Visual Dysfunction Following Acquired Brain Injury – What to Expect

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Disclosure Slide

- I have no financial relationship with any commercial interest related to the content of this lecture.

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What is Acquired Brain Injury?

- Traumatic
- Acquired
  - Stroke
  - TBI
  - Concussions
  - Brain tumors
  - Degenerative Causes: MS, Parkinson's
  - Developmental Causes: CP, Downs

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How Big is the Problem?

- Incidence: 650/100,000 (under-reported)
- 1.7m / yr (USA) with 35% being <16 yo
- It is speculated that as many if not more have ahead injury that goes unreported

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How Big is the Problem?

- 15% remain symptomatic (PCS)
- 33% - 52%: Percentage of people who suffered major depressive disorders in the first year after a TBI
- 3x higher risk of suicide

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Pathophysiology

- Diffuse (widespread) vs. Focal (localized)
- Left vs. Right Hemisphere
- Effect on Function by Brain Location

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What Can Cause Vision Dysfunction?

- Disruption of neurologic pathways
- Damage to structures
  - Brainstem
  - Cortex
  - Cerebellum

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Visual Pathways & Subsystems

- **Primary Visual Pathway**
- **Dorsal Path - "Where is it"**
  Magnocellular Pathway
- **Ventral Path - "What is it"**
  Parvocellular Pathway
- **Midbrain Pathway – "Where am I"**
  - **Superior Colliculus (18% of ON fibers)**

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Ambient System

- More primitive system present at birth
- Visual information travels to the midbrain
- Mediated by the magnocellular system
  - Respond to large and fast moving stimuli

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Focal System

- Associated with the primary visual pathway
- Mediated by the parvocellular system
  - Much slower than the ambient system
  - React to stationary small targets, detail and color

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Comparing the Systems

- **Ambient:** spatial orientation, posture balance, movement, preconscious
  - Rapid speed in processing
- **Focal:** detail discrimination, identification, attention, concentration, conscious
  - Slow speed in processing

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Focal and Ambient Systems

- A disconnect in the ambient system will cause problems with spatial orientation
- Patient will report: difficulty with balance and/or navigation, frequently bumping into objects

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Post Trauma Vision Syndrome:

- Headaches (71%)
- Feeling "slowed down" (58%)
- Difficulty concentrating (57%)
- "Fogginess" (53%)
- Fatigue (50%)
- Blurred vision / double vision (49%)
- Light sensitivity (47%)
- Memory dysfunction (43%)
- Balance dysfunction (43%)

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What does it look like to the patient?

- Difficulty with lots of print on a page
- Difficulty with movement in the environment - can't go to crowded places anymore
- Tunnel vision - caused by increased concentration by the pt in order to single out the detail of attention

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Patient Demographics

- Who do we collaborate with?
  - MD's / Hospitalists
  - In-patient rehabilitation facilities
  - OD's
  - Therapists
- Concurrent treatment patients are receiving:
  - Occupational therapy
  - Physical therapy
  - Speech therapy
- Other referrals to consider?

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Common Findings with Acquired Brain Injury

- Oculomotor Dysfunction – fixation, pursuit & saccadic
- Binocular Vision Dysfunction
- Visual Field Loss

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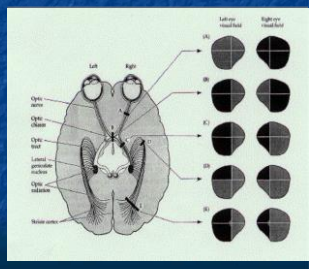
Common Field Deficits in CVA and TBI

- Unilateral
- Bitemporal
- Hemianopsia
- Quadrantanopsia
- Pie in the Sky (temporal lobe)
- Other Superior field loss (AION)
- Scattered islands



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Common Findings with Acquired Brain Injury

- Unilateral Spatial Inattention
- Egocentric Localization (Visual Midline Shift)
- Poor Spatial Localization
- Difficulty with Visual Motor Tasks
- Loss of Visual-Vestibular Integration

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Neuro-Visual Exam Elements

- Ocular motility:
  - King-Devick Eye Movement Test
  - DEM Test
  - ReadAlyzer / Right Eye
- Accommodation:
  - Facility testing
  - Grasp-release
  - NRA/PRA

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Neuro-Visual Exam Elements

- Binocularity:
  - Cover test
  - NPC
  - Vergences
  - Stereopsis – Randot, local, KBB

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Neuro-Visual Exam

- Sensorimotor Evaluation:
  - Maddox Rod
  - Park's 3 Step
  - VTS3/4
- Visual Field Testing
  - Confrontation fields
  - Automated visual field
  - Motion/color field charts

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Neuro-Visual Exam

- Visual Neglect
  - Dual Presentation - Extinction
  - Line Bisection
  - Copying – clock, house, flower

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Neuro-Visual Exam

- Visual Midline Test (Ludlam)
- Contrast sensitivity
  - Pelli-Robson
  - Continuous Text
- Perceptual Testing

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Neuro-Visual Exam

- Contrast Sensitivity
- Binasal occlusion evaluation
- Selective occlusion (if needed)
- Absorptive filter / UV Shield evaluation
- Standardized Eye Movement Testing:
  - King-Devick Eye Movement Test, ReadAlyzer

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Evaluation of Pursuits: Latency

- Movement should begin simultaneously with target movement
- Delay indicates higher cerebral dysfunction such as Frontal Eye Field (FEF)

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Evaluation of Pursuits: Speed

- Eye movement should match target speed
- Significant mismatch indicates compromised non-visual afferent modules
- Noncomitancy indicates dysfunction in the Medial Longitudinal Fasciculus (MLF) or cranial nerve nuclei or pathway

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Evaluation of Pursuits: Directional Differences

- If significantly worse in one direction, the *parietal-FEF* complex on ipsislateral side is implicated
- Pursuits/Saccades:

  If saccades are intact, but pursuits are worse on one side, the contralateral *occipital cortex* may be involved

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Evaluation of Saccades: Latency, Inability, Velocity

- Cerebral areas are implicated (FEF) when it takes longer to initiate saccades
- Consider visual field defect, neglect, or cognitive deficits with inability
- Slowness indicates compromised non-visual afferent modulus (cerebellum and vestibular)

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Evaluation of Saccades

- If >2 saccades between targets (hypometria), without latency defect, implicates superior colliculus and/or ambient system

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Maddox Rod Checking Muscle Fields

- Hold the Maddox rod in front of one eye and a penlight in front of the patient
- Ask the patient to report if there is a red streak/line and one white light
- Patient reports the relative position of the lights to one another
  - Repeat in all cardinal positions at near

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Maddox Rod
Checking Muscle Fields

- Neutralize the deviation in the different positions of gaze with loose prisms
- Repeat the procedure with both vertical and horizontal orientation to direction of diplopia
- If there is a vertical component, perform the Park's Three Step Test

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Park's Three Step Test

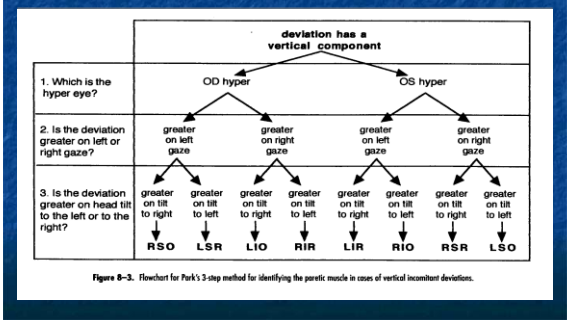

Figure 8–3. Flowchart for Park's 3-step method for identifying the paretic muscle in cases of vertical incomitant deviations.

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Abnormal Head Posture Related to Affected Extraocular Muscles

Muscle — Position of Face

	Turn	Elevation	Tilt
RLR	R	-	-
RMR	L	-	-
RSR	R	UP	L
RIR	R	DOWN	R
RSO	L	DOWN	L
RIO	L	UP	R
LLR	L	-	-
LMR	R	-	-
LSR	L	UP	R
LIR	L	DOWN	L
LSO	R	DOWN	R
LIO	R	UP	L

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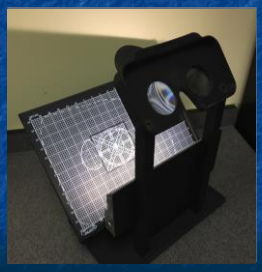
Visual Field Testing

- Automated Visual Field
- Confrontation Fields
- Motion/Color Field Charter



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Unilateral Spatial Inattention - Visual Neglect

- A patient with TBI or stroke does not process information on one side of their body
- Can also exist with a field defect
  - Differentiate between neglect vs. defect by performing confrontation fields (with and without movement) then doing extinction test

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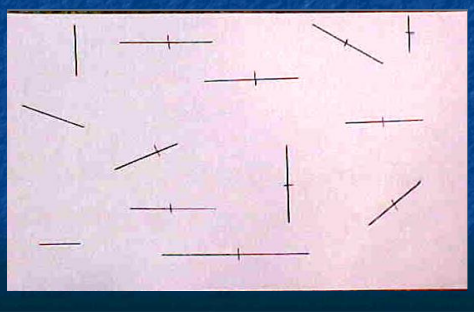
Unilateral Spatial Inattention Testing - Line Bisection



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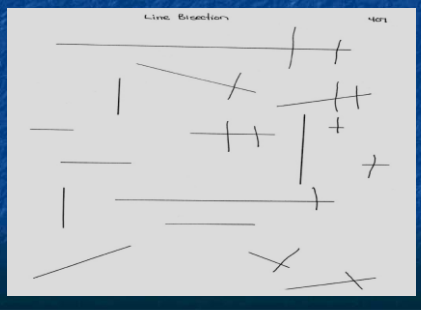
Line Bisection
Left Inattention (stroke)



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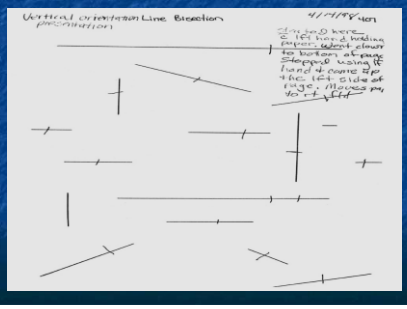
Line Bisection
Left Inattention (TBI)



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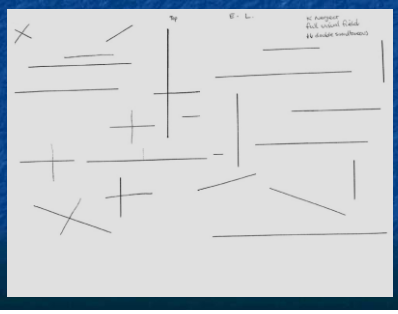
Line Bisection
Right Inattention (encephalitis)



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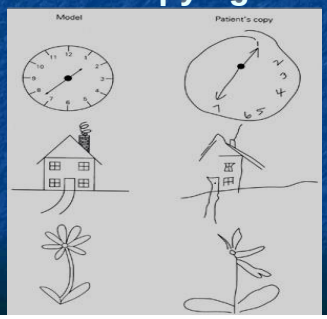
Unilateral Spatial Inattention
Copying



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Charles Bonnet Syndrome

- Presence of visual hallucinations in individuals with VF loss without having psychosis or dementia
- Likely caused by the brain continuing to interpret images, even in their absence
- Associated, underlying conditions include stroke and macular degeneration
- Symptoms often resolve if underlying vision deficit is corrected

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Visual Midline Shift

- Mismatch between the perceived egocentric visual midline and the actual physical midline
- Causes an expansion on one side
- Causes a contraction on the opposite side

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Visual Midline Shift

- May be caused by:
  - Midbrain dysfunction
  - Oculomotor imbalance
  - Spatial shifts caused by unilateral hemispheric damage

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Visual Midline Shift Syndrome

Signs and Symptoms:

- Floor may appear tilted
- Walls and/or floor may appear to shift and move
- Veering during mobility
- Person leans away from the affected side
- Feelings of imbalance or disorientation similar to vertigo

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Contrast Sensitivity

- Letters of the same size with decreasing contrast
- The faintest triplet out of which 2 letters are correctly identified is stopping point

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Contrast Sensitivity – Pelli Robson Chart

- Lowest read determines a log contrast sensitivity score
- Score below 1.5 suggests sensitivity impairment

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Visual Field Loss/Neglect

- Prescribe sector prism to allow for expansion and/or awareness of missing visual field

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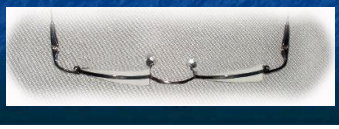
Yoked Prism for Visual Midline Shift

- Determine the appropriate prism correction for prescribing or therapy by observing the patient's posture, gait, spatial orientation, and mobility skills
- Shift the perceived midline images to the real midline
- Low amounts of prism can make a difference
- Visual motor activities to re-establish the midline



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Binasal Occlusion Prescribing Tip

- The purpose is activate more peripheral-ambient systems which may affect timing
- Use of a small piece of tape placed on the inner portion of the lens and angled inward
- The tape should not block the patient's distance or near vision

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Patching the Diplopic Patient

- Partial patching – central spot patch
- Selective occlusion – most often nasal or temporal sector
- Consider this as a temporary solution until further treatment can be pursued
- Translucent occlusion is preferred to opaque

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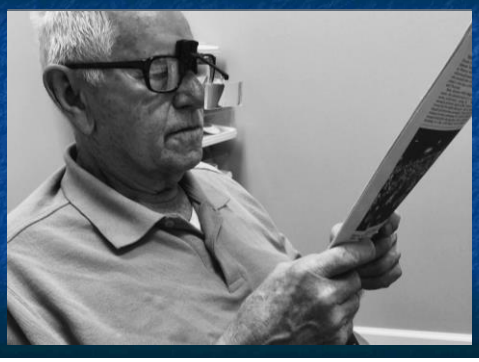
Nasal Occlusion for Diplopia



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Absorptive Filters

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Absorptive Filters

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Prescribing Tips For Post Trauma Vision Syndrome

- Lens Designs: avoid progressives
  - Single Vision- consider separate pair for distance and near
- Additional Considerations:
  - AR coating
  - Binasal occlusion
  - Low base in prism

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Lens Prescribing Tips

- Many of the young TBI patients need plus for near work due to accommodative problems
- Yoked prisms help many patients with balance, navigation and gait problems

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Components of the Neuro-Visual Rehabilitation Care Plan

- Co-management with other physicians
- Therapists
- Adjustment counseling
- Education of patient and/or family members

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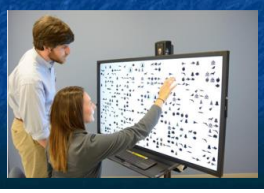
Consultation and Co-management with other Professionals

- Techniques for Visual Field Loss / Neglect
- Visual-motor-sensory reintegration



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Case Studies

"If you've seen one brain injury, you've seen one brain injury."

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Case Study 1: J.H. 74 yo female

- History of heart attack and 3 ischemic strokes within 24 hours
- Constant double vision
- No depth perception
- Balance problems – fall risk
- Motion sickness
- Referred by physical therapist

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Case Study 1: Clinical Findings

- Best corrected visual acuity: 20/30 OD,OS
  - -0.75 sphere / +2.50 add
  - -0.50 sphere / +2.50 add
- Cover test: Right XT, Right Hypo
- EOMs: (-) Adduction OD, FROM OS
- Maddox Rod: 30 BI, 15 BU central gaze
- Visual Field: Within normal limits OD, OS

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Case Study 1:

- Diagnosis:
  - Cranial Nerve III Palsy with absence of adduction OD
- Translucent occlusion OD was used to alleviate diplopia until she could get single vision glasses
- Fresnel was dispensed on distance only and near only glasses as temporary solution

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Case Study 1:

- No diplopia reported at follow-up with Fresnel – patient wanted ground-in prism
- Consulted with lab in regard to minimizing thickness of the lenses
  - Lab uses a slightly oblique orientation of prism
  - Zyl frame – thickness 17-17.5mm each lens
  - Small metal frame – thickness 13.5-14 mm each lens

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Prism Glasses: Distance and Near

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Case Study 1:

- Prism considered in this case because:
  - Longstanding condition with no improvement in angle of deviation
  - Patient had previously been referred by another optometrist to ophthalmologist for surgical consult
    - Told surgery would not be option based on blood thinner that patient takes daily
    - Patient not interested since there was no guarantee surgery would eliminate diplopia

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Case Study 2: C. P. 64 yo male

- "I had a right-sided stroke ~1 month ago"
- Hospitalized for elevated blood pressure
- Patient reported death of spouse a few months prior to stroke
- "Things look blurry and distorted when I try to work on pottery wheel"
- "Can I drive again?"

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Case Study 2: Clinical Findings

- Uncorrected Visual Acuity: 20/20 OD, OS
- Trial frame refraction:
  - OD: +0.50 sph / +1.75 add
  - OS: plano / +1.75 add
- Visual Midline Shift to patient's right
- Slight right postural shift observed

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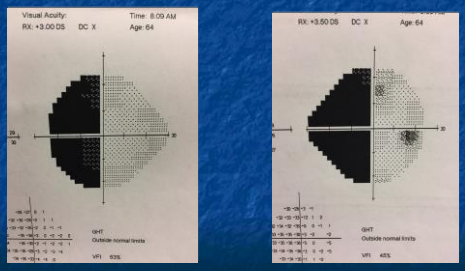
Case Study 2: Visual Fields



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Case Study 2: Treatment/Recommendations

- Separate, single vision prescriptions for distance and intermediate/near
- 1 prism diopter base-left OU in spectacles
  - Resolved subjective blur/distortion
  - Improvement in posture and walking observed
- Planned to monitor and consider sector prism for field expansion if needed

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Case Study 2: Multi-disciplinary Approach

- Patient was referred to Occupational Therapist for work on scanning techniques and mobility
  - Wore prism lenses during therapy
- Referred back to office to determine if pt was ready for Driver Evaluation Test

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Case Study 2: Multi-disciplinary Approach

- Driver Evaluation Test at rehab hospital:
  - Provides assessment of many skills involved in driving such as vision, reaction time, and cognition
  - Provides a percentage likelihood of person causing motor vehicle accident if driving

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Case Study 2: Most Recent Update

- Pt returned for follow-up visit last month
  - Had cataract surgery OU since last seen
  - Needs updated prescription for distance
  - Reported he is much more comfortable with prism at distance and near
  - Ready for referral to Driver Evaluation Test

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Case Study 2: Multi-disciplinary Approach

- Panoramic rearview mirror for vehicle
- Will return to office for final approval to return to driving

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Case Study 3: 44 yo male

- History of testicular cancer with surgical removal and lymph node dissection
- Paraneoplastic syndrome causing limbic predominant encephalitis
- Treated at Mayo Clinic with high dose steroids, IVIG, and plasma exchange

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Case Study 3: Vertical Gaze Palsy

- Inability to look down voluntarily overcome with Doll's Head maneuver
  - Indicated supranuclear palsy
- Vertical saccade generators in midbrain were affected by paraneoplastic encephalitis
  - Doctors hoped it would improve with plasma exchange but there was no change

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Case Study 3: Symptoms

- "My eyes are not tracking correctly"
- Difficulty focusing, especially at distance
- Feels like his left eye is intermittently "drooping"
- Wife reports that he often does not look at things he's trying to pick up or eat
- Physical therapist reports he often closes his eyes when walking

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Case Study 3: Clinical Findings

- Record from previous exam showed uncorrected VA of 20/400 OD, OS with "eccentric vision OS with PH and patient laying back during test"
- Previous refraction showed myopia OU
- Initial exam findings in my office:
  - Uncorrected acuities: 20/20 OD, OS, OU
  - Refraction: plano OD, OS
  - Patient would lay back/tilt head when viewing chart

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Case Study 3: Clinical Findings

- EOMs: Inability to depress either eye
- Visual Fields: Within normal limits OD, OS
- Cover Test: Small angle, intermittent exotropia
  - Worsened with time
- VTS4: Central gaze less than 1 diopter exo

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Case Study 3: Prism Trial

- Base-down yoked prism was trialed in various amounts while observing the patient performing activities of daily living such as:
  - Walking
  - Eating with contrasting food/plates
  - Picking up objects
  - Pouring liquids
  - Holding conversation while performing tasks

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Case Study 3: Prism Trial Observations

- 2 base-down: Eyes were open from the start but head was still back, improved walking but still unstable
- 3 base-down: Much improved from 2 diopters, but still unable and crossing feet a few times while walking
- 4 base-down: Eyes open the entire time, head posture normal, walking at normal pace, stable without crossing feet and tripping
- 5 base-down: Patient immediately reported feeling less stable and was reaching for the wall at times

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Case Study 3: Prism Trial Observations

- 4 base-down: He was able to eat while having conversation
- He was able to focus on various faces and shift gaze with ease while continuing to eat
- He was so overwhelmed he began to cry

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Case Study 3: Treatment/Recommendations

- Spectacle prescription issued:
  - Plano / 4 base-down OU
- Topaz filters for indoor glare, Grey/green for outdoor glare
- Patient to wear spectacles during physical therapy to improve mobility and decrease fall risk

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Case 4: A.W. 34 yo male

- History of injury to left eye during high school – reported “multiple surgeries” with reduced central vision after
- History of anoxic brain injury 1 year ago – swept out by riptide while trying to save his daughter
- Diagnosed with Lance Adams Syndrome with action myoclonus

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Case 4: A.W. 34 yo male

- Diagnosed with optic atrophy and CVI secondary to anoxic brain injury
- Pt felt like he had previously ignored OS, but after accident felt the eyes were competing with one another
- Had been prescribed prism glasses by another eye doctor but did not feel they helped and never wore them

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Case 4: Prior Services

- Spent 3 months inpatient between hospital and Shepherd Center in Atlanta
- 1 month outpatient services at Shepherd
- 2 months outpatient therapy at local rehab hospital
- Blind Rehab Services at local AT Center
- In-home services from State of TN Independent Living Program

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Case 4: Devices and Tools

- Magnification – optical and digital
- Max TV glasses
- White cane
- Apple watch
- Voice over

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Case 4: Clinical Findings

- Previous Near-only Rx:
  - +3.00 sph / 10.5 PD Base-down
  - +3.00 sph
- Uncorrected VA: 20/50 OD, CF OS
- No improvement with MaxTV glasses
- Pelli-Robson: Early loss in contrast sensitivity

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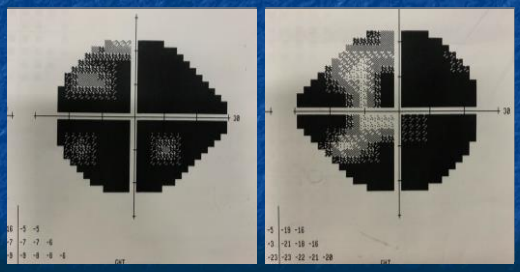
Case 4: Visual Fields



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Case 4: Recommendations

- Trialed BO prism over OD only – pt responded immediately
- Trialed prism in other directions to verify that BO gave most benefit
- Better with translucent occlusion OS to decrease rivalry

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Case 4: Recommendations

- Final Rx given and BCVA:
  - Plano / 4 PD Base-out 20/25-2
  - Plano CF
- Patient went to a 1-hour lab across the street to have glasses made
- Returned to my office after lunch to have OS lens frosted
- Referred back to rehab hospital for OT to address difficulty with ADL's

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Case Study 5: M.L. 12 yo female

- Acute onset, sharp and throbbing frontal headache accompanied by nausea, vomiting, and altered mental status
- History of migraines so parents treated as such x 5 days
- Took to ER when it did not improve and she was unable to be roused

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Case Study 5: M.L. 12 yo female

- Presented to ER with sided facial droop, slurred speech, and left upper limb weakness
- MRI showed completed right posterior middle cerebral artery infarction

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Case Study 5: Symptoms

- Patient complained of diplopia
  - Horizontal
  - Intermittent
  - Equal at distance and near
  - Parents felt left eye was "wandering at times"
- Neuro-optometric inpatient consultation was ordered by hospitalist

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Case Study 5: Clinical Findings

- Pt was wearing safety glasses with OS occlusion when I saw her in hospital
- Uncorrected VA (distance and near) –
  - 20/20 OD, OS, OU
- EOMs: FROM OD,OS
- Cover Test: Constant alternating esotropia

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Case Study 5: Treatment/Recommendations

- Maddox Rod attempted but pt responses were unreliable – likely secondary to cognitive deficits
- Approx. 25 prism diopter comitant deviation measured
- Binasal occlusion applied to safety glasses
  - Diplopia resolved
  - Improved spatial awareness

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Case Study 5: Treatment/Recommendations

- Manifest refraction with BCVA:
  - Plano -0.50 X015, 20/20
  - +0.50 -0.50 X165, 20/20
- CF: FTFC OD, OS
- VTS4: 13 left ET, 5 right hyper

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Case Study 5: Treatment/Recommendations

- Pt reported no diplopia and "best" vision with 1 prism diopter BO OD / OS
- Prism had to be trialed by starting with high and low amounts, bracketing until consistent pt responses were achieved
  - Cognitive deficits made it very difficult to rely on pt input

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Case Study 5: Multi-disciplinary Approach

- Pt was referred back to the rehab hospital for continued outpatient OT and PT
  - Instructed to wear prism glasses full-time
  - Pt tells therapists that she has no double vision with glasses but sometimes shows up to therapy without them because she "forgets"

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Case 6: K.M. 48 yo female

- History of CVA 4 months prior – Acute infarcts in left parietal white matter with subcortical and cortical extension
- Ataxia, aphasia, and visual deficits
- Patient was referred by inpatient rehab hospital – she was not progressing well in OT/PT/ST

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Case 6: Symptoms

- Complained that vision seemed blurry
- Seeing "dark spots" in vision
- Cannot see out of left eye when looking down
- Cannot drive, see to cook, or see to do basic self care
- "Can you help me understand my vision?"

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Case 6: Clinical Findings

- Uncorrected Distance VA:
  - 20/125 +2 OD
  - 20/160 OS
- Near VA with +2.00 sph OU:
  - 20/250 OD
  - 20/320 OS

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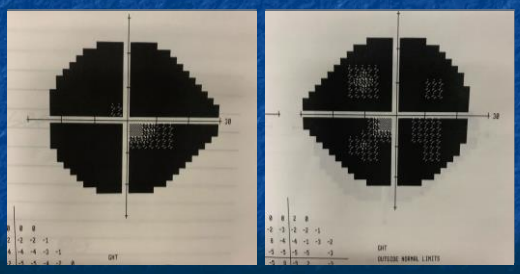
Case 6: Visual Fields



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Case 6: Recommendations

- Final Spectacle Rx with Prism:
  - +0.50 -0.50 X145 / 3 PD BI , 20/100
  - Plano -0.50 X105 / 1 PD BO, 20/125
  - +2.00 Add able to read 20/63 continuous text
- Pt preferred Noir Light Topaz filter to manage indoor/moderate outdoor glare

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Case Study 6: 75 yo male

- Prior history of Parkinson disease vs. Lewy body dementia
- Highly functional before a one-week progressive decline in overall function
- Sent to ER for evaluation – neurology was consulted and pt was diagnosed with encephalopathy

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Case Study 6: 75 yo male

- Prior history of Parkinson disease vs. Lewy body dementia
- Highly functional before a one-week progressive decline in overall function
- Sent to ER for evaluation – neurology was consulted and pt was diagnosed with encephalopathy

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Case Study 6: Symptoms

- Was not able to see patient during inpatient stay – hospitalist referred to office for evaluation after discharge
- Complains of difficulty with reading
  - Losing place frequently
  - Difficulty finding beginning of next line
  - Omitting/re-reading words
  - Letters/words appear to blur at times

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Case 6: Clinical Findings

- Uncorrected VA: 20/40 OD, 20/30 OS
- BCVA with Manifest Refraction:
  - +0.50 -0.25 X160, 20/30 OD
  - +0.50 -0.50 X050, 20/30 OS, 20/20 OU
  - +2.25 Add, 20/20 OU at near

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Case 6: Clinical Findings

- EOMs: FROM OD, OS
- CF: FTFC OD, OS
- Cover Test: Exophoria at near

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Case 6: Treatment/Recommendations

- Lighting:
  - Contained
  - Position
  - Intensity
  - Temperature

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Case 6: Treatment/Recommendations

- Able to read Bible on lap table with:
  - Habitual spectacles
  - Stella lamp
  - E.Z.C. Reader strip

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