What’s Vision Got to Do With It?

Jill K. Hadler, OD, FAAO, FCOVD

Visual Dysfunctions Following Acquired Brain Injury: Treatment with Neuro-Optometric Rehabilitation

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Who am I?

Jill K. Hadler, OD, FAAO, FCOVD

• Fellowship trained in Vision Development and Vision Therapy
• Special training in: pediatric vision care, functional vision, care of special populations, brain injury, developmental delays, learning problems related to vision.
• Center Director, Bright Eyes Vision Clinic and Advancements in Vision. Otsego and Wayzata locations.
• State Coordinator, College of Optometry in Vision Development. Co-Clinical Director MN Special Olympics Opening Eyes Program. MOA Board of Trustees.
Neuro-optometric rehabilitation

If the eye is like a camera:
- Who is deciding which pictures to take?
- Who is pointing and focusing the camera?
- Who is developing the film?
- How much does it cost to develop the film?
- Where are the pics stored and how is the retrieval system?

“Watch a patient from the minute they enter your office and they will tell you the problem before the examination”. Ret ADM David Sullins, OD, FAAO

Today’s Outline – 2 hr lecture
(Could be 12+ hours!)

- Introduction – The eyes are just for seeing, right?
- Definitions and Statistics
- Vision Problems Encountered
- Evaluation & Management
- Screening Techniques
- Rehabilitation Techniques

Vision

- Visual information is NOT just visual cortex
- Vision is efferent and afferent.
- VISION is MOTOR!
- Eye movement therapy incorporates use of the: superior colliculus, vestibular nuclei, cerebellum, frontal eye fields)
- Structures involved in visual processing (e.g., lateral geniculate body, pulvinar, visual cortex)
- And more that we don’t know about.
Visual processing problems affect a majority of patients following traumatic brain injury (TBI) [1,2]. Sensory, motor, emotional and cognitive systems interact and process stimuli transmitted via retinal fiber pathways [3]; therefore, these systems are susceptible to TBI-related visual processing dysfunctions. Retinal processing problems can be visual, non visual or both [4]. Thousands of retinal fibers are part of the visual system but not necessarily involved with eyesight [5].

More than 30% of the human cortex is devoted to vision and visual processing connections with non-visual systems.

The retinal signals from the remaining 20% (approximately 200,000 fibers) of the 1 million eye nerve fibers branch off to non-visual structures ... where a majority of visually responsive neurons receive non-visual sensory signals. What do these non-visual pathways connect to?
The eyes are for seeing...

For example, the retino-hypothalamic tract is a non-visual pathway, non-visual irradiance detection pathway, a complex non visual photoreceptive system in the inner retina and visual functions that do not require image formation on the retina [6–9].

Signals transmitted through these fibers affect balance, posture, motor function, sensory integration, visualization, sleep and emotion centers in the brain and can function even with the eyelids closed [10].

The eyes are for seeing...

These multi-sensory neurons are cross-modal and their non-visual inputs can have a significant impact on visual as well as non-visual responses (conscious cortical level), reactions (subconscious cortical level) or reflexes (unconscious subcortical level) [22].

The superior colliculus processes retinal signals at reflexive subcortical, subconscious, and conscious cortical levels [23]. It functions independent of and parallel with the visual cortex. The superior colliculus links incoming sensory information with motor output. [11]

What happens when this system doesn’t function well?

Vision Care: The “O’s”

- Optometry (OD)
- Ophthalmology (MD)

The two fields share the same patient base and work as adjuncts to each other

- Opticianry
- Oculists
Vision Care: OD -vs- MD

- Ophthalmology (MD) specializes in the evaluation, diagnosis, and treatment of structures of the visual pathways
  - General Ophthalmologists
  - Specialty Ophthalmologists
    - Cornea / Refractive Surgery
    - Glaucoma
    - Cataract
    - Neuro-Ophthalmologists

Vision Care: OD-vs-MD

- Optometry (OD) specializes in the evaluation, diagnosis, and treatment of functions of the visual systems
  - General Optometrists
  - Specialty Optometrists

Optometry

- General Optometrists
  - Eye exams for glasses and contacts
  - Eye disease diagnosis and treatment
  - Pre-operative and Post-operative care
Optometry

- Specialty Optometrists
  - Ocular Disease
  - Contact Lens
  - Behavioral / Developmental / Functional / Neuro
    - Pediatrics / Binocular Vision / Vision Therapy
    - Sports Vision
    - Low Vision Rehabilitation
    - Neuro-Optometric Rehabilitation

Vision Rehabilitation:
Neuro-Optometric (NOR)

- Identify visual-motor, visual-spatial processing, and visual-information-processing dysfunctions in the neurologically affected person.
- Correlate these visual dysfunctions with ADL dysfunctions
- Develop a plan of visual rehabilitation to maximize ADL’s

NOR Therapy / Management

- Lenses – non-compensatory (near, far, astigmatism)
- Prisms – non-compensatory
- Selective occlusion
- Filters
- Vision therapy
- VEP visually evoked potential
- (VRT NOVA vision restoration
- Syntonic Light Therapy
- Combinations of the above
NOR is Part of the Rehab Team:
- Medicine
- Occupational Therapy
- Physical Therapy
- Speech Therapy
- Psychology/Psychiatry
- Cognitive Therapy
- Driving Rehab
- Nutrition
- Chiropractic
- Cranio-Sacral
- Neuro-Optometric Rehab
- Case Manager

Who benefits from NOR?
- Patients of all ages who have experienced neurological insults require Neuro-Optometric Evaluation and may benefit from Neuro-Optometric Rehabilitation

Why is NOR required?
80% of the brain is connected to visual processing
Why is NOR required?

- Until the visual system is rehabilitated, the patient is not capable of reaching his/her highest functional potential in post-injury Activities of Daily Living

Why is NOR required?

- Without accurate perception of the environment, the individual is unable to make clear and effective sense of what is happening
- Visual processing problems have been shown to be associated with poor performance in reading, accident proneness and dependence in self-care activities after ABI's
- Cognitive deficits are worse when visual processing problems are not identified or treated
- Cost effective rehabilitation

When is NOR required?

- As soon as (ASAP) visual dysfunction is identified or is suspected in interfering with the progress of rehabilitation.
NOR Serves Patients With:

- Traumatic Brain Injury
- Cerebrovascular accident
- Cerebral palsy
- Multiple sclerosis, Alzheimer’s, Parkinson’s, other degenerative brain diseases / syndromes
- Anoxia (drowning, shock, anaphylaxis, choking)

NOR Serves Patients With:

- Chemical
- Penetrating
- Trauma patients with Ocular Involvement
- Complicated Surgical Cases
  - Prolonged Heart Surgery (anoxia)
- Post-Op Brain Surgery
- Congenital Brain Anomalies

Cerebrovascular Accidents (CVA) Statistics

- 3rd leading cause of death in developed countries
- 794 per 100,000 prevalence
- 5% of the population over age 65 is affected by stroke
- 80% survival rate after stroke
**Traumatic Brain Injury (TBI) Statistics**

- 400,000 people/year in the US acquire a TBI and over 50% of these suffer from visual impairment.
- 1 out of 500 school children hospitalized each year for a TBI.
- TBI is the leading cause of death and disability of children and adolescents in the US.
- “Mild” TBI often never see a health care professional.

**Visual Processing Following Brain Injury**

- 50-75% of severely brain injured individuals had visual processing problems which required further professional exploration by an ophthalmologist or optometrist.

(From Gianutsos et al)

**Visual Processing Following Brain Injury**

- 38% of acute traumatic brain injured individuals had vergence difficulties.
- 42% had vergence insufficiencies at a 3 year follow-up.

(From Cohen et al)
Visual Processing Following Brain Injury

- 79% of brain injured individuals had *strabismus with diplopia*

  *(Mitchell, MacFarlane, and Cornell)*

Visual Processing Following Brain Injury

- 20% of all stroke patients suffered from some sort of visual problem

  *(Samo and Samo)*

Visual Processing Following Brain Injury

- 20% of all individuals admitted to a rehabilitation center had perceptual problems and that these were clearly associated with increased length of stay in the hospital and an adverse affect on discharge and subsequent placement

  *(Ferguson, McCarthy, Greenberg, and Feingenson)*
Visual Processing Following Brain Injury

- 60% of stroke patients had unilateral neglect (USI)

(Adams and Hurwitz)

Visual Processing Following Brain Injury

- 59% of brain injured patients in their study displayed visual problems

(Schlageter, Gray, Hall, Shay, and Sammet)

How Big is Vision?

- Vision is the dominant sense
- Vision plays a critical role in all activities of daily living (ADL’s)
  Over 1 million nerve fibers exit each eye—this represents about 70% of the sensory nerve fibers in the entire body
How Big is Vision?
Primary Visual Pathway
- Retina—Optic Nerve—80% to LGN—then
- Visual Cortex (V1)
- V1 Projects to 30 distinct visual areas including:
  - Temporal lobe
  - Parietal lobe
  - Frontal lobe
  - Amygdala

How Big is Vision?
Primary Visual Pathway
- These projections integrate with:
  - Memory
  - Audition
  - Language
  - Cognition
  - Emotions

How Big is Vision?
Collicular Visual Pathway
- Retina—Optic Nerve—20% to Superior Colliculus
- These fibers integrate with other sensory input from:
  - Vestibular
  - Proprioception
  - Kinesthetic
  - Tactile
  for balance and orientation.
Vision Problems Encountered

Medical Problems Encountered:
- Dry eyes
- Glaucoma
- Cataracts
- Diabetic Retinopathy
- Macular Degeneration
- Venous Occlusive Disease
- Other Retinal Degenerative Diseases

Sight Problems Encountered
- Sight
  - Acuity
  - Contrast Sensitivity
  - Color Vision
  - Glare Sensitivity
  - Visual Field
Ocular-Motor Problems
- Fixation
- Pursuits
- Saccades
- Nystagmus
- Vestibular-Ocular Reflex
- Pupils
- Accommodation

Visual Processing Problems
- Visual-Motor-Integration Skills
  - Handwriting
  - Reach & Grab
  - Ambulating
  - Driving

Visual Processing Problems
- Visual-Analysis Skills
  - Visual Discrimination
  - Visual Closure
  - Visual Form Constancy
  - Visual Figur Ground
  - Visual-Spatial Relations
  - Visual Memory
  - Examples….
Visual Figure Ground

Visual Spatial Relations

Visual Memory
Visual Memory

Visual Processing Problems

- Visual–Motor Integration Skills
- Visual Analysis Skills
- Visual-Spatial Skills
  - Visual Midline
  - Unilateral Spatial Inattention (Neglect)
  - Visual Multitasking

Functional Vision Problems

Encountered

- Visual Processing Problems
  - Visual–Motor Integration Skills
  - Visual Analysis Skills
  - Visual-Spatial Skills
    - Visual Midline
    - Unilateral Spatial Inattention (Neglect)
    - Visual Multitasking

Visual Spatial Problems

THE MAJORS

- All 6 are Visual-Spatial Problems
  1. Diplopia
  2. Visual Field Defects
  3. Unilateral Spatial Inattention (Neglect)
  4. Visual Midline Shift Syndrome
  5. Post-Traumatic Vision Syndrome
  6. Visual Multitasking Dysfunction
THE MAJORS
“The Dangerous Ones”
“The Disabling Ones”

- All 6 can slow the rehab process
- All 6 can lead to greater risk of subsequent injury and illness
- All 6 can lead to adverse psychological sequellae
- All 6 can lead to more medications
- All 6 can lead to greater dependence on others

Diplopia (double vision)

- Occurs when the eyeballs do not point in the same direction at the same time.
  - Ocular Trauma
  - Cranial Nerve Palsy (3\textsuperscript{rd}, 4\textsuperscript{th}, 6\textsuperscript{th})
  - Supranuclear Palsy
  - Decompensation
  - Visual-Spatial Dysfunction

Diplopia

- Not always reported by patient.
  - May claim “blurry vision”
- Patient may exhibit postural shifts
- Can cause dizziness / vertigo
- Can cause visual-motor-integration problems
- Eliminated by covering one eye but, patching is not the best treatment
Diplopia Treatments

- compensatory prisms
- partial occlusion
- vision therapy
- total occlusion
- patching
- surgery
Visual Field Defects

- Unilateral
  - Central scotoma
  - Paracentral scotoma
- Superior and Inferior
- Concentric
- Homonymous Hemianopsia
- Unilateral Spatial Inattention

Homonymous Hemianopsia

- Bump into objects on one side
- Can’t find objects on one side of the room
- Says they can’t see out of one eye
- Is surprised by objects or people that seem to pop into view
- Is aware of their deficit
- High accident risk for elderly

Unilateral Spatial Inattention

- “Neglect”: term connotes a purposeful act
- Damage to the right posterior parietal lobe
- Mostly seen on left side
- Can be with or without field defect
- Generally causes visual midline shift
- Patient at high risk of injury
- Patient has higher dependency
- Patient is unaware of their deficit
Unilateral Spatial Inattention

- Bumps into things on one side
- Can’t find things on one side
- May not shave or dress one side
- May not use one side of body (even non-paralytic)
- Orientes and postures away from USI side
- Doesn’t know to look in direction of USI
- Is unaware that there is space that they can look into
- May not be able to turn eyes in USI direction

Unilateral Spatial Inattention

3 Key considerations:

- Pt is prone to Extinction Phenomenon, in terms of body and in the two visual spaces
- Can occur in the presence or absence of a basic motor or basic sensory dysfunction
- Key is an unawareness or denial of the USI

THE MAJORS

“The Dangerous Ones”

1. Diplopia
2. Visual Field Defects
3. Unilateral Spatial Inattention (Neglect)
4. Visual Midline Shift Syndrome
5. Post-Traumatic Vision Syndrome
6. Visual Multitasking Dysfunction
Visual Information Processing

- Coupling of two separate processes
  - Focal process *(mostly the 80% of visual processing)*
  - Ambient process *(mostly the 20% of visual processing)*
- Both systems are needed to work in synchrony to function well
- Who has difficulty with maintaining a balance of these two systems?

Focal Visual Process

- Through the macula (detailed vision)
- Through the peripheral vision (detailed attention process)
- 80% of the fibers leaving the eyes go to the Occipital Cortex
- Parvo, Cones, Focal, Detail
- What is it?

Ambient Visual Process

- 20% of the fibers leaving the eyes go to the Midbrain
- Provides ambient information used for
  - balance
  - movement
  - coordination
  - posture
- Lets you know where you are in space
- Magno, Rods, Ambient, Motion
- Where Am I?
Ambient Visual Process

- Part of the sensory motor feedback loop in the midbrain
- Matches up with information from the following systems for the purpose of orientation and acting as a master organizer of these other systems:
  - kinesthetic
  - proprioceptive
  - vestibular
  - Tactile
- CAUSES A SUPPRESSIVE FEEDBACK LOOP TO THE FOCAL PROCESSING SYSTEM (processing deficit basis in USI)

- Provides stability and spatial-temporal orientation
- A mismatch between an object and where I know it to be=learning occurs. VISION THERAPY
- “Vision writes spatial equations for muscles to solve” Unknown
- Visual motor problems are a result of a “where” problem
Major Ambient Visual Process Syndromes

- Visual Midline Shift Syndrome (VMSS)
- Post-traumatic Vision Syndrome (PTVS)

Visual Midline Shift Syndrome (VMSS)

- Patient has mismatch in perception of space related to self
- Common Characteristics
  - Dizziness or nausea
    - (balance, coordination, and posture)
  - Spatial disorientation
  - Leaning forward / backward / one side
  - Other associated Neuro-motor difficulties

Visual Midline Shift Syndrome (VMSS)

- Common Characteristics
  - Seeing the floor tilted
  - Illusions of movement of environment
  - Constantly walking to one side of hall or room
  - Bumping into objects when walking
  - Leaning to one side, back or forward or posture changes
Post Trauma Vision Syndrome (PTVS)

Common Characteristics
- exotropia / exophoria (eyes turned out)
- convergence insufficiency
- accommodative insufficiency
- ocular motor dysfunction

- Increased myopia or nearsightedness (almost every ABI pt. over time)
- Low blink rate
- Spatial disorientation
- Poor fixation
- Unstable ambient vision
**Post Trauma Vision Syndrome (PTVS)**

**Common Symptoms**
- Diplopia
- Blurred or hazy vision—ghost images
- Inappropriate motion sensation, dizziness, nausea
- Headache, especially when reading
- Glare or light sensitivity

**Post Trauma Vision Syndrome (PTVS)**

**Common Symptoms**
- Headache with light exposure (photophobia)
- Dry eye syndrome
- Reading problems
  - including unstable focusing, poor line tracking, losing place in text, poor comprehension and memory of text

**Visual Multitasking**

**Simultaneous Central / Peripheral Visual Processing**
- The ability to attend to a central visual target and simultaneously respond to peripheral visual stimuli.
Visual Multitasking Dysfunction

- Virtually ALL brain-injured patients have some dysfunction of this ability
- They approach the world with a "tubular-vision" approach, sequentially looking at one thing at a time.
- Significantly slows "Speed of Processing" down

Visual Multitasking Dysfunction

- Anxious in crowds
- Difficulty shopping
  - Overwhelmed by too much stuff
  - Gets lost easily in store
- Driving is dangerous
  - Poor lane maintenance
  - Anxious with increased traffic and speed, or night driving

Words to live by

- "Watch a patient from the minute they enter your office and they will tell you the problem before the examination".  
  (Ret) rADM David Sullins, OD, DOS, FAAO
Sight Testing

- Visual Acuity
- Contrast Sensitivity
- Color Vision
- Glare Sensitivity
- VEP visually evoked potential (only objective measure)

Acuity

Contrast Sensitivity
Color Vision

Sight Testing

• Visual Fields
  • Confrontation
  • Amsler Grid
  • Static Threshold
  • Campimetry (functional visual fields)
  • Functional Binocular Testing—Accuvision, Dynavision, or Saccadic Fixator
Visual Motor Testing

- Ocular Alignment
- Ocular Motility
  - Pursuits
  - Saccades
  - VOR
  - Visagraph Recording
- Accommodation
- Pupils
Fusion Testing

- Stereopsis
- Suppression
- Vergence Compensatory Ranges

Refractive Testing

- Objective
- Subjective
- Distance and Near

Visual Spatial Testing

- USI
- Walking / ambulating through the office
- Visual Midline Shift
- Loop Poking/Capping Pen
- Visual Scanning
- Visual Multitasking
Visual Analysis Testing

- TVPS, Line bisection, VMI, etc
- Computer testing (visagraph)
- VEP – monocular and binocular
- Tachistoscope
- VTS3 for vergence, motor field, etc.

Neuro-optometric management of the brain injured patient

NOR Therapy / Management

- Lenses—noncompensatory
- Prisms—noncompensatory
- Selective occlusion
- Filters
- Vision therapy
- NOVA vision restoration therapy
- Syntonic Light Therapy
- Combinations of the above
Selective occlusion

- **Binasal** – Decreases peripheral processing load to enable hypo-thalamic tract function
- **Bitemporal** – works with long standing exofusional difficulties
- **Sectoral** – as needed
Treatment

**Filters**
- **Glare**
  - Polarization — organizes light in straight lines to reduce glare
  - Tints
  - Gradient
  - Transition
  - Combinations

**Vision therapy**
- Eye movement — must be SLOW and in developmentally correct order — vertical, horizontal, rotational, then diagonal
- Vestibular (root of eye movements)
- Vergence ranges (range of motion for VOR)
- Awareness — peripheral awareness stationary/mobile
- Ambulation

**NOVAVision**
- **NovaVision VRT™ Vision Restoration Therapy™** (VRT) is based on groundbreaking research in neuroplasticity. VRT is an FDA-cleared, patented, non-invasive medical device that may restore vision in stroke and traumatic brain injury (TBI) patients with visual deficits. While speech, physical and occupational therapies are the long-standing treatment regimens for stroke and TBI patients, VRT is the first FDA-cleared clinical application of rehabilitation for vision loss.
Treatments

- Novavision VRT treatment

Syntonic Light Therapy
- Applied use of specific wavelengths to the eyes for specific changes to blood chemistry (affecting endocrine)
- Started in the 1900’s by Spitler, MD. Used in many other countries
  [www.syntonicphototherapy.com](http://www.syntonicphototherapy.com)

Summary of NOR Therapy / Management

- Must Have Coordination of Care
  - OT
  - PT
  - ST
  - Psychiatrist
  - Neurology
  - Primary Care
  - Voc Rehab
  - VT
  - Others
| The Efficacy of Vision Rehabilitation Therapy |
| Training of visual scanning reduced neglect in right damaged stroke patients (Diller and Weinberg) |
| 4/5 studies reviewed (150 patients) found consistent beneficial effects of visual processing skills training for the patients which were over and above improvements resulting from conventional therapy (Gianutsos and Matheson) |

| The Efficacy of Vision Rehabilitation Therapy |
| Research indicates that visual processing therapy has a possibility of reducing the size of the visual field problem (Warren) |
| Visual processing gains through therapy are maintained a year after discharge (Weinberg et al) |

| What is Vision Therapy? |
| “…the art and science of developing visual abilities to achieve optimal visual performance and comfort. It provides the patient with an opportunity for both development and learning experience.” Journal of Behavioral Optometry, Vol. 1, 1990, Number 3, p. 66-67. |
What is Vision Therapy?

“…a clinical approach for correcting and ameliorating the effects of eye movement disorders, non-strabismic binocular dysfunctions, focusing disorders, strabismus, amblyopia, nystagmus, and certain visual perceptual (information processing) disorders. The practice of vision therapy entails a variety of non-surgical therapeutic procedures designed to modify different aspects of visual function.”

Advanced Therapist Vol. 34, Number 1, p. 131

What is Vision Therapy?

“…creates a visual environment in which the patient may modify their visual behavior and alter their visual performance to meet the visual needs of their specific environment.”

Rehabilitation Techniques for Binocular Dysfunctions by Richman and Cohen, p. 1.

What is Vision Therapy?

“…vision therapy arranges conditions….so that the patient can learn many visual abilities which will allow them to take in, use and understand more information over a large area in less time. It allows one to use his vision to learn more and succeed better at his task or pastime, whatever it may be. Rather than exercises for the eyes, it involves an awareness of movement, control of movement and, ultimately, the automatic movement of eyes integrated with movement in many of the body systems.”

Learning to See and Seeing to Learn—Orem, R.C., p. 84
What is Vision Therapy?

“...is the art and science of developing visual abilities to achieve optimal visual performance and comfort.”


What is Vision Therapy?

“...is based on a medically necessary plan of treatment which is designed to improve specific vision dysfunctions determined by standardized diagnostic criteria. Treatment plans encompass lenses, prisms, occlusion and other appropriate materials, modalities and equipment.”

AOA Definition of Vision Therapy

Locating a Doctor

- To locate a Neuro-Optometric Rehabilitation Specialist
  - www.covd.org vision development
  - www.nora.ca neuro-rehabilitation
  - drhadler@thechildrenseyedoctor.com
  - www.thechildrenseyedoctor.com
  - www.brighteyesvisionclinic.com
References