Neuro Restorative™
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Vision Impairments Following Trauma to the Brain

Julie Dyken, M.Ed.

Course Objectives

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- To become familiar with common vision impairments following injury to the brain.
- To learn key elements of a vision screen.
- To identify key areas of ocular anatomy and the visual pathway.
- To identify how to implement treatment memos to improve vision function in the living environment.

About Julie Dyken, M.Ed.

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- BS from Slippery Rock State College
- M.Ed. From University of Texas at Austin
- Low Vision Teaching Certification
- Employment Specialist
- ACBIS

Career Positions

- NeuroRestorative
- Core Healthcare
- Mentis Neuro Health
- St. David's Rehabilitation Hospital
- The Cognitive Clinic
- Texas Rehabilitation Commission
- The Rehab Hospital
- Director of Cognitive Rehabilitation of Brown Schools Healthcare Rehabilitation Center (currently Texas Neuro-rehab. Center)
- Master Teacher and Vision/Cognitive Consultant for Region XIII
- Private Practice

About Julie Dyken, M.Ed.

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New Hope of Indiana Residential Treatment Center

Individual Vision Therapy

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- Provides screened assessments of impairment and recommendations for therapy
- Exercises for convergence, ocular motility, accommodation, visual scanning, ptosis, awareness of deficits, visual perception disorders
- Refer for consultation with ocular specialists in the community.
- Attend community appointments with specialists as requested

What Is Vision?

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Vision is the process of deriving meaning from what is seen. The main purpose of the visual process is to arrive at an appropriate motor, and/or cognitive response.

(Politzer, 5/2016)

Vision Impairment and Brain Injury/Stroke

Research shows that 50 to 80% of individuals incurring CVA or Traumatic Brain Injury experience some vision impairment.

Vision Impairment and Brain Injury/Stroke

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Up to two thirds of people experience some changes to their vision after a stroke.

National Stroke Association, 2018

Vision Impairment and Brain Injury

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Current research indicates that approximately 80% of patients that suffer from a traumatic brain injury are struggling with vision deficits which are a direct result of their injury.

Vision Impairment and Brain Injury

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Table 1. (Scheiman, 2013)

VISION DEFICIT	ABI POPULATION STUDIED	GENERAL ADULT POPULATION (EXPECTED)
Eye teaming	42%	10%
Eye movement	40%	<1%
Focusing	10%	2-3%
Visual field deficits	32%	<1%

Vision Impairment and Brain Injury

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There are a myriad of types of brain injuries that can result in visual disturbances including:

- strokes
- motor vehicle accidents
- concussions/whiplash injuries
- status-post neurosurgery for tumor resection or aneurism repairs

Vision Deficits and Neurological Illness

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Vision deficits are also extremely common in individuals struggling with Parkinson's disease, myasthenia gravis and multiple sclerosis.

http://www.visiontherapysuccess.com/headtrauma.php

Vision Impairment and Brain Injury

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Vision deficits have been so prevalent among service members diagnosed with TBI, that in 2007 the U.S. Department of Veterans Administration (VA) modified its standard of care to include vision assessment for everyone with a TBI.

(Scheiman, 2013)

Processing Visual Information

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The processing of visual information— through the eyes, interpreted by various brain centers, and translated into visual images—has been estimated to involve as much as 40 percent of the brain.

Vision Impairment and Brain Injury

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It is common for families to be told that a survivor should wait 6 months before evaluating or confronting vision impairments.

The Anatomy of the Eye

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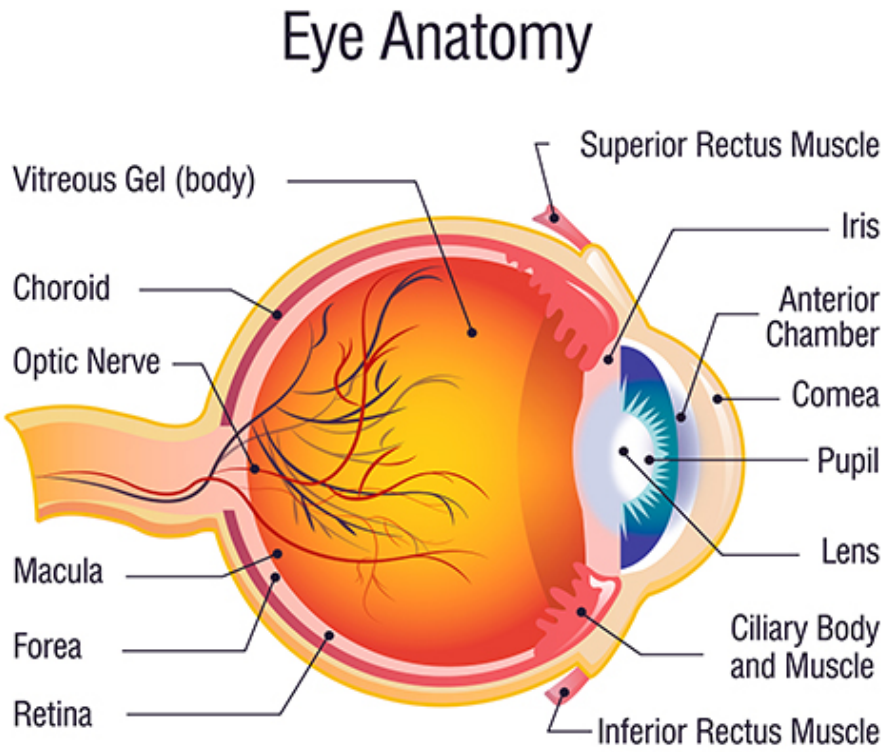

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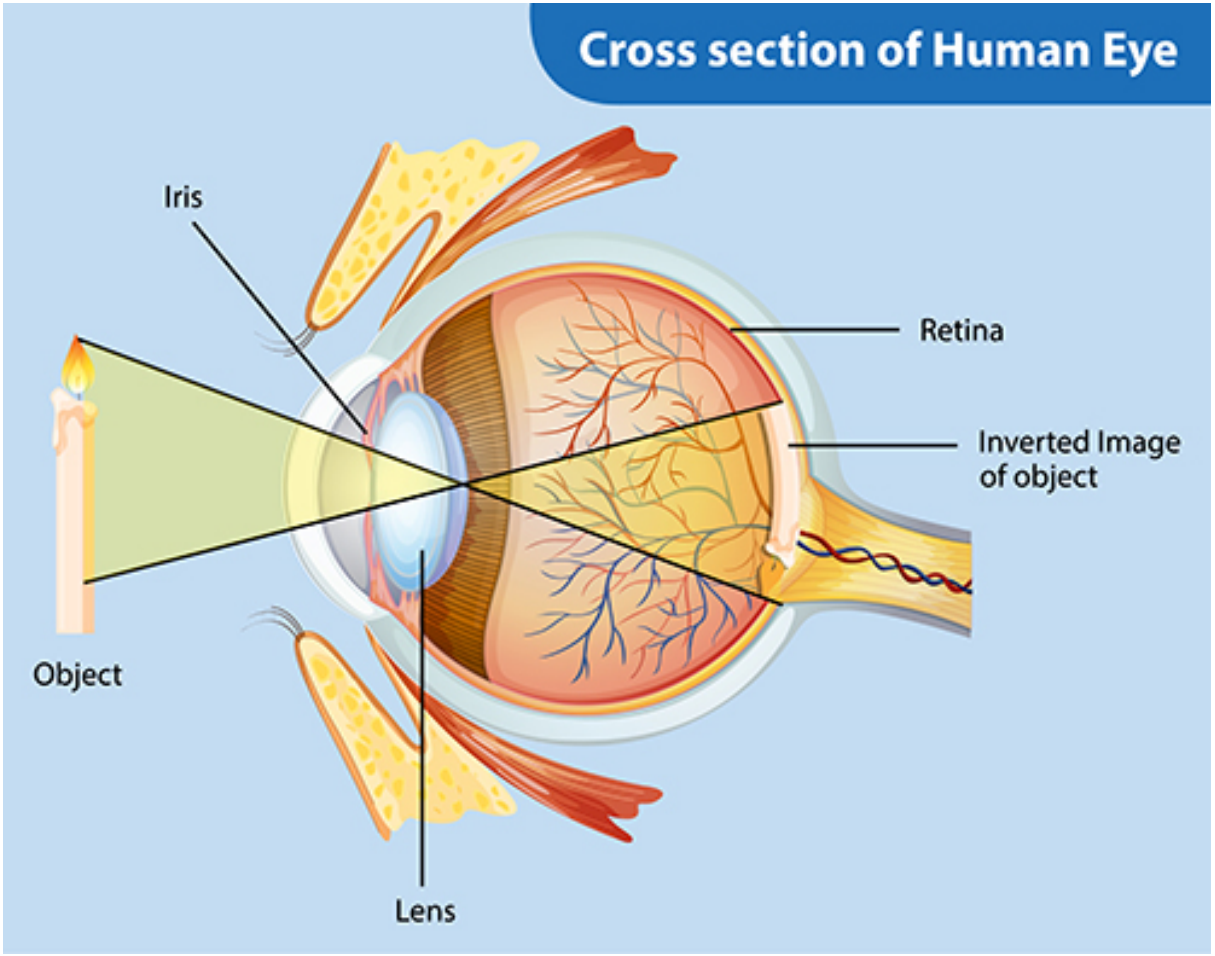

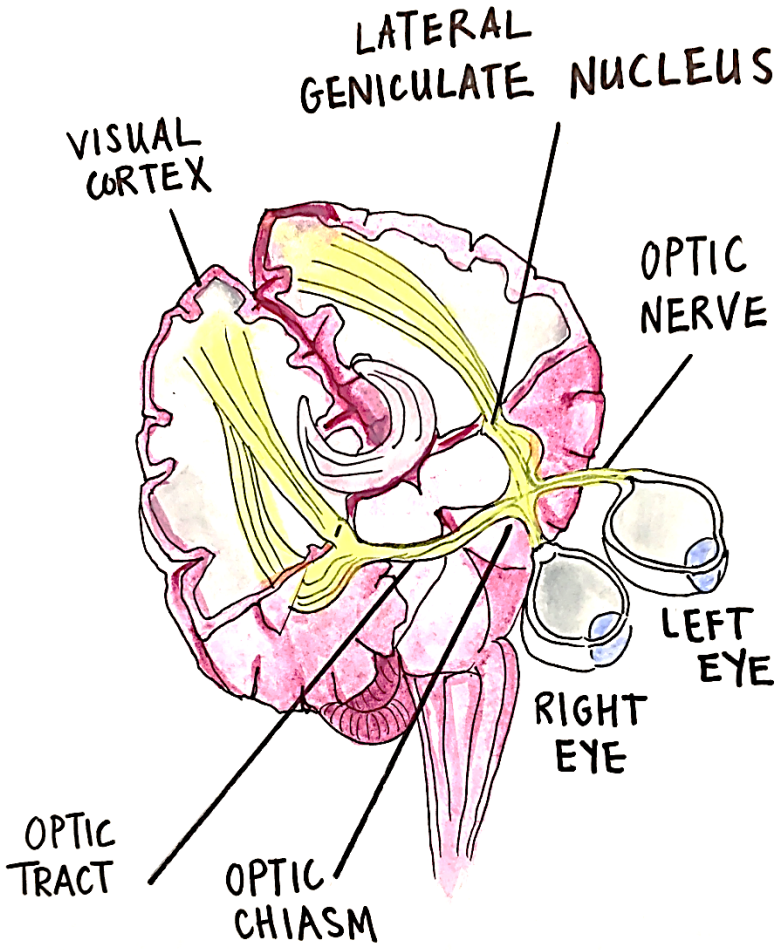
LATERAL GENICULATE NUCLEUS
VISUAL CORTEX
OPTIC NERVE
LEFT EYE
RIGHT EYE
OPTIC TRACT
OPTIC CHIASM

Vision and the Brain

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The occipital lobe at the back of the brain is our primary vision center, but all of the brain lobes receive visual information.

"Almost every major area receives Input from vision."

- Dr. Carl Garbus, an optometrist at the Neuro Vision Rehabilitation Institute in Santa Clarita, Calif., and president of the Neuro-Optometric Rehabilitation Association, or NORA

Eye Muscles

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- Lateral Rectus - Abduction
- Medial Rectus - Adduction
- Superior Oblique
- Inferior Oblique
- Superior Rectus
- Inferior Rectus

Extra Ocular Movements

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- Elevation (pupil directed upwards)
- Depression (pupil directed downwards)
- Abduction (pupil directed laterally)
- Adduction (pupil directed medially)
- Extorsion (top of eye rotating away from the nose)
- Intorsion (top of eye rotating towards the nose)

Cranial Nerves

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Cranial 4 (Trochlear)

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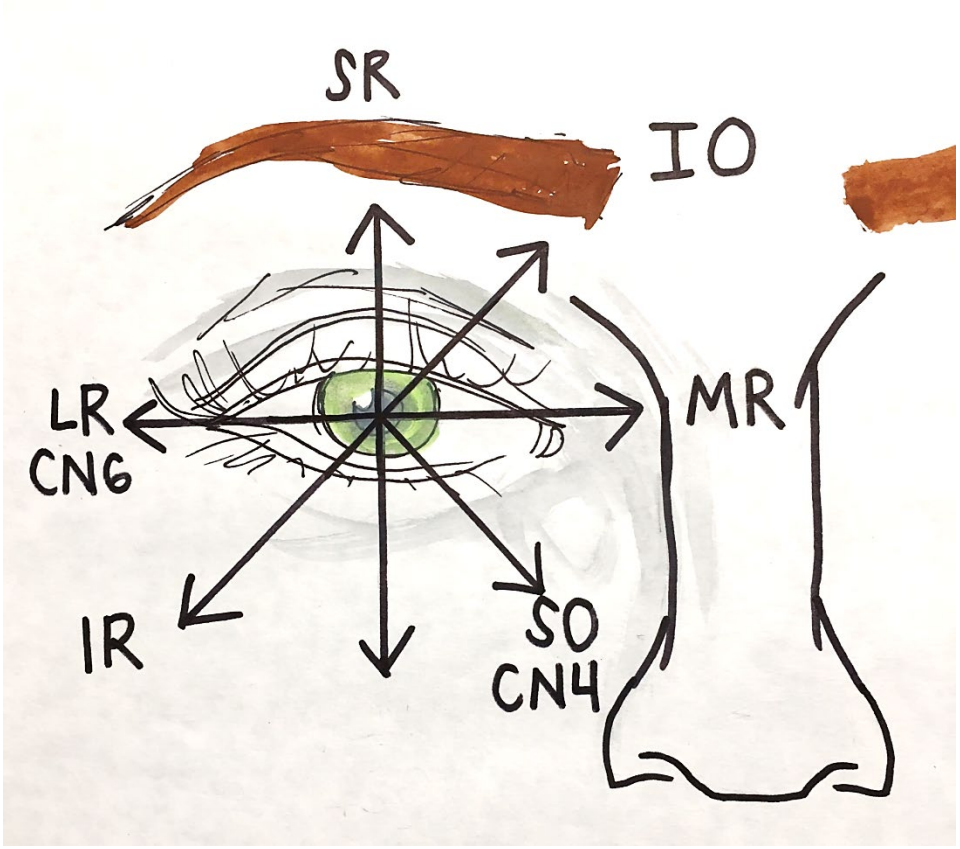
Cranial 4 (Trochlear) innervates the superior oblique.



Cranial Nerve 6 (Abducens)

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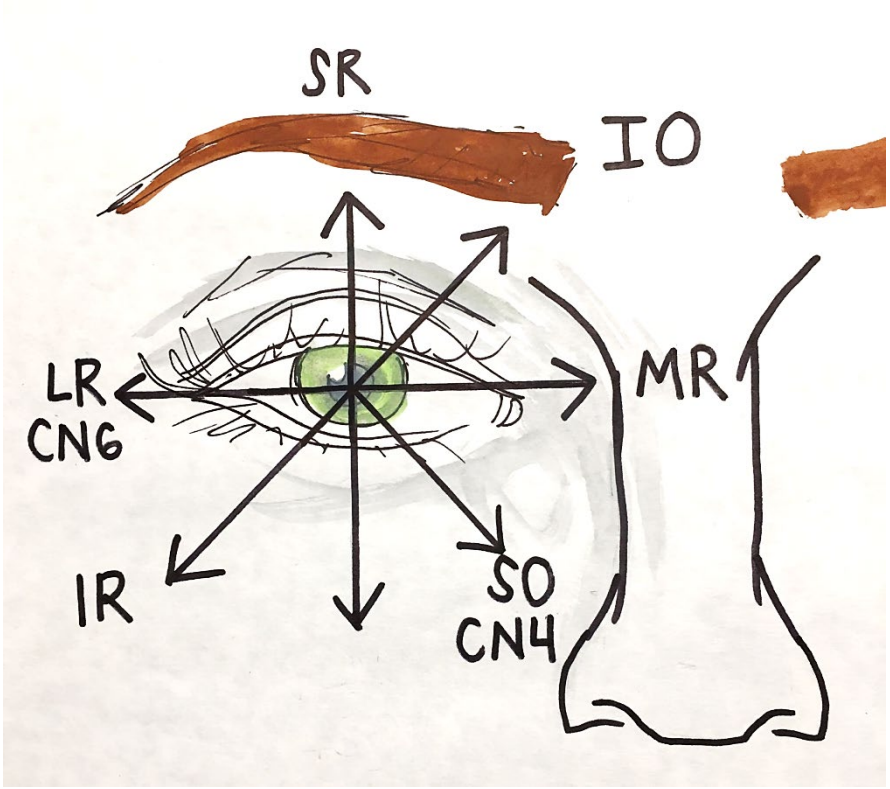
Cranial Nerve 6 (Abducens) innervates the lateral rectus.



Cranial Nerve 3

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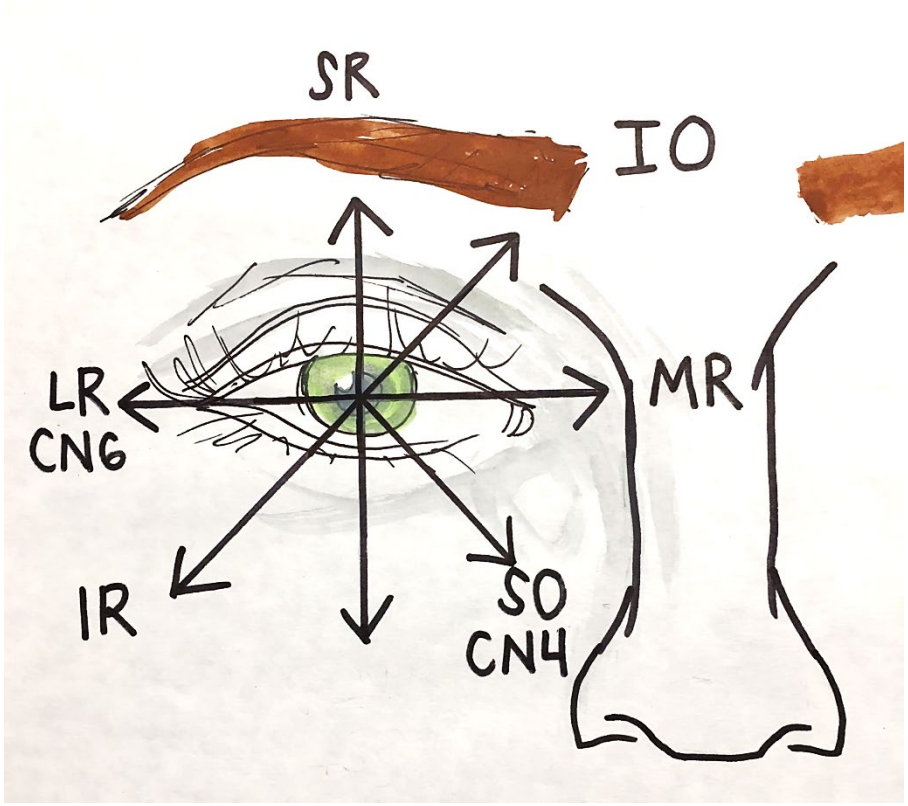
Cranial Nerve 3 (Oculomotor): innervates medial rectus, inferior oblique, superior rectus and inferior rectus.



Cranial Nerve 3

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Cranial Nerve 3: pupils and eyelids

Ptosis

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Cranial Nerve 3

Dry Eye Syndrome

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Common Impairments Following Trauma

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Reduced Visual Acuity

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Myopia

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Nearsightedness

Hyperopia

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Farsightedness

Normal Vision/ Nearsightedness/Farsightedness

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Normal vision: light is focused on the retina, not in front of it or behind it.

Nearsightedness: the image is focused in front of the retina.

Farsightedness: the image is focused behind the retina.

Presbyopia

Presbyopia

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In a normal eye, images are focused on the retina, enabling good vision close up.

Presbyopia is age-related farsightedness as a result of the lens aging and stiffening. Images are formed behind the retina, resulting in blurry vision up close.

Accommodative Disorders

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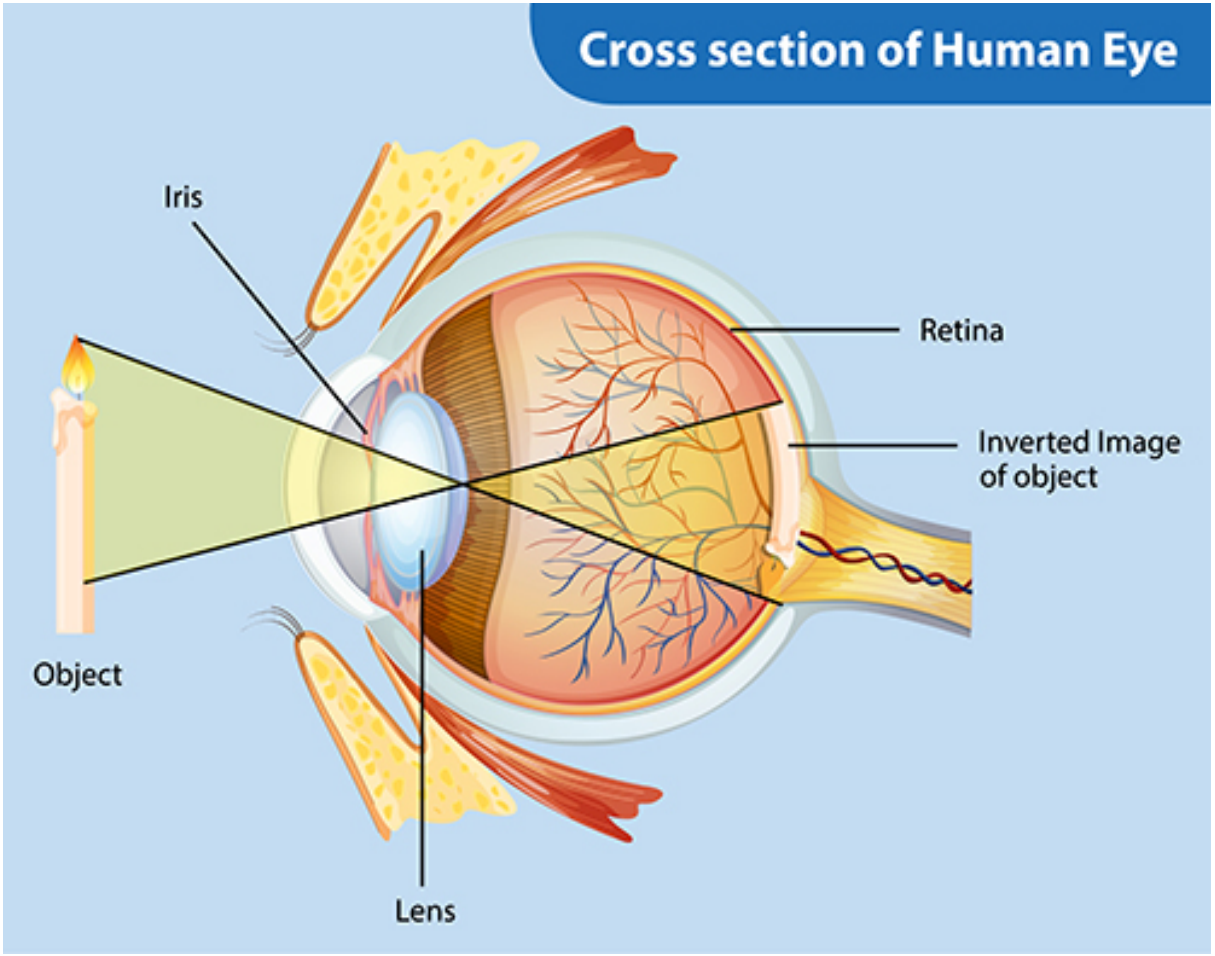

Visual Field Loss

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Scotoma

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Scotoma is a blind spot occurring in any part of the visual field.

Hemianopsia
Homonymous Hemianopsia
Quadranopsia
Central Field Loss
Neglect

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Hemianopsia

May lose one half of their side vision to the right or left.

Homonymous Hemianopsia

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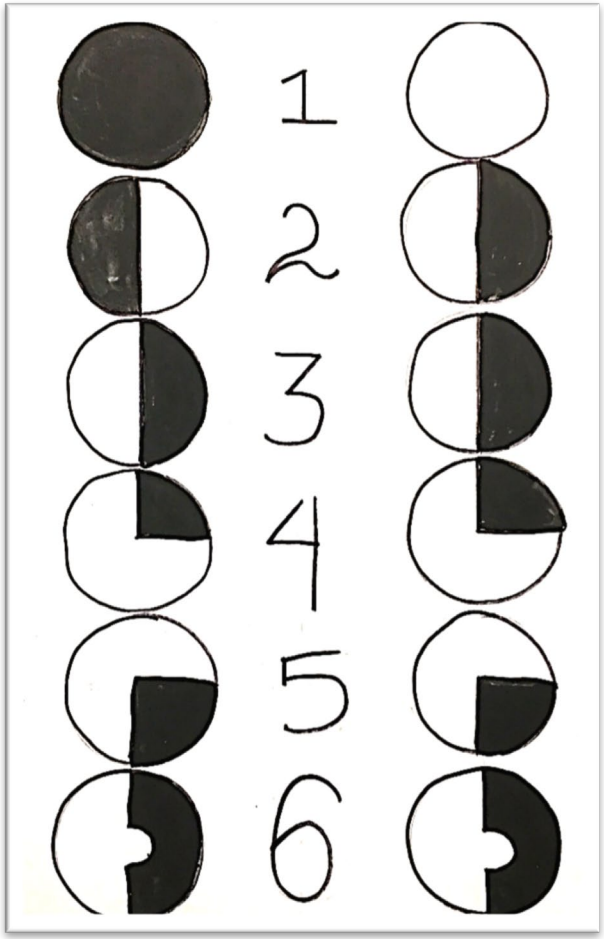
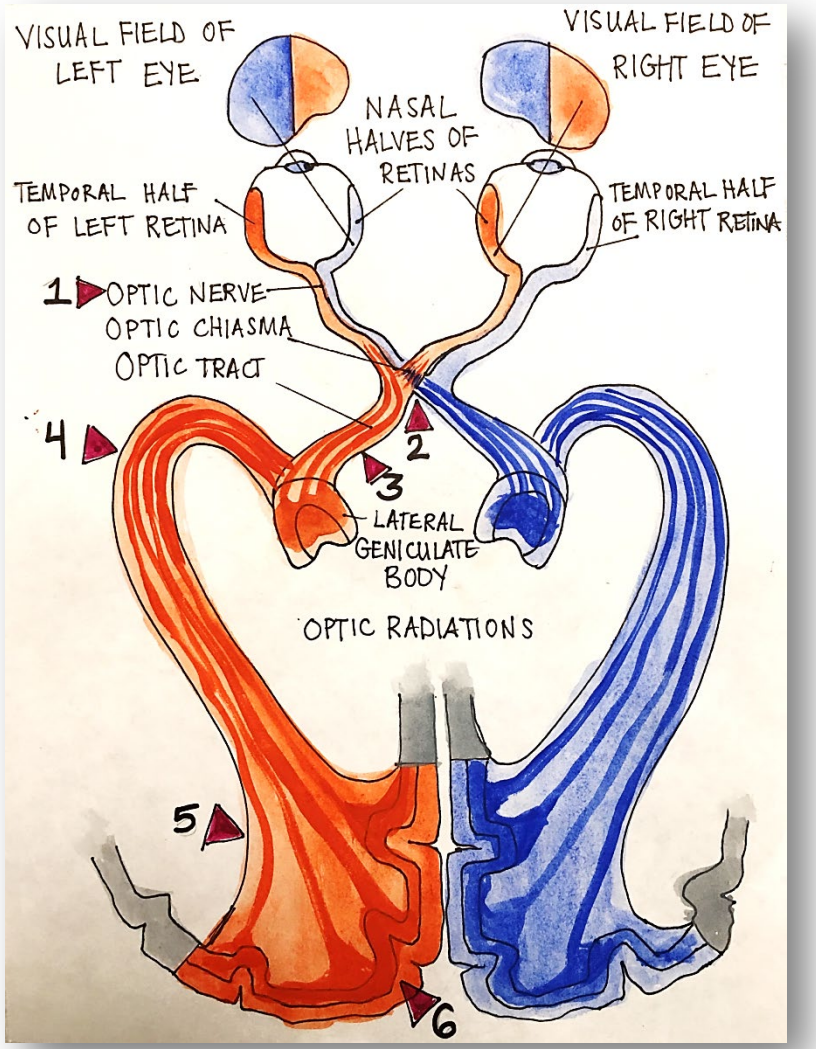
The right half or the left half of your vision is missing from each eye.

Homonymous Hemianopsia

Homonymous hemianopsia on admission is linked to poor early survival and conversely around 10% [30] experience full spontaneous recovery within the first 2 weeks.


1
2
3
4
5
6


VISUAL FIELD OF LEFT EYE
VISUAL FIELD OF RIGHT EYE
NASAL HALVES OF RETINAS
TEMPORAL HALF OF LEFT RETINA
TEMPORAL HALF OF RIGHT RETINA
1
OPTIC NERVE
OPTIC CHIASMA
OPTIC TRACT
2
3
4
LATERAL GENICULATE BODY
OPTIC RADIATIONS
5
6

Visual Field Defects Following Stroke

Visual field defects seriously impact on functional ability and quality of life following stroke [31]. Patients with visual field defects have an increased risk of falling, impaired ability to read, poor mood, and higher levels of institutionalisation.

Impacts of Visual Field Loss

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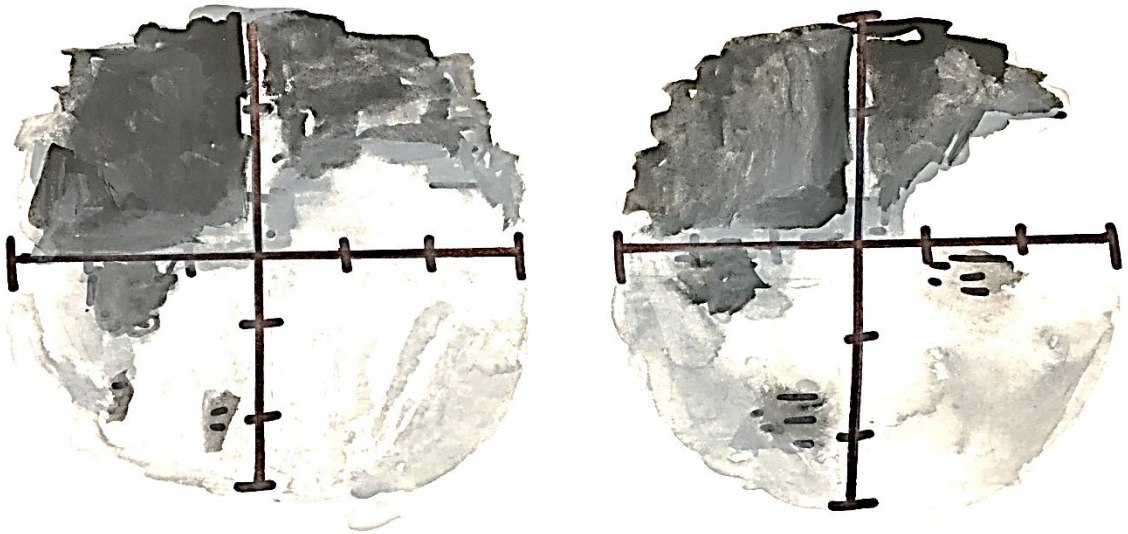
Visual field loss impacts on a patient's ability to participate in rehabilitation, may ultimately result in poor long term recovery, and can lead to loss of independence, social isolation, and depression.

Quadranopsia

Incomplete hemianopia, referring to a quarter of the schematic "pie" of visual field loss.



SUPERIOR QUADRANOPIA FROM PARIETAL STROKE

Central Field Loss

Loss may be central/foveal (e.g., an optic disc or nerve problem).

Management of Field Loss

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1. Let the person's partner walk on the affected side and have the patient take their arm.
2. Encourage eye and head movements to the affected side – environmental scanning. This will require significant practice to develop an ongoing habit.
3. Visual scanning can include timed intervals via "clickers" for rhythmic scanning.

Neglect

Neglect is the inattention to or lack of awareness of visual space to the right or left and is most often associated with a hemianopsia.

Neglect

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Neglect is almost always for the left hemifield. This is explained by the left hemisphere monitoring the right hemispace, while the right hemisphere monitors both hemispaces. A left hemisphere lesion will still allow the right hemisphere to survey the entire visual field, hence neglect does not occur. By contrast, with a right hemisphere lesion, the left hemisphere monitors only the right hemispace; therefore, because of the lack of monitoring the left hemispace, left sided neglect occurs.

Visual Motor Abilities

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Alignment

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This refers to eye posture (position, e.g. straight and aligned, versus abnormal alignments).

Fixation Pursuits, Saccades, Accommodation, Convergence

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Diplopia

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"Double Vision"

Monocular
Binocular
Horizontal
Vertical

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Monocular Diplopia

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More than one image of the object of regard is formed in the retinae of one or both eyes.

- Irregular astigmatism (corneal scars, haze, corneal distortion)
- Subluxated clear lenses
- Poorly fitting contact lenses
- Early cataract
- Macular disorders – edema, CNVM, etc.

Double/Blurry Vision

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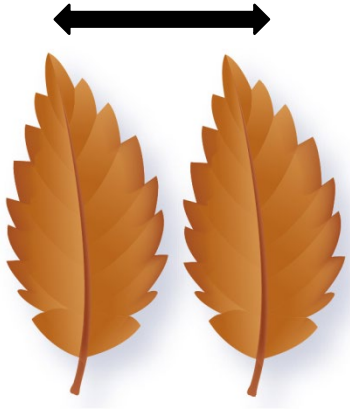
Monocular Double Vision/Blurry Vision
Overlapping images with blurring

Horizontal Binocular Double Vision
Two identical images side by side

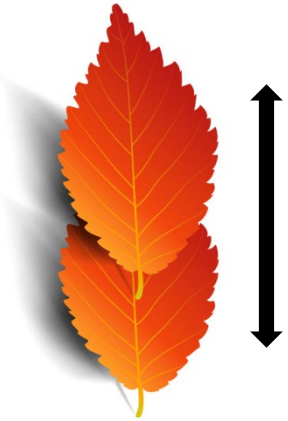
Vertical Binocular Double Vision
Two identical images on top of one another

Oblique Binocular Double Vision
Two identical images at an angle to one another

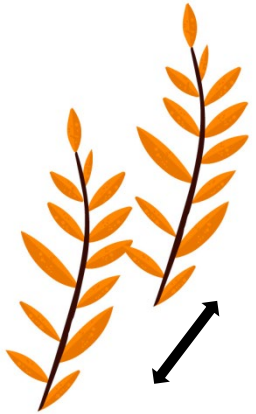
Monocular Double Vision/Blurry Vision



Horizontal Binocular Double Vision



Vertical Binocular Double Vision



Oblique Binocular Double Vision

Convergence Insufficiency

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Convergence Insufficiency

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Convergence Insufficiency (CI) is the leading cause of eyestrain, blurred vision, double vision and/or headaches.[1]

Scientific research by the National Eye Institute has proven that office-based vision therapy is the most successful treatment.[8]

Suppression

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Suppression of vision in one eye causes loss of binocular (two-eyed) vision and depth perception.

Poor binocular vision can have a negative impact on many areas of life, such as coordination, sports, judgment of distances, eye contact, motion sickness, etc.

Cranial Nerve Paresis/Paralysis

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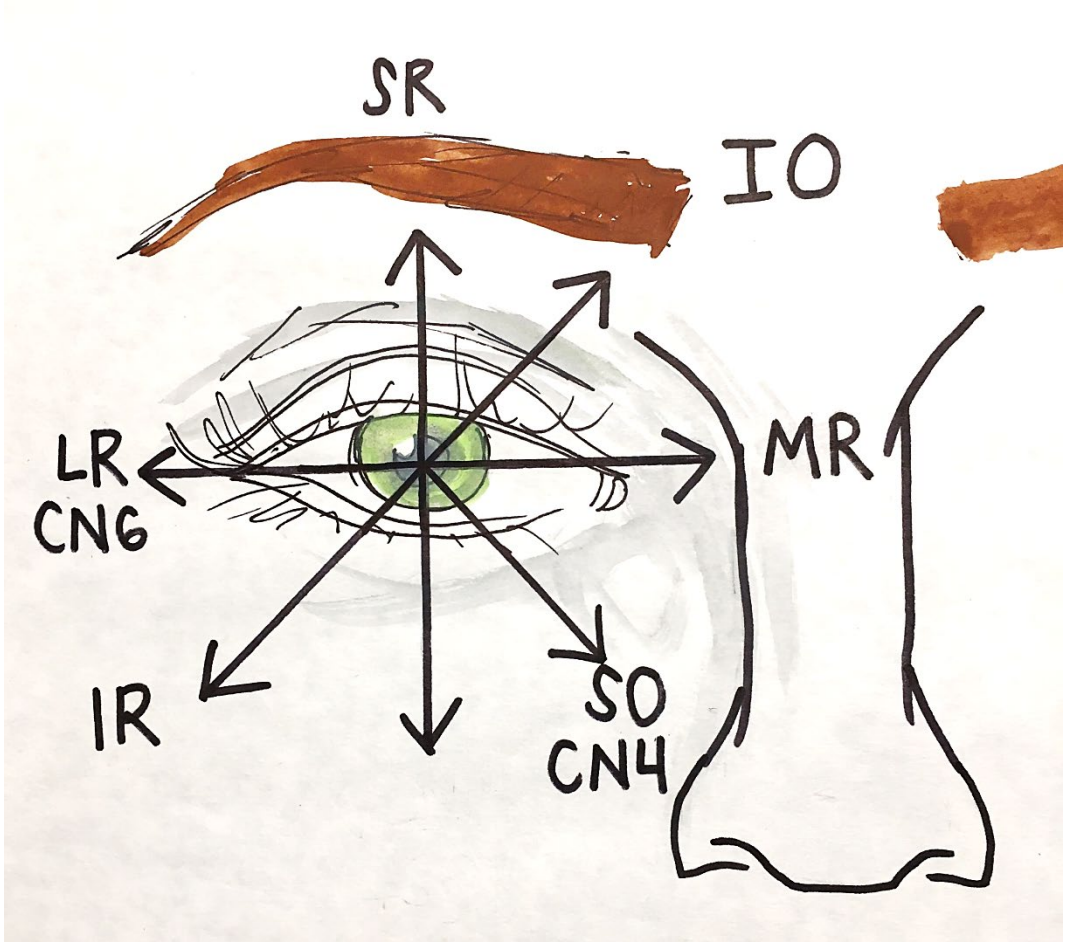
SR
IO
LR
CN6
MR
IR
SO
CN4

Ocular Motility Disorders

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Fixation
Saccades
Smooth Pursuits
Vergence
Vestibulo-Oculomotor

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Fixation

Fixation is the act of maintaining **visual** attention on one point in space.

Saccades

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Saccades are rapid, ballistic movements of the eyes that abruptly change the point of fixation such as reading or room scan.

Smooth Pursuits

Slower tracking movements of the eyes designed to keep a moving stimulus on the fovea.

Vergence

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Convergence or divergence of the lines of sight of each eye to see an object that is nearer or farther away.

Vestibulo-Oculomotor

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Vestibulo-ocular movements stabilize the eyes relative to the external world, thus compensating for head movements. These reflex responses prevent visual images from “slipping” on the surface of the retina as head position varies.

Nerve Fiber Interaction

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Approximately 20% of the nerve fibers from the eyes interact with the vestibular system.

Nystagmus

Nystagmus is a vision condition in which the eyes make repetitive, uncontrolled movements. These movements often result in reduced vision and depth perception and can affect balance and coordination.

Strabismus

- Vertical skew deviation
- Horizontal skew deviation
- Eso-tropia
- Exo-tropia
- Hyper-tropia
- Fatigue causing temporary tropias

Strabismus

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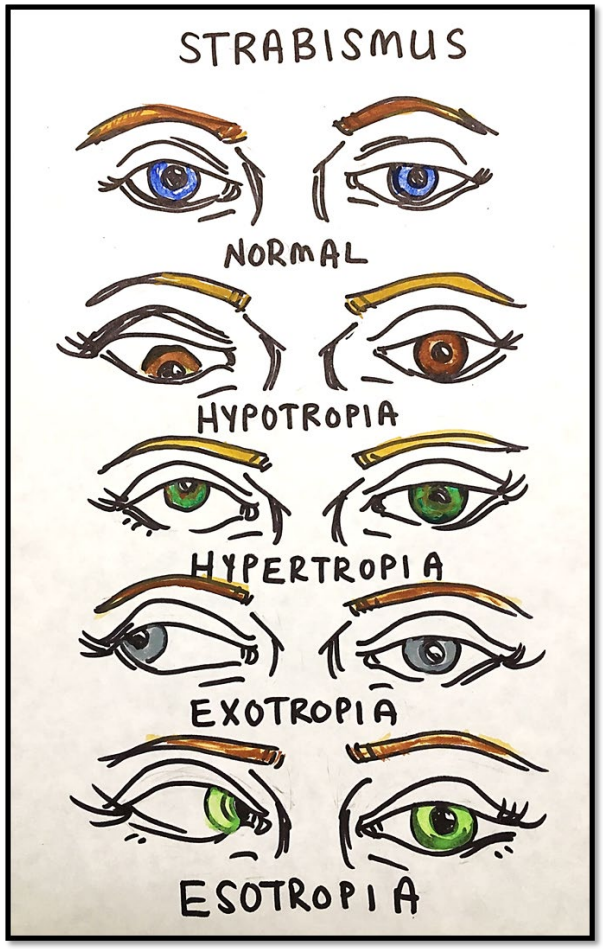

Photophobia

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Apraxia

Oculomotor apraxia: Difficulty moving the eye, especially with saccade movements that direct the gaze to targets.

Prosopagnosia

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Prosopagnosia, also called face blindness, is a cognitive disorder of face perception where the ability to recognize familiar faces, including one's own face (self-recognition), is impaired.

Damage in right occipital temporal cortex and fusiform gyrus.

Chowhan S. (2013). Living with face blindness. theatlantic.com/health/archive/2013/09/living-with-face-blindness/279898

Prosopagnosia

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It’s estimated to affect about 2 percent of the general population.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3904192/

Visual Perceptual Disturbances

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Visual Midline Shift (VMSS)

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A person with a condition called visual midline shift may think the floor is tilted. The walls will also appear tilted, and the survivor will tilt his or her body to compensate. The visual system is telling this person that the world is at an angle, and the brain is making adjustments.

Visual Information Processing

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Evaluation and Management of Vision Disorders

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Screening and Assessment

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- Vision Screen by Vision Specialist
- Annual Optometric Exam with Escort
- Extended Sensori-motor Evaluation
- Higher cerebral function assessment of visual processing (visual memory, speed and span of recognition, form perception, etc)
- Vestibular Testing

Definition of Vision Impairment

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Division for Blind Services

- A visual acuity of 20/70 or less in the better eye, with best correction
- A visual field of 30 degrees or less in the better eye
- A combination of both.

Social Security Act

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Defines blindness as central visual acuity of 20/200 or less in the better eye with the use of a correcting lens.

A visual field limitation such that the widest diameter of the visual field subtends an angle no greater than 20 degrees as having a central visual acuity of 20/200 or less.

Treatment and Management of Visual Disorders

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Vision Therapy Research

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Orthoptics

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Emphasis on binocular vision and eye movements

Eye Movement Control
Near/Far Accommodation
Binocular Alignment
Central Vision (Visual Acuity)
Depth Awareness
Reading Fatigue

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Behavioral Vision Therapy
Non Strabismic Therapy

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1. Accommodation
2. Vergence disorders
3. The underachieving child
4. Prisms for near binocular disorders and for producing postural change
5. Near point stress and low-plus – the use of special lenses to adjust near-field vision, even for people who would not normally need glasses. Use of low-plus lenses at near to slow the progression of myopia
6. Therapy to reduce myopia
7. Behavioural approaches to the treatment of strabismus and amblyopia
8. Training central and peripheral awareness and syntonics
9. Sports vision therapy
10. Neurological disorders and neurorehabilitation after trauma/stroke

Behavioral Management Approaches

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"A large majority of behavioural management approaches are not evidence-based, and thus cannot be advocated."

-BT Barrett, UK, 2009

Behavioral Management Approaches

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"Although there are areas where the available evidence is consistent with claims made by behavioural optometrists (most notably in relation to the treatment of convergence insufficiency, the use of yoked prisms in neurological patients, and in vision rehabilitation after brain disease/injury."

-BT Barrett, UK, 2009

Non-strabismic Visual Therapy and Learning

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The **American Optometric Association**, the **American Academy of Optometry**, the **College of Optometrists in Vision Development**, and the **Optometric Extension Program**, support the assertion that non-strabismic visual therapy does not directly treat learning disorders, but rather addresses underlying visual problems which are claimed to affect learning potential.

Individual Vision Therapy

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- Provides screened assessments of impairment and recommendations for therapy
- Exercises for convergence, ocular motility, accommodation, visual scanning, ptosis, awareness of deficits, visual perception disorders
- Refer for consultation with ocular specialists in the community.
- Attend community appointments with specialists as requested

- Presentation of room or home settings
- Use of prosthetics such as patching, lenses, prisms
- Unit programs or daily homework
- Vision exercises
- Recommendations for specialists in the community
- Recommendations for further exams (vestibular, visual perception)
- Counseling and education of client, family or caregiver of visual problems, functional implication, goals, prognosis, and strategies

Vision Screen

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Personal Account

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Double Vision	Halos	Headaches
Bumping into things on R/L	Watery eyes	Diabetes
Out of focus	Itchy eyes	Thyroid
Eye infections	Dry eyes	Floaters
Difficulty reading	Flashes of light	Photophobic
Glaucoma	Use eyedrops	Cataracts

Treatments for Vision Impairments

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Glasses: Bifocals, lined or progressive

Readers: Tint

Eye injuries

Eye surgeries:

- Cataract?
- Glaucoma?

Personal Presentation

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Pupil Size and Constriction
Pupil Alignment

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Pursuits

- OS
- OD
- Binocular

Evidence of Strabismus

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OS: hyper hypo exophoric exotropic esophoric esotropic wnl

OD: hyper hypo exophoric exotropic esophoric esotropic wnl

Fixation

Gaze in affected eye for _____ seconds

- Convergence: breaks at _____ inches
- Eye wanders at break:
- OS OD alternates wnl

Confrontation

Sees stimuli ___degrees left of OD midline
___degrees right of OD midline

Sees stimuli ___ degrees left of OS midline
___ degrees right of OS midline

Acuity

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Distance of Ten Feet Acuity
OS: 20/___ OD: 20/___ Bi: 20/____

Near Distance Acuity w/o Glasses
OS: 20/___ OD: 20/___ Bi: 20/___

Near Distance Acuity with Glasses
OS: 20/___ OD: 20/___ Bi: 20/_____

Nystagmus

OS: Horizontal vertical
Only outer extremes in pursuits wnl

OD: Horizontal vertical
Only outer extremes in pursuits wnl

Room Scan

Systematic search

Random search

Slow scan

Misses more on L R

Visual Processing Speed

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Delayed:

Severe Mod Min Shadow WNL

Visual Cancellation

- Random scan Slow Scan
- Misses more on L / R
- Systematic scan

12 Point Font at Near Distance Reading

- Inches held from eyes OS _____ OD ____
- Laborious reading
- Skips lines
- Neglects R L
- No problems noted _____

Community Store Scan/Search

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Search of aisles: random systematic

# of distractions: _____

Use of signs: yes no

 # found on left: ____/10

 # found on right: ____/10

Total time: _____

Driving Search

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Items found on left _____

Items found on right _____

Number of omissions _____

Recommendations for Further Exams

Vestibular, visual perception

Recommendations for Specialists in the Community

Neuro Restorative™
Rebuilding Lives. Restoring Hope.

Vision Exercises

Neuro Restorative™
Rebuilding Lives. Restoring Hope.

Unit Programs or Daily Homework

Neuro Restorative™
Rebuilding Lives. Restoring Hope.

Use of prosthetics such as patching, lenses, prisms

Neuro Restorative™
Rebuilding Lives. Restoring Hope.

Presentation of Room or Home Settings

Neuro Restorative™
Rebuilding Lives. Restoring Hope.

Counseling and education of client, family or caregiver of visual problems, functional implication, goals, prognosis, and strategies

Neuro Restorative™
Rebuilding Lives. Restoring Hope.

References

http://www.strokeassociation.org/STROKEORG/LifeAfterStroke/RegainingIndependence/PhysicalChallenges/Vision-Disturbances-After-

http://www.stroke.org/we-can-help/survivors/stroke-recovery/post-stroke_-conditions/physical/vision

http://www.visiontherapysuccess.com/headtrauma.php

theatlantic.com/health/archive/2013/09/living-with-face-blindness/279898/

http://dx.doi.org/10A Prospective Profile of Visual Field Loss following Stroke: Prevalence, Type, Rehabilitation, and Outcome.1155/2013/719096

Rowe, F. J., Wright, D., Brand, D., Jackson, C., Harrison, S., Maan, T., & ... Freeman, C. (2013). A Prospective Profile of Visual Field Loss following Stroke: Prevalence, Type, Rehabilitation, and Outcome. Biomed Research International, 20131-12. doi:10.1155/2013/719096

Ulm, L., Wohlrapp, D., Meinzer, M., Steinicke, R., Schatz, A., Denzler, P., & ... Winter, Y. (2013). A Circle-Monitor for Computerised Assessment of Visual Neglect in Peripersonal Space. Plos ONE, 8(12), 1-10. doi:10.1371/journal.pone.0082892