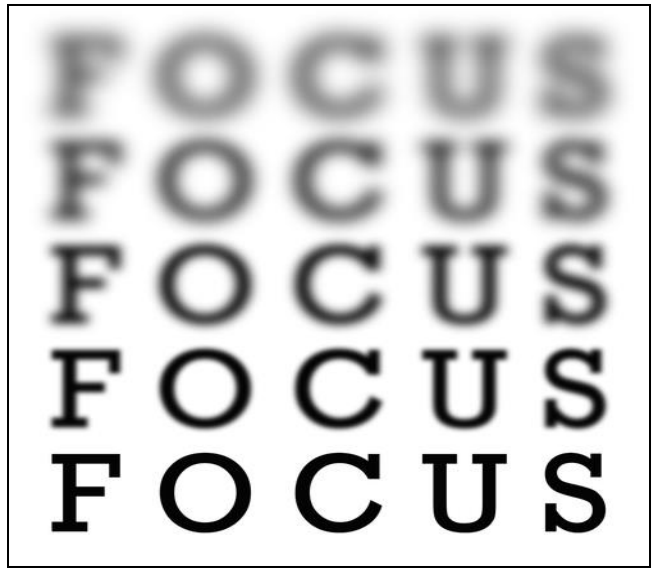
- Function
  - Reading
  - Sports (tracking ball)
  - Giving attitude
  - Grocery shopping
  - Driving
  - Packing medications





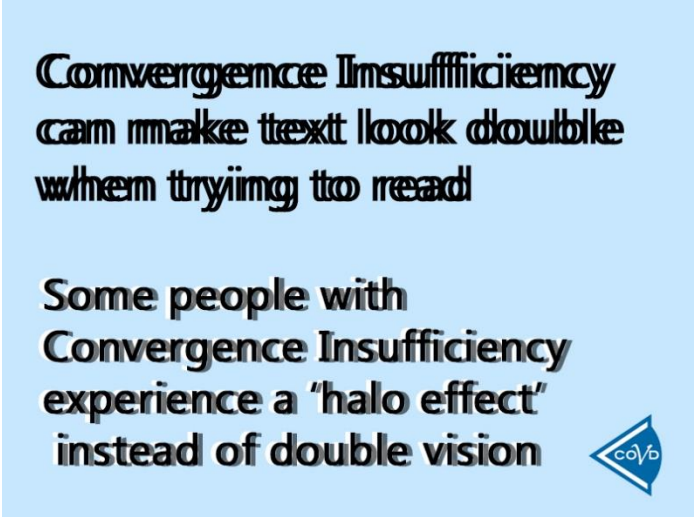
Accommodation

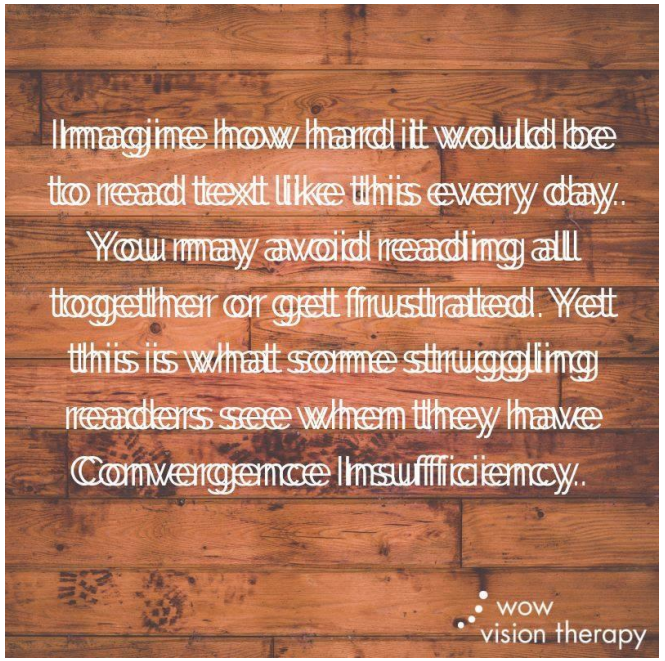
- The automatic adjustment of the eye for seeing at different distances
- Three Components
  - **Amplitude**- Getting it clear
    - Parasympathetic system
    - Can be a problem for many farsighted individuals who usually pass the far Snellen chart.
  - **Sustenance**- Keeping it clear
    - Print comes into and out of focus, especially with fatigue.
    - Sympathetic system
  - **Facility**- Changing focus from one distance to another.
- Function
  - Ability to take notes in school shifting focus from white board to notebook
  - Shifting visual focus from the speedometer in the car to traffic signs
  - Ability to read directions on a recipe and then set the timer/oven temperature



Vergence Skills

- Convergence
  - Coordinated movement of the two eyes so that the image of a single point is formed on corresponding retinal areas.
  - Common to have difficulty with both accommodation and convergence in the pre-presbyopic population
- Function
  - Sewing
  - Reading pill bottles
  - Dialing a phone
  - Texting





Vergence Skills

- Divergence
  - More strenuous/harder

- Vergence facility
  - Changing alignment at change in distance
  - Affects how quickly we can change our viewing distance

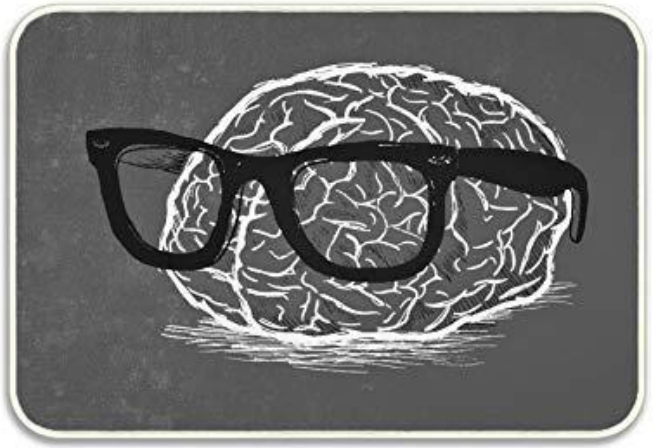
- Function
  - Playing board games
  - Packing medication box
  - Measuring ingredients
  - Reading labels in the grocery store
  - Driving

Depth Perception

- Binocular
  - Stereopsis, or 3rd degree fusion
  - Requires 2 eyes working together
  - Brain uses retinal disparity to compare information from two differing points of view
  - Lack of stereopsis leads to difficulty with coordination
- Monocular cues
  - Shadowing
  - Line of parallax
  - Superimposition
- Function
  - Driving
  - Stairs/curbs
  - Getting into the bathtub
  - Pouring liquids

Objectives

3. Understand screening techniques and how/when to refer to neuro-visual/behavioral optometry.



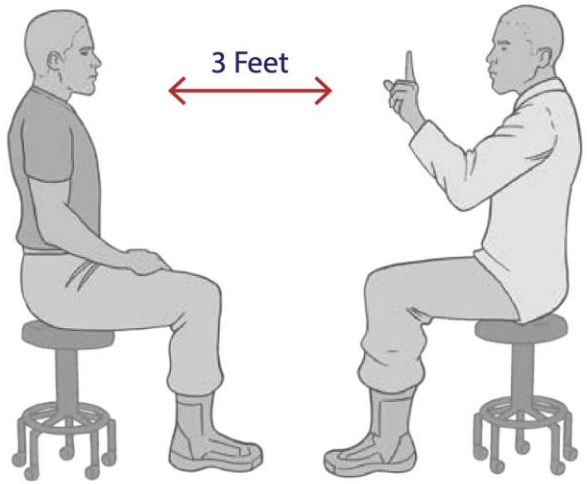
Vestibular/Ocular-Motor Screening (VOMS)

- Vestibular/Ocular-Motor Screening (VOMS)
  - Abnormal findings
    - Blurred/double vision
    - Nystagmus
  - Symptom provocation
    - Headache
    - Dizziness
    - Nausea
    - Fogginess
  - Coordination failure
    - Inability to keep pace
    - Inability to perform

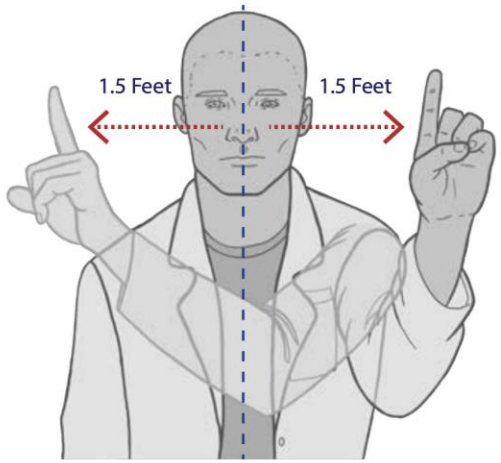
Vestibular/Ocular-Motor Screening - Pursuits

VISUAL GUIDE TO PERFORMING A VESTIBULAR/OCULAR-MOTOR SCREENING (VOMS)

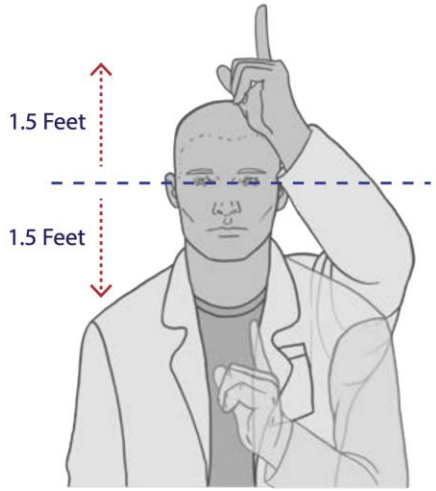
VOMS - Smooth Pursuits



- Sit facing the patient.
- Hold your finger tip 3 feet from the patient.



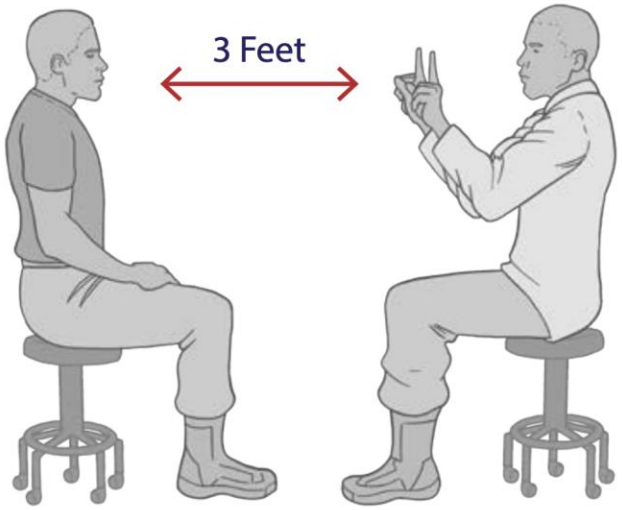
- With the patient focused on your fingertip, smoothly move your finger 1.5 feet to your left. Then move your finger 1.5 feet to the right (it should take 2 seconds to move 3 feet). Perform twice.



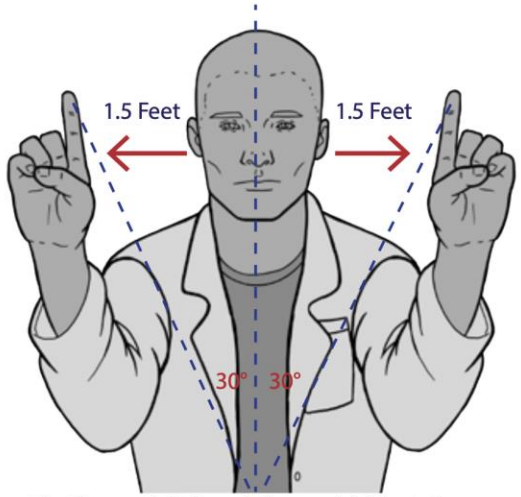
- With the patient focused on your fingertip, raise your finger 1.5 feet. Then lower your finger 1.5 feet (it should take 2 seconds to move 3 feet). Perform twice.
- Have the patient rate headache, dizziness, nausea and fogginess (HDNF) on a scale of 0 to 10. Record the results.

Vestibular/Ocular-Motor Screening – Horizontal Saccades

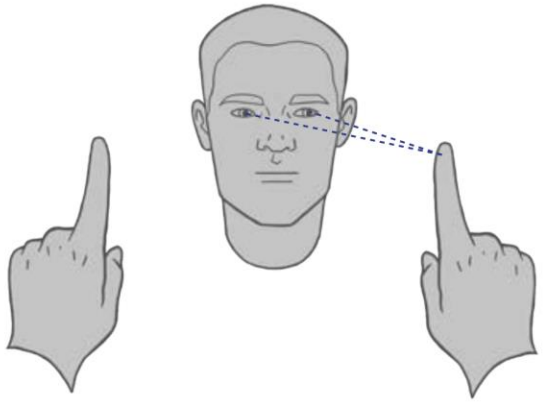
VOMS - Horizontal Saccades



- Sit facing the patient.



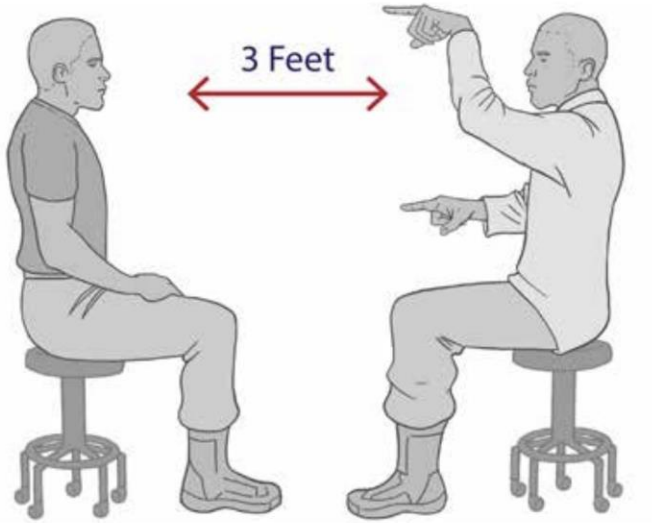
- Hold your left hand finger 1.5 feet from midline and your right hand finger 1.5 feet from midline, about 3 feet from the patient (so that the patient must gaze 30° left and 30° right).
- Ask the patient to move their eyes from point to point as quickly as possible. Perform 10 times.



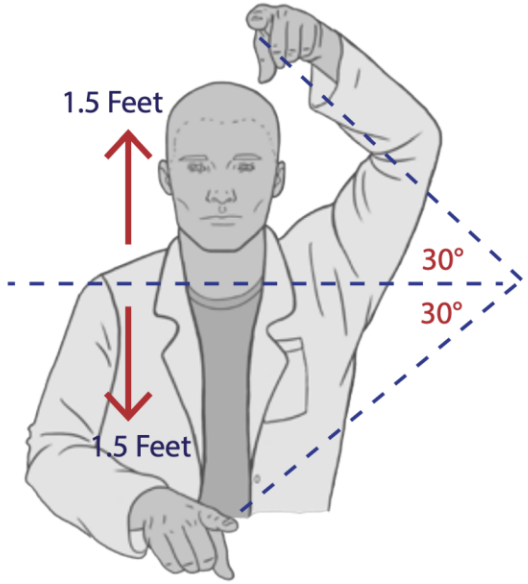
- Have the patient rate HDNF on a scale of 0 to 10. Record the results.

Vestibular/Ocular-Motor Screening – Vertical Saccades

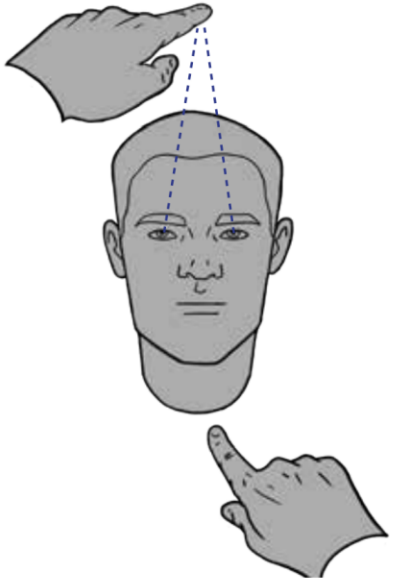
VOMS - Vertical Saccades



- Sit facing the patient.



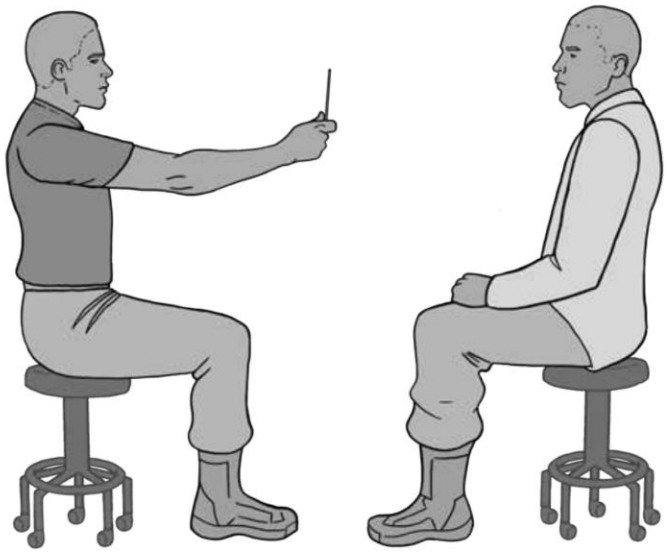
- Hold 1 finger 3 feet below the other, and about 3 feet from the patient (so that the patient gazes 30° up and 30° down).



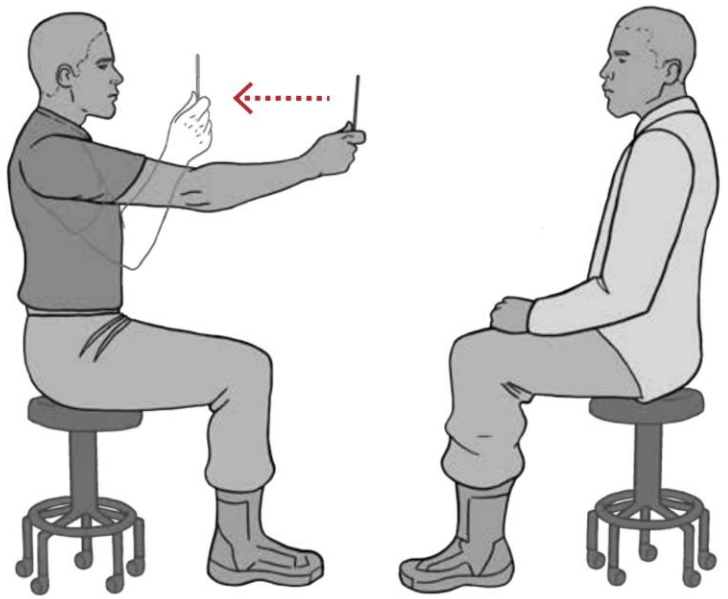
- Ask the patient to move their eyes from point to point as quickly as possible. Perform 10 times.
- Have the patient rate HDNF on a scale of 0 to 10. Record the results.

Vestibular/Ocular-Motor Screening – Near Point of Convergence (NPC)

VOMS - Near Point Convergence

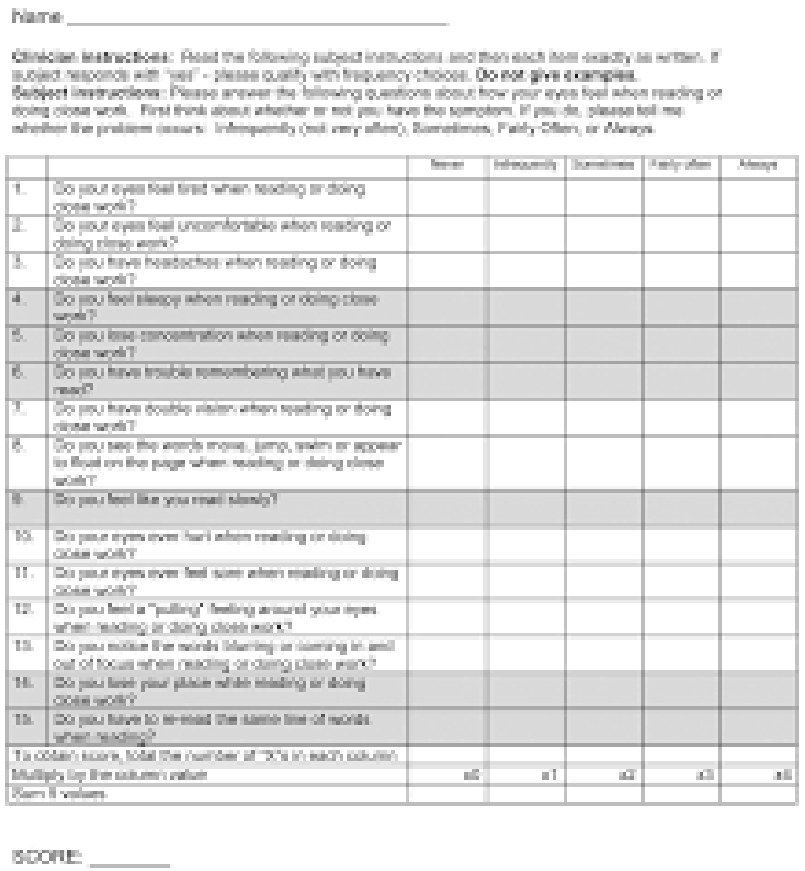


- Sit facing the patient.
- Ask the patient to focus on the target, holding it about an arm's length from their nose.



- Ask the patient to slowly move the target toward the tip of their nose and stop when they see two distinct images, or when you see an outward deviation of the eye.
- Measure the distance between the nose and the target, and record it in centimeters. Repeat 2 more times.
- Convergence points greater than or equal to 5 centimeters are considered abnormal.
- Have the patient rate HDNF on a scale of 0 to 10. Record the results.

Convergence Insufficiency Symptom Survey (CISS)



Name: _____

Clinician Instructions: Read the following subject instructions and then each item exactly as written. If subject responds with "yes" - please qualify with frequency choices. **Do not give examples.**
Subject Instructions: Please answer the following questions about how your eyes feel when reading or doing close work. First think about whether or not you have the symptom. If you do, please tell me whether the problem occurs: Infrequently (not very often), Sometimes, Fairly Often, or Always.

		Never	Infrequently	Sometimes	Fairly often	Always
1.	Do your eyes feel tired when reading or doing close work?					
2.	Do your eyes feel uncomfortable when reading or doing close work?					
3.	Do you have headaches when reading or doing close work?					
4.	Do you feel sleepy when reading or doing close work?					
5.	Do you lose concentration when reading or doing close work?					
6.	Do you have trouble remembering what you have read?					
7.	Do you have double vision when reading or doing close work?					
8.	Do you see the words move, jump, swim or appear to float on the page when reading or doing close work?					
9.	Do you feel like you read slowly?					
10.	Do your eyes ever hurt when reading or doing close work?					
11.	Do your eyes ever feel sore when reading or doing close work?					
12.	Do you feel a "pulling" feeling around your eyes when reading or doing close work?					
13.	Do you notice the words blurring or coming in and out of focus when reading or doing close work?					
14.	Do you lose your place while reading or doing close work?					
15.	Do you have to re-read the same line of words when reading?					
To obtain score, total the number of "X's in each column						
Multiply by the column value		x0	x1	x2	x3	x4
Sum 5 values						

SCORE: _____

- **Test:**
  - Questionnaire pertaining to near work
  - 15 questions with answers
  - ≥ 16 for children
  - ≥ 21 for adults
- **Diagnosis:**
  - Measure for baseline and improvement for treatment

NSUCO

- **Test:**
  - Have two beads on wands, holding them approx. 1 foot apart.
  - Assess pursuits and saccades
  - Measure patients based on head movement, body movement, accuracy and ability.
- **Diagnosis:**
  - Oculomotor dysfunction

Neurovisual Optometrist

- Functional evaluation
  - Eye posture
  - Stereo depth perception
  - Suppression
  - Diplopia
  - Acuity
  - Prisms
  - Glasses/Contact Lenses
  - Ocular Health
- Goal is to determine if the visual system is effectively processing information for functional skills
- Prescribes vision therapy
- Standardized visual fields test
- Important to medical clearance for driving

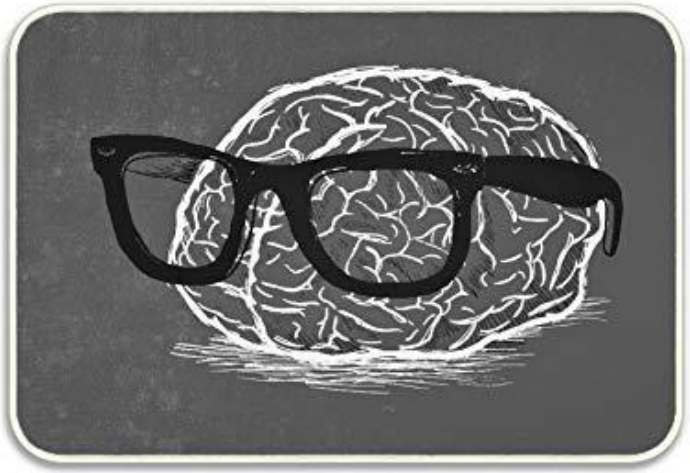
When to Refer to a Neuro-Visual/Behavioral Optometrist?

- Any reduction in clinical skills on previously mentioned tests.
- Any of the symptoms, especially visual, present.
- Symptoms are not improving with time (however, earlier treatment is typically better).
- Balance, vestibular, physical issues, etc.

- Where?
  - Multi-disciplinary rehab center
  - Local neuro-visual or behavioral optometrist
    - Optometric Vision Development and Rehabilitation Association (formerly COVD)
    - Neuro-Optometric Rehabilitation Association

Objectives

4. Understand basic knowledge of vision therapy.



Treatment

- When to refer
  - Typically, will give patient about 4 weeks
  - Can be years later though
  - Must be individualized and personalized
    - Listen to the patient and their struggles
    - Understand vision can be their culprit even without true vision changes
    - May not have blurred/double vision instead headache/fatigue after reading

Treatment

- Identify needs/Recommendations
  - Sub-symptom threshold activity
    - 30 minutes daily
  - Physical therapy with vestibular
  - Occupational therapy
    - Fine motor
    - Vision therapy
  - Speech therapy
  - Psychological/Counseling
  - **Refer to Neuro-Optometry**
  - Osteopathic manipulative medicine
  - Alternative treatments
    - Biofeedback
    - Diet
    - Brain Yoga

Vision Therapy

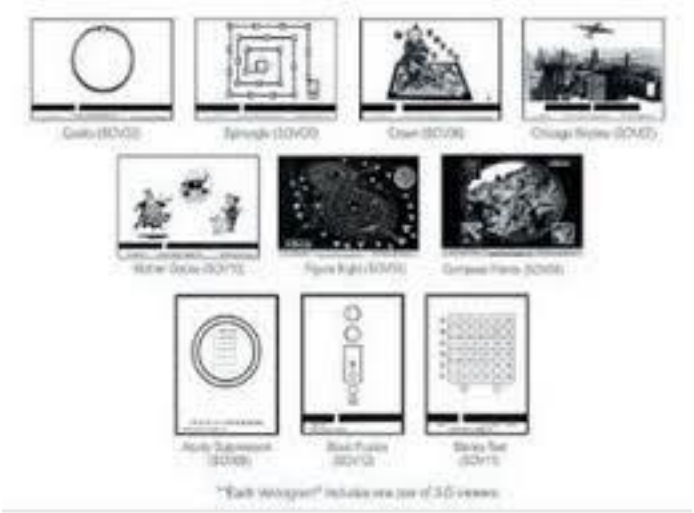
- Vision therapy is a rehabilitative program, prescribed to treat developmental and/or neurologically induced dysfunctions of the visual system. The **American Optometric Association** defines vision therapy as a sequence of neurosensory and neuromuscular activities individually prescribed and monitored by a doctor to develop, rehabilitate, and enhance visual skills and processing.
- "The ultimate goal of optometric vision therapy is not simply to impact positively on various aspects of the oculomotor system *per se*, in isolation, but to attain clear and comfortable binocular vision at all times". Ciuffreda, 2002.
- The history of strabismus orthoptics dates back to 7th century
- AM Skeffington
  - Recognized as the Father of behavioral optometry
  - Coined the idea of the behavioral concept of vision
    - Emphasizes the influence of the environment and experience on visual function
    - Recognize the plasticity of the visual system
    - The relationship of vision with other organismic function
    - Recognized the role of vision as a modality for gathering and processing information

Vision Therapy

- Think of vision therapy like Physical Therapy, but for the eyes.
- A set of individualized eye exercises focusing on the patient's weak area(s).
- Activities focus on the following
  - Accommodative training
  - Oculomotor training
  - Vergence training
  - Visual processing
- Helps re-train the brain to coordinate eye movements
- 1 to 3 times per week
- Various length of treatment time

  Months to Years

Vision Therapy



Remediation Approach

- The remedial or developmental approach is typically initiated based on the premise that the brain can acquire or reacquire function through environmental stimulation.
- Reacquisition of skills should follow the original path of development.
  - In Piaget's model of cognitive development, and in Warren's visual hierarchy model, the lower level performance components are acquired prior to more advanced visual and cognitive skills.
  - Treatment activities should place initial emphasis on foundational skills, regardless of the individual's level of functioning, in order to ensure that the foundation is solid prior to advancing to higher level skills.
- Choosing activities that have multiple levels of difficulty, the ability to alter speed requirements, and offer the opportunity to adjust levels of attention complexity are important to consider for grading activities up or down to foster meeting the client's goals while considering his or her just right challenge.

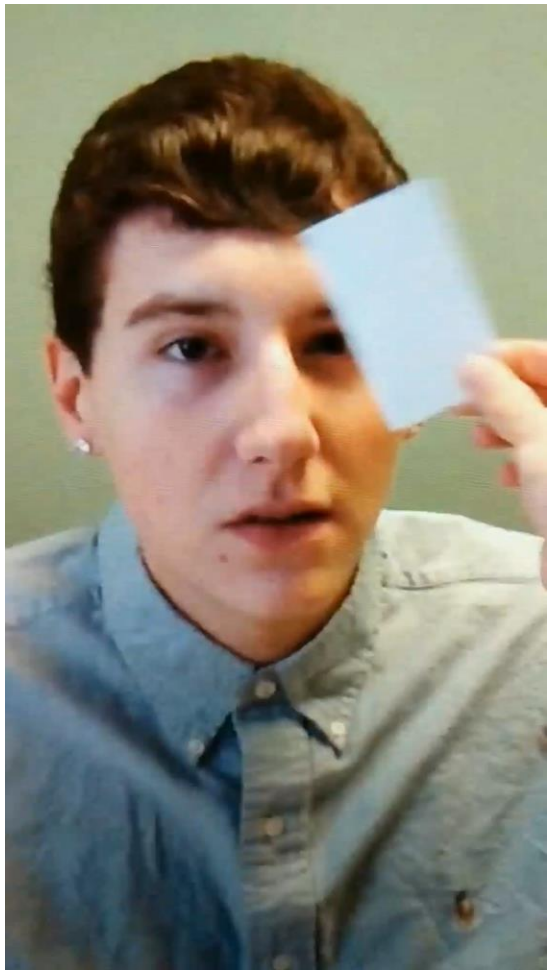
Compensatory Approach

- Compensation is a treatment approach that aims to maximize existing visual function by providing strategies to enhance the patient's ability to assimilate visual information efficiently.
- A compensatory approach should also place emphasis on understanding underlying difficulties in visual perception in order to learn when to initiate the use of strategies to overcome limitations.
- Rather than focusing on one task specific skill, the client should gain the ability to use the learned strategies in various situations.
- Warren supports the use of practicing strategies for visual perceptual deficits within context to ensure carryover of application to ADLs.

OT/PT Role

- Vision Screen
  - Completed as a part of the initial OT/PT evaluation
    - Acuity
    - Diplopia
    - Suppression
    - Visual fields
    - Convergence
    - Accommodation
    - Saccades
    - Pursuit
  - Starts the referral process if red flags are present
- Provides Vision Therapy which is directed by the Neurovisual optometrist (OTA as well)
- Developmental approach **based on function**
- Tools and activities
- Discharge per Neurovisual Optometrist recommendations

Before and After Therapy



Research

Research

- **Vision Diagnoses are common after concussion in adolescents**
  - Master, C. L., MD, CAQSM et al 2015
- Cross sectional study reviewed records from 7/1/2013 to 2/28/2014
- Patients age 11-17 years with concussion diagnosis.
  - Total of 100 adolescents, mean age 14.5 years
- 69% with vision diagnoses
  - 51% accommodative disorders
  - 49% convergence insufficiency
  - 29% saccadic dysfunction
  - 46% manifesting in more than one vision diagnosis
- General population
  - 2% - 8% convergence insufficiency
  - 5% accommodative dysfunction
- Convergence Insufficiency Symptom Survey (CISS)
  - Screening tool – validated 15 point questionnaire to monitor changes
- ImPACT
  - Computerized neurocognitive testing for acute concussions
  - Correlation between poorer composite scores of visual motor speed and visual disturbances –to be expected…
- Academic accommodation considerations

Research

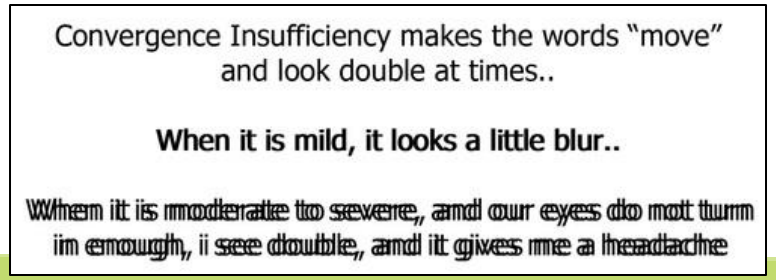
- **Occurrence of oculomotor dysfunctions in acquired brain injury: a retrospective study**
  - Ciuffreda, K. J., O.D., Ph.D. et al 2007
- Reviewed records of 220 ambulatory individuals with acquired brain injury (n=160 TBI, n=60 CVA) with vision symptoms
- Records from 2000-2003, searching for oculomotor dysfunctions including accommodation, versional oculomotility, vergence, strabismus, and cranial nerve palsy
- Results:
  - 90% of TBI manifested in oculomotor dysfunction
    - Accommodation
    - Vergence
    - Versional oculomotility
  - 86.7% of CVA manifested in oculomotor dysfunction
    - Strabismus
    - Cranial nerve palsy
    - Versional oculomotility
- Non-ABI cohort with near work symptoms
  - Convergence Insufficiency in 4% of cases
  - Accommodative insufficiency in 9% of cases

Research

- **Vision Therapy for oculomotor dysfunctions in acquired brain injury: A retrospective analysis**
  - Ciuffreda, K. J., O.D., Ph.D. et al 2008
- Computer based query retrospective analysis for ABI patients between the years of 2000-2003
- Reviewed records of 220 ambulatory individuals with acquired brain injury (n=160 TBI, n=60 CVA) with vision symptoms
  - Only those with vision therapy prescribed and completed the vision therapy program for remediation of oculomotor dysfunctions were selected
    - N=33 TBI, n=7 CVA
    - Treatment success = marked/total improvement in at least 1 primary symptom and 1 primary sign
  - Oculomotor dysfunctions considered: vergence, versional oculomotility, and accommodative deficits
- 90% TBI treatment success
- 100% CVA treatment success
- Improvements remained stable 2-3 months later
- Findings suggest considerable visual system plasticity in response to targeted vision therapy

Research

- **The scientific basis for and efficacy of optometric vision therapy in nonstrabismic accommodative and vergence disorders**
  - Ciuffreda, K. J., O.D, Ph.D. 2002
- Vision therapy for non-strabismic accommodative and vergence disorders
  - Highly specific, sequential, sensory-motor-perceptual stimulation paradigms and regimens
  - Purposeful, controlled, evidence based manipulations of target blur, disparity, and proximity to normalize
- Using bio-engineering models of the oculomotor system as a conceptual framework, a detailed quantitative overview of various static and dynamic models of accommodation and/or vergence optometrist vision therapy was completed
- Selected research studies that provide objective support for the scientific basis for and efficacy of optometrist vision therapy were reviewed
- Accommodative vision therapy: the objective findings support modifiability and normalization of accommodative responsivity following vision therapy
- Fusional Vergence vision therapy: the objective findings support modifiability and normalization of vergence responsivity following vision therapy

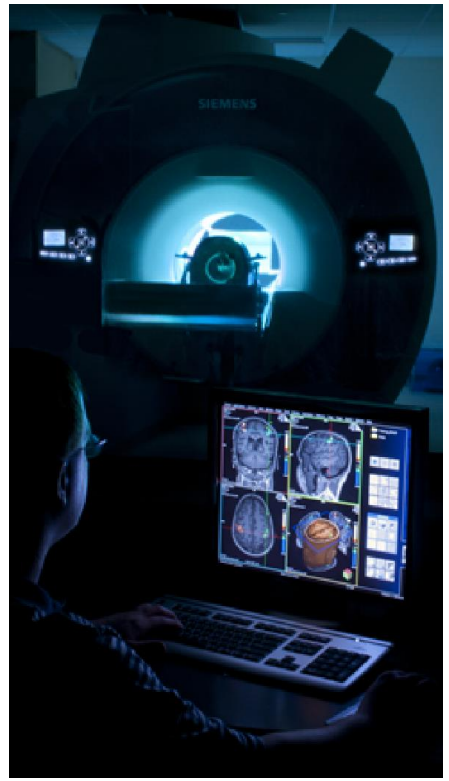


Research

- **A randomized clinical trial of vision therapy/orthoptics versus pencil pushups for the treatment of convergence insufficiency in young adults**
  - Scheiman, M, O.D., et al 2005
- Randomized, multicenter clinical trial.
- 46 adults, 19 to 30 years of age, with symptomatic convergence insufficiency were randomly assigned to receive 12 weeks of treatment
  - Office-based vision therapy/orthoptics
  - Office-based placebo vision therapy/orthoptics
  - Home-based pencil pushups
- Primary outcome measure: Convergence Insufficiency Symptom Survey (CISS)
- Secondary outcome measures: Near Point Convergence (NPC) and positive fusional vergence at near
- Only patients in the vision therapy/orthoptics group demonstrated statistically and clinically significant changes in the near point of convergence (12.8 cm to 5.3 cm, $p = 0.002$) and positive fusional vergence at near (11.3Δ to 29.7Δ, $p = 0.001$).
- Patients in all three treatment arms demonstrated statistically significant improvement in symptoms with 42% in office-based vision therapy/orthoptics, 31% in office-based placebo vision therapy/orthoptics, and 20% in home-based pencil pushups

Research

- **Post-therapy functional magnetic resonance imaging in adults with symptomatic convergence insufficiency**
  - Widmer, D. E., OD, MS et al, 2018
- Purpose to investigate changes in brain activation following office-based vergence-accommodative therapy versus placebo therapy for CI
- Adults age 18-30 years (n=7) with symptomatic CI randomized to 12-week treatment groups
  - Vergence-accommodative therapy n=4
  - Placebo n=3
- Baseline fMRI scan with viewing a red/blue randot stereogram, increasing convergence demands
  - Activation observed in occipital lobe and areas of the brain devoted to attention
- After vergence-accommodative therapy
  - Decreased in occipital lobe spatial extent, increased in level of posterior, inferior portion.
  - New activation in lingual gyrus (not seen in placebo group)
  - Significant decrease in areas devoted to attention
- After placebo therapy
  - Continued activation in areas devoted to attention
  - No activation in lingual gyrus
- Suggests that when experiencing CI symptoms, convergence requires conscious effort. Decreased attention activation was associated with improvements in clinical signs (fusional vergence)



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Thank you!
Questions?

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