As Far as the Eyes Can See

Facilitating Ocular Motor Skills in Children

Jenny L. Clark, OTR/L
www.JennyLClark.com

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Disclosures

Financial:

- Medbridge royalties for courses
- AAPC Publishing royalties for books 'Learn to Move'
- Therapro royalties for game 'Letter Treasure Hunt'
- Abilitations royalties for Learn to Move kit
- Cross Country Education/Pesi royalties for recorded courses
- Summit Professional Education

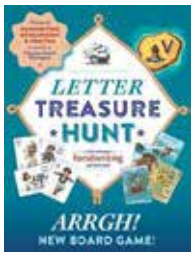
Nonfinancial:

- none

2

Jenny's Bio

- Pediatric OT 30+ years
- Schools, EI, Private Practice SI Clinic
- CE Instructor 20+ years
- Author *Learn to Move* books
- Invented *Letter Treasure Hunt* Handwriting Game
- Loves mountain biking, yoga, kayaking, hiking, gardening, photography, kitties!
- www.JennyLClark.com



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Poll Question
What is your occupation?

- OT
- PT
- Speech
- Teacher
- Parent

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Poll Question
In what setting do you work?

- Schools
- Homes
- Clinic
- Hospital
- Other

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Course Objectives

1. Identify pediatric ocular motor deficits and their impact on daily childhood occupations.
2. List a variety of therapeutic activities that can facilitate functional visual skills in children.

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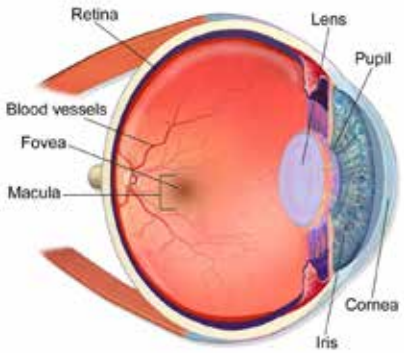
Anatomy of Visual Pathway

1. Eye/Lens
2. Retina
   - Fovea (center of vision, clearest vision of all)
3. Optic Nerve (blind spot)
4. Optic Chiasm
5. Lateral Geniculate Nucleus
6. Primary Visual Cortex (occipital lobe)
7. Secondary Visual Cortex - Higher Level Brain Functions



Eye Anatomy

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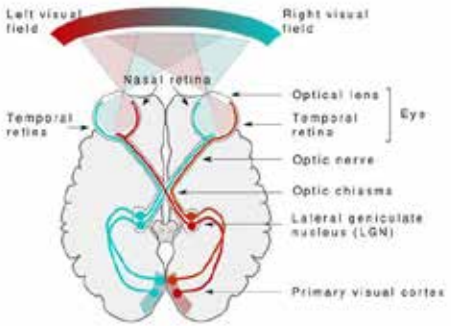
Optic Chiasm

- Nasal Retina Temporal Retinal fields
- Left half of each eye goes through the right side of the brain
- Right half of each eye goes through the left half of the brain



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Magnocellular Functions - Research

- Retinal ganglion cells are neurons located near the retina
- 2 types of Retinal Ganglion cells
  - Magnocelluar cells convey info about general features of objects and movement
  - Parvocellular cells convey info about details in vision relating to form and color
- Magnocelluar pathway tells us where an object is
- Parvocellular pathway tells us what the object is
- (Dohla, et al. 2018) Spelling ability is related to visual magnocellar functions

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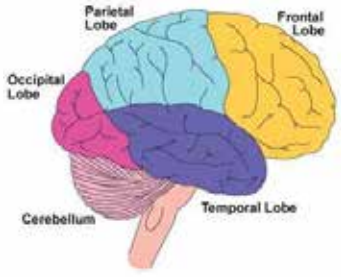
Primary Visual Cortex V1

- Located in occipital lobe
- Functions: receive, segment, and integrate visual information
- Multisensory processing occurs with visual, tactile, and auditory input
- An intact cerebellum is a prerequisite for optimal ocular motor performance.
- The cerebellum fine-tunes each of the subtypes of eye movements so they work together to bring and maintain images of objects of interest on the fovea.



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Secondary Visual Areas

V2 Pathways

Temporal lobe: What is the object?
Parietal lobe: Where is the object?

Functions (30 Areas):

Motion
Stereopsis
Face recognition
Attention
Working Memory
Visual motor integration
Audio-visual-and depth

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Therapy Can Address Secondary Visual Areas

Visual motor integration

Visual perception

Ocular motor skills

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Ocular Motor Skills

Ocular motor skills involve how a child utilizes their eye movements to perform childhood occupations such as buttoning, tying shoes, cutting, reading, sports, and handwriting.

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4 Types of Eye Movements

- Pursuits: Voluntary smooth eye movements that involve following or tracking a moving target
- Saccades: Rapid eye jumps, bringing our focus from one object to another
- Vergence: Eyes teaming for convergence (near) or divergence (far)
- Vestibulo-Ocular Reflex: Stabilization of the eyes relative to head movement (vestibular system)

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Fun Fact About Pursuits

- 6 extraocular muscles work together to control horizontal, vertical, rotational voluntary eye movement
- Most people are better at horizontal than vertical pursuits
- Most people are better at downward than upward pursuits
- Essential in ball sports

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Functional Problems with Eye Pursuits

- Turns book sideways to read vertically with head on table
- Moving head/neck excessively when reading
- Re-reads or skips words
- Confuses similar words when reading
- May contribute to short attention span
- Poor reading comprehension
- Difficulty following written directions
- Writing up or downhill
- Misalignment of math columns
- May impact directional orientation

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Fun Facts About Saccades

- We make 3-4 saccades per second without noticing
- REM (Rapid eye movements) are also saccades
- Bring objects of interest onto the high-resolution (fovea)
- Saccades allow receptors next to the optic nerve to be exposed to the visual scene, meaning that the blind spot isn't blind for long
- The saccades we produce when reading often mean that each eye looks at a slightly different part of the word.

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Functional Problems with Eye Saccades

- Using a finger to track when reading
- Errors or omission of words when copying from board or paper
- Frequently losing place when reading
- Poor spacing and orientation to the line when writing
- Frequent errors when spelling
- Challenges with sequencing
- Read same line over and over and/or skips lines

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Fun Facts About Vergence

- Convergence is the ability to turn the two eyes inward toward each other to look at a close object
- Divergence is the opposite of convergence and is the ability to turn the two eyes outwards to look at a distant object
- Allows for binocular vision
- The left eye and right eye move in opposite directions

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Functional Problems - Convergence Insufficiency

- Complains of intermittent blurred vision
- Frequent headaches r/o medical problems
- Blinks excessively
- Difficulty performing tasks up close
- Blurred vision while grooming, buttoning, and fine motor tasks
- Difficulty catching balls
- Floating letters when writing

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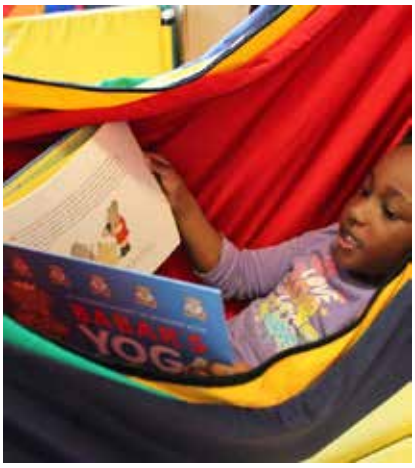
Functional Problems - Convergence Insufficiency

- Challenges focusing, especially reading at distance and writing up close
- Words appear to jump on a reading page
- Complains of swirling or moving print
- Double vision when reading
- Skips words or lines when reading



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Vestibulo-Ocular Reflex

- Uses information from the vestibular labyrinth of the inner ear to generate eye movements that stabilize gaze during head movements
- Post Rotary Nystagmus test assesses for this
- When the body is rotated and then the rotation is stopped a form of vestibular nystagmus occurs
- This is a normal reaction
- Stimulation of the semicircular canals causes this type of nystagmus

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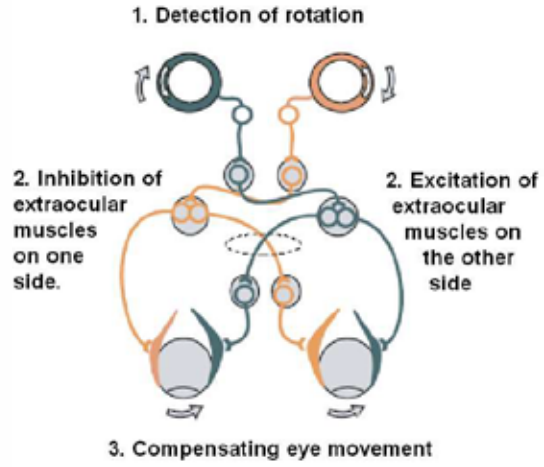
Vestibulo-Ocular Reflex



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Post Rotary Nystagmus Test

- An atypically high PRN score is a sign of insufficient CNS inhibition of the lower nystagmatic reflex
- PRN is produced by stimulation of the 3 semicircular canals in each inner ear (vestibular receptors)
- Semicircular canals are concerned with ocular functions
- The direction of pull of the ocular muscles is approximately aligned to the planes of the semicircular canals
- Each semicircular canal strongly activates a pair of ocular muscles, one in each eye, aligned with its plane of action, and inhibits the antagonist pair

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Extraocular Muscles ROM Deficits

- Slowness or unequal eye movements
- Blurred/ double vision and difficulty focusing
- Headache or eye strain/fatigue
- Attentional deficits
- Depth perception deficits
- Functionally overshoots or undershoots (poor hand-eye coordination)

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Functional Problems - Visual Attention

- Impulsivity during tasks and rushing through activities
- Abbreviated scanning
- Decreased attention to visual details
- Skewed body position
- Increased obstacle collision
- Reluctant to recheck work
- Disorganized visual scanning
- Dressing or grooming only one side of the body; reading one side of page

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Signs & Symptoms Ocular Motor Deficits

Jerky eye movements during reading/ tracking tasks	Unnecessary head movements	Difficulty coordinating visually guided movements
Unable to fixate on an object and sustain fixation	Balance deficits	Decreased speed or increased time required when looking for objects

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School Vision Screenings only rule out problems with visual acuity

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Differences in Oculomotor Function Between Children With Sensory Processing Disorder and Typical Development

- 150 children aged 7 to 11 years
- The Short Sensory Profile (SSP) was used to assign the children into two groups.
- Results showed that children with SPD demonstrate decreased oculomotor skills on all tests compared with TD children.
- Children with SPD have significant differences in oculomotor function compared to children with SPD
- (Walker, et al 2019)

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Identifying Ocular Motor Skill Difficulties

- OT Clinical Observations
  - Ocular tracking
- Formal assessment
  - Visual Skills Appraisal-2
- Teacher Classroom Vision Checklist
  - Classroom visual skills
- Parent Interview
  - Functional visual problems at home/community

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OT Clinical Observations

- Gross observation of ocular pursuits and vergence
- Use a visual target about 12" from child's nose
- Instruct child to follow target with eyes only while keeping head stationary
- Move visual target in horizontal plane back and forth
  - Note any eye jerks at midline
- Move visual target in vertical plane, circular plane
- Move visual target toward/away from child's nose

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Assessing Eye Movements

https://visionrehabot.com/assessing-eye-movements/

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Visual Skills Appraisal -2

- Screening for visual skill difficulties
- Good validity & Reliability
- Standardized & Norm Referenced
- Ages 5-14
- Administer in 10-15 min.

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Visual Skills Appraisal - 2

Pursuits (Object Tracking) – Assess the child's ability to smoothly track vertically, horizontally, and in a circle.

Scanning (Trails) – Assess the child's ability to accurately and efficiently visually follow intersecting lines between two points. (timed)

Aligning (Push-Ups) – Assess the child's near point of convergence

Locating/Saccadic Eye Movements (Numbers) – Assess the child's ability to accurately and efficiently move the eyes between two visual targets. (timed)

Eye-Hand Coordination (Design Completion) – Assess the child's ability to accurately complete six unfinished forms when presented with a visual model to copy.

https://www.therapro.com/Browse-Category/Visual-Perception-and-Visual-Skills/Visual-Skills-Appraisal-2-VSA-2.html

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Teacher Classroom Vision Checklist - Reading

- ☐ Head movement when reading
- ☐ Loses place often or needs finger to keep place
- ☐ Omits words frequently
- ☐ Re-reads or skips lines
- ☐ Short attention span
- ☐ Fails to recognize some words
- ☐ Confuses similar words
- ☐ Whispers to self when reading
- ☐ Quickly loses interest when reading
- ☐ Holds book to close to face

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Teacher Classroom Vision Checklist - Writing

- ☐ Writes uphill or downhill
- ☐ Repeats letters within words
- ☐ Omits letters, numbers, or phrases
- ☐ Misaligns digits
- ☐ Squints, closes or covers one eye
- ☐ Tilts head
- ☐ Fails to recognize same word when repeated in text
- ☐ Reverses letters & words when writing
- ☐ Fails to visualize
- ☐ Makes mistakes when copying from board
- ☐ Writing poorly spaced and crooked
- ☐ Unable to stay on ruled lines
- ☐ Poor placement of words on page
- ☐ Odd working posture at desk activities
- ☐ Uses hand as “spacer”
- ☐ Holds face too close to desk

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Teacher Classroom Vision Checklist – Student Complaints

- ☐ Headaches
- ☐ Burning or itching eyes
- ☐ Print blurs or double vision
- ☐ Words move or "swim" on the page
- ☐ Repeatedly confuses right/left
- ☐ Nausea after reading Difficulty with similarities/differences
- ☐ Avoids desk work
- ☐ Squints, blinks, rubs eyes frequently
- ☐ Fatigues easily

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Parent Interview

- Which childhood occupations does child have most difficulty? Are there any visual skills needed for this?
- Challenges with activities of daily living requiring visual skills?
  - Dressing, brushing teeth, grooming, toileting
- Problems with sports?
- Visual problems with homework?

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Child-Focused Therapist-Lead Interventions

Ocular Motor Skills

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Therapeutic Interventions

- Vestibular-Ocular
- Infinity Walk
- Astronaut Training
- School Moves
- Speed Stacks

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Therapeutic Interventions

- Vestibular Ocular
- Combine movement with a visual target
- Swing and toss
  - Net swing while tossing ball into basket
- Jump and catch
  - Jump on trampoline while catching balloon
- Balance and bop
  - Stand on balance board and pop bubbles

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Therapeutic Interventions

- Infinity Walk http://www.infinitywalk.org/

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Video

Infinity Walk

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Astronaut Training

- https://vitallinks.com/course/astronaut-training/
- Developed by Mary Kawar, MS, OTR/L
- Uses a special "astronaut" board
- Three major components
  1. Active engagement in therapeutic linear & rotary movement that integrates vestibular-visual inputs
  2. Oculomotor localization & tracking exercises
  3. Structured vestibular protocol with specific head orientation during rotary movement to stimulate all 5 vestibular receptors

Vestibular system activates core postural muscles, contributes to keeping eyes steady, helps ability to move efficiently in environment

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Video

Astronaut Training

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www.schoolmoves.com

- Developed by Debra Wilson, teacher
- *S'cool Moves for Learning*
- Integrates Movement & Music
- Includes ocular motor, eye-hand coordination, sensory, posture, balance, body image, laterality

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www.Speedstacks.com

1-877-GOT-CUPS
Sport Stacking with Speed Stacks

- Developed by Bob Fox
- Upstack & downstack specially designed cups
- Develops eye-hand coordination, bilateral coordination, reaction time, laterality, focusing skills, self-esteem

- Evidence-based
  - Dr Hart Texas Tech University examined electrical activity of 2 hemispheres of brain (EEG) results indicate sport stacking uses both sides of the brain
  - Dr. Udermann & Dr. Murray examined sport stacking on hand-eye coordination & reaction time of 24 boys & 18 girls in 2nd grade. Significant improvements were notes for both. (results published in *Perceptual and Motor Skills* and *Research Quarterly*)

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Ocular Tracking Therapy Activities

- Zoom Ball
- Bean bag toss
- Alphabet scanning
- Practice sports skills

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Zoom Ball

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Bean bag toss

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Alphabet Scanning Example

- In-Person: Modify for eye scanning by using red pin light to target letter.
- Teletherapy: Screenshare child could laser pointer to find letter

Jamie Wilkins Teacherspayteachers

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Practice Sports Skills

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Ocular Motor Therapeutic Activities

- Finger monster on penlight to follow with eyes in all planes
- Hit a suspended ball with a paper towel tube.
- Roll a marble or ping-pong ball back and forth catching it in a cup.
- Pie pan and marble rotations while following with the eyes.
- Use a flashlight to locate specific items in the room. The child names objects that you point out with the flashlight.

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Ocular Motor Therapeutic Activities

- Play with a ping-pong ball, bounce into cup.
- Hold two small objects in front of the child, move them back and forth ask them to say which one is closer.
- On a large number line the child looks at the number you name.
- On a large number line the child looks at the number you name.
- Play balloon volleyball while seated or standing.

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Ocular Motor Therapeutic Activities

- Bubble blowing and popping with hand clapping or finger poking
- Scarf tossing and catching while seated or standing.
- Ball toss & catch can be with a partner or while lying prone with self.
- Wall ball by tossing and bouncing off of wall to catch.
- Balloon bop using noodle
- Velcro ball & mitt

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Ocular Motor Therapy Games

- Elefun
- Simon
- Whack a mole
- Mr. Mouth

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Telehealth Ocular Motor Activities – Screen Share

- Shark Attack: Visual Fixation. Every time shark appears, yell "Shark!"
- https://eyecanlearn.com/tracking/fixation/shark/
- Bug Walk: Visual Pursuits. Keep eye on bug as he walks across screen. https://eyecanlearn.com/tracking/pursuits/bug-walk/
- Rabbit Jumps: Visual Saccades. Watch rabbit jump across screen. Keep head still.
- https://eyecanlearn.com/tracking/saccades/rabbit/

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Environmental Supports & Adaptations

Ocular Motor Skills

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Visual Accommodations – Classroom

- Move student closer to teacher
- Place student in area with natural lighting
- Increase font 14-18pt to reduce visual stress
- Highlight important information
- Use sticky notes to draw visual attention to text
- Add visual graphics
- Print free graph paper (see resources)
- Orient notebook paper lines vertically for math problems

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Visual Accommodations in the Classroom

- Bold lined paper
- Wide rule paper
- Colored guideline paper
- Raised line paper
- Good contrast colors
- Encourage proper paper placement and posture for writing.
- Window guide to keep place on page when reading

https://www.therapro.com/Browse-Category/Reading-Guides/Reading-Guide-Strips.html

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Caregiver-Focused Interventions Ocular Motor Skills

Parent & Teacher Mediated

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Computer Vision Syndrome

- Children are susceptible to computer vision syndrome (CVS), also called digital eye strain, after extended use of computers or digital devices.
- Symptoms of CVS include eye fatigue and eye strain, dry eyes, headaches, blurred vision, and neck and shoulder pain.

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Teacher Mediated: Preventing CVS in Children

- Location of computer screen - Optimally, the computer screen should be 15 to 20 degrees below eye level (about 4 or 5 inches) as measured from the center of the screen and 20 to 28 inches from the eyes.
- Reference materials - Position documents to avoid moving head back and forth to look from the document to the screen.
- Lighting - Position the computer screen to avoid glare, particularly from overhead lighting or windows.

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Teacher Mediated: Preventing CVS in Children

- Anti-glare screens – Adjust with computer settings or use a screen glare filter.
- Seating position - Chair height so feet rest flat on the floor. Wrists shouldn't rest on the keyboard when typing
- Rest breaks - For every 20 minutes of computer viewing, look 20’ away for 20 seconds to allow your eyes to rest
- Blinking - Blinking keeps the front surface of your eye moist to minimize dry eyes.

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Parent Mediated: Ocular Motor Home Activities

- Complete mazes
- Pour liquid from container to container
- Connect-the-dots exercises
- Play with a remote-control car. Tell the child when to turn left or right. Try it with an obstacle course.
- Do at Dot art
- Fly a kite. Outline it in the sky with a pointed finger.
- Bubbles, Balloons, balls

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Case Study: Ocular Motor 2nd Grade Boy 7 years 10 months

- Referred to OT from optometrist due to ocular convergence insufficiency
  - RX glasses for up close work
  - Vision Therapy
- Difficulty in school with handwriting, spelling, & reading
  - Problems aligning words on left margins when writing
- OT clinical observations
  - Right eye preference
  - Smooth pursuits, ↓ convergence
- VSA-2: 52% overall score
  - Pursuits 5/5
  - Scanning 2/5
  - Aligning 2/5
  - Locating 2/5
  - Eye-Hand coord. 2/5

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Case Study: Integrating Ocular Motor Activities in OT Treatment

- Alphabet Scanning
- Speed Stacks
- Movement with visual target
- School Moves

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Case Study: Outcomes

- After 1 year of OT:
- Improved performance in school w/ IEP and school OT accommodations
- Improved convergence – smooth
- Met OT goals for handwriting legibility & functional visual skills
- Improved self-esteem & confidence

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Resources

- https://eyecanlearn.com/
- https://www.theottoolbox.com/visual-saccades-activities/
- https://www.printfreegraphpaper.com/
- https://www.aota.org/~/media/Corporate/Files/AboutOT/consumers/Youth/School-Success.pdf

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Questions?

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