Vision Field Restoration
Dr. DeAnn M. Fitzgerald, OD
CR Vision in Motion
Active Evolution
MSST

Let’s start with the end in Mind

• Case studies
  1) RH 45 field loss after aneurysm surgery
  2) EF stroke field loss
  3) CK roll over car accident
  4) JS vision loss after surgery

RH – 45 year old male

• Had surgery for an aneurysm
• Upon waking discovered that his vision seem not right

RH – 2/26/2013

• Lost his job and has not driven for 4 years
• Wears contacts -4.50 ou OD 20/30 OS 20/40
• Unable to do fusion ranges
• Walking had to touch the wall
• Watched his feet to wall
• Offered therapy to help in any way for him to not be a fall risk

• We started with multi systems therapy—vision, vestibular, auditory and proprioception—all at the same time for 1 hour every day for 12 days in a row
• We looked at his metabolic system and he was not sleeping well added magnesium at bedtime
• Along with the therapy for 12 days— we continued to see him twice a week doing eye hand coordination and motor with vision vestibular exercises
• He continued the light therapy for 18 more days 2x/day for 20 minutes each time
**RH – 5/29/2013**

- Original goal was to get him to ambulate better in his world and to decrease his fall risk—using his vision and vestibular and motor system with better results
- VA with original rx: OD 20/25 OS 20/30—fusion ranges able to perform
- Reaction time went from 5.2 seconds to 0.87
- Was able to get his drivers license and got his job back
- He returns now each year and has maintained his visual field

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**EF 65 year old**

- Was diagnosed with hemorrhagic stroke
- She comes to our care 4 months after the stroke
- Plano OD 20/25 OS 20/30
- Dynavision reaction time 4.54 seconds
- Did not demonstrate walking or gait problem
- Noticed that she was having trouble with driving, braking late and not seeing as well on the right side

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**EF 65 yo stroke – 1/14/13**

- Offered vision vestibular auditory and proprioception all at the same time for 1 hour for 12 days in a row
- Did not recommend any magnesium
- In addition, posture gait vestibular vision –2x/week plus light therapy 2x/day for the 18 days
- We continued to work with her—goal 60 lights in a minute and 240 lights in a 4 minute run—endurance
- Sent her back to get her license

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**EF – 4/10/13**
CK
• 27 year old who was involved in a roll over car accident
• Severed a TBI that left him with right arm and right leg paresis
• Left homonymous hemi OU
• Easily fatigued, slowed speech and thought
• OD 20/20 Plano  OS 20/40- Plano

CK – 12/12

CK – 9/13

• Recommended therapy MST
• Unable to begin was traveling 2 hours to see us
• Did not start therapy until May 2013
• Dynavision reaction time—left hand only 2.33

• Reaction score—60 lights in a minute
  240 lights in a 4 minute run
  one handed

Moved forward to get his license and a special equipped car for return to driving
Returned for follow up 2 years later and has maintained his visual field

JS
• Hit by a train after being
Neuroplasticity

- Neuronal connections are strengthening and remodeled by our experiences and movements

“What fires together, wires together”

Let’s Talk

What are mechanisms behind recovery

- Neuroplasticity
- Reducing neuron fatigue
- Increasing the brains ability to recognize a weaker signal
- ATP and mitochondrial energy
Dynamic Systems Theory

- Task Goals
- Musculo Skeletal Components
- Environmental Systems
- Individual Sensory Systems
- Central Sensory Organization
- Anticipatory Mechanisms
- Neuro Muscular Synergies

Sensory Integration

- Systems are precisely calibrated
- Seamless integration is integral for efficient performance of cognitive & physical tasks

Review of Brain Anatomy

- Frontal Lobe
- Temporal Lobe
- Parietal Lobe
- Occipital Lobe
- Brainstem
- Cerebellum

Systems

- Autonomic—parasympathetic/sympathetic
- Neuronal networks

Key concepts

- Posture
- Gait
- Stability
- Ocular function/functional vision networks
- Rapid and coordinating movement
- Smoothness of movement
Postural Control

- Essential foundation for movement
- Requirements for functional movement:
  - Balance strategies
  - Patterns of movement
  - Speed and accuracy
  - Strength and endurance

Requirements for Efficient Movement

- Postural Control
- Base of Support
- Alignment
- Sensory Input

Base of Support

- Can be any body part:
  - Feet
  - Hands
  - Trunk
- System needs to accept base of support in order to build movement on top

Sensory Inputs that Provide Equilibrium

- Visual
- Vestibular
- Proprioceptive

All three systems integrate to form a complete mental picture

Vision Anatomy

- Superior colliculus in the midbrain involved in spatial orientation and eye movement control and integration of spatial information with vestibular, tactile and auditory information.

Posterior Parietal Cortex

- 20% of retinal input
- Dorsal visual stream: "where to go"
- Ventral visual stream: "what to do"
**Posterior Parietal Cortex**

- Center of multisensory convergence where visual, proprioceptive and vestibular information are combined
- Awareness of the movement and direction of movement of objects
- Localizing objects in space in relation to our bodies
- Awareness between objects in space
- Organizing and preparing our bodies for action

**EFFICIENCY OF SENSORY PROCESSING**

- Dependent on an intact neural communication within sensory processing areas and the pathways between these areas
- Needs intact connections and reception

Now imagine the neural highway after a brain injury?...

**DR. PADULA’S DEFINITION OF VISION**

- A dynamic, interactive process of motor and sensory function mediated by the eyes for the purpose of simultaneous organization of posture, movement, spatial orientation, manipulation of the environment and to its highest degree of perception and thought.

Review of systems
Optometry and the Brain

- 70% of our brain is dedicated to vision and vision processing
- 80% of all sensory processing in the entire body is directly affected by information coming in from the eyes
- 90% of TBI patients experience 1 or more oculomotor dysfunctions
- 40% of TBI have visual dysfunctions that persist > 3 months
- The eye is the ONLY organ innervated by the CNS and the autonomic division of the PNS

Three Visual Pathways

- **Parvo-cellular (80%)**
  - Occipital Lobe
  - What?/Temporal/Ventral
- **Magno-cellular (18%)**
  - Midbrain
  - Where?/Parietal/Dorsal
- **Konio-cellular (2%)**
  - Midbrain

Central/Focal/Parvo/What?

- Focal – central – mostly macular function
- Detail discrimination – visual acuity
- Attention
- Concentration
- Orientation to present consciousness
- **Slow speed** in processing/occipital cortex
- Mostly cortical/higher processing

Peripheral/Ambient/Magno/Where?

- Spatial orientation
- Posture/balance
- Movement
- Anticipates change in the preconscious
- **Rapid speed** in processing
- Fight or Flight - survival

Peripheral/Ambient/Magno/Where?

- 20% of the nerve fibers from the eye do not go to the occipital cortex—goes to midbrain
- Midbrain delivers SENSORIMOTOR!

Spatial visual processes include:
- Preconscious and proactive
- Receives feedback from the cortex
- Brings forward all possibilities for neuro organization
Visual Processing & Balance

- Visual processing is **bi-modal**
  - **Spatial or Ambient Vision** – Where Am I?, Where is it?
  - **Object or Focal Vision** – What is it?

Trevathan published these 2 mechanisms of vision in primates in 1968

Demo

Spatial Visual Process

- Organizes spatial information
- Allows for the development of concepts of midline, position, and orientation
- **Feed-forward phenomenon** – visual information relayed from the midbrain to the occipital cortex to *pre-program* the higher cortical areas to first evaluate visual information spatially before focalizing on detail

Visual fields

- Visual fields normal
- Visual field defect
- Visual field defect with Unilateral spatial neglect
- No visual field defect with unilateral spatial neglect

Visual fields vs Dynavision

- Structural vs functional
- Reaction time to indicate function
- Motor returns before sensory

Review of Visual field defects

- Hemianopia
- Unilateral Spatial Inattention (USI)
- Increased Extension
- Increased Flexion

Visual fields

- How read them and how to take them
- Confrontation—cover each eye, use 1 or 2 fingers—pediatric use distraction
- Automation—Humphrey
Flow

- Optic nerve
- Chiasm
- Tract
- Radiations

Common Field defects in CVA and TBI

- Unilateral
- Bitemporal
- Hemianopsia
- Quadranopsia
- Pie in the Sky
- Scattered Islands

Rules to reading visual fields

1) the more posterior the lesion(stroke) the more congruous (similar) the defect
2) Occipital cortex lesions often spare the macula
3) The more posterior the defect rotate it 180 degrees and it will tell you where the lesion is at ie "Pie in the sky"(lower right—temporal)
   "pie in the floor"—parietal
4) Chiasm lesion give tunnel vision

Unilateral Spatial Inattention

Right parietal lobe allocates attention to both sides of the body
Left parietal lobe allocated attention to the right side of the body
Can be personal space, peripersonal space and extrapersonal space

Causes

- Brain areas in the parietal and frontal lobes are associated with the deployment of attention (internally, or through eye movement—head turns—it reaches) into extrapersonal space. Neglect is most closely associated with the right parietal lobe. Damage to the left side of space can manifest in the visual, auditory, proprioceptive, and olfactory domains. Although hemispatial neglect often manifests as a sensory deficit (a frequent association with sensory deficit), it is essentially a failure to pay sufficient attention to sensory input.

- Although hemispatial neglect has been identified following left hemisphere damage (resulting in the neglect of the right side of space), it is most common after damage to the right hemisphere. The disparity is thought to reflect the fact that the right hemisphere of the brain is specialized for spatial perception and memory, whereas the left hemisphere is specialized for language—there is redundant processing of the right visual fields by both hemispheres. Hence, the right hemisphere is able to compensate for the loss of left hemisphere function, but not vice versa. Neglect is not to be confused with hemianopsia.

- Hemianopsia arises from damage to the primary visual pathways cutting off the input to the cerebral hemispheres from the retina. Neglect is damage to the processing areas. The cerebral hemispheres receive the input, but there is an error in the processing that is not well understood.

Unilateral Spatial Inattention (USI)

- Awareness—attention—does not bring eye movements to that field
- Exploration and curiosity are not there
- It may look like a visual field defect
- Very much impacts negatively daily living skills
- Can be in tandem with a visual field defect
- With therapy mild, moderate and severe will respond
Tests for USI

- Dual extinction
- Line Bi section
- Clock
- Flower
- 3 foot rod

Tests

- Dual extinction
- Line Bi section
- Clock
- Flower
- 3 foot rod

Therapy

- Yoked prism
- Scanning and searching techniques
- Dynavision
- Tapping to alert to that side

DeAnn’s Clinical Pearls

- Thoughts: Place the base of the prism in the direction that you want the person to go
- Find the edge of the affect and push beyond that line with eye hand activities
- Searching for coins (closer)
- Searching out in the distance (Farther)

Using Yoked Prism

- My General Rules of Thumb:
  1. Put the base of the prism in the direction that you want them to go
  2. Start at a moderate amount (2PD) then increase by 2 until you get the change you are looking for
  3. Start base left and don’t finish with base up
  4. Used in therapy only (approx 15 - 60 min)
  5. Reassess in 3-6 weeks – get feedback from PT/OT
  6. If don’t get effective change you want at reassessment will do a prescription

Neuroplasticity/Brain reserve
Pathways of treatment

- Direct neuronal pathway
- Indirect neuronal pathway
- Vision /vestibular/somatosensory input pathways
- Using common blood supply system to increase neuronal activity

Treatment thought

- Multisystem therapy
- Immersion technique—several days in a row
- Duration of therapy—daily (hour) upto 18 months

Case study

- NB 65 yo had a stroke 20 years ago that left her with central vision only in repeatable visual fields
- She would come in about every 5 years because she did not see any reason to come in more often
- August 2015—came in for routine care—signed her name by placing head on the paper, needed to be facilitated by son on one side and husband on the other and has done that for years
- I asked norma when she would do therapy with us

Leverage

- She said she would love to see the faces of her two new granddaughters
- And signed up

August 25 2015

- Started a multisystems therapy—light, vestibular, auditory and somatosensory
- 1 hour for 12 days in a row
- And then doing dynavision before or after

- She was able to do the D2 in a seated position. Norma’s first run was proactive, bottom half of the board. Her score was 7 lights in 60 seconds with a reaction time of 8.57 average seconds. Yoked 5 base left prisms were put on for all remaining runs during this session. Scores for these runs were 20, 23, 29, and 30 at an average speed of 2.00.
• August 19th 2015
  Today Norma started with yoke 5 base left prisms on. She worked the bottom half of the board at a proactive pace. Her scores increased today and ranged from 26-48 lights.

• August 20th 2015
  • “Today at the end of SLP I was able to see more!” Norma says that she is noticing a difference. I wanted to challenge Norma. I left the lights on during the first 5 runs to reduce the contrast. All runs were bottom half at proactive. Scores on the first 5 runs ranged from 36-47. At the end of 5 rounds Norma asked that the lights be turned off. She said that it was harder this way and was making her eyes tire. Norma did 4 more runs with the lights off. Scores for these runs were between 51-56 with her fastest reaction time at 1.07.
  • August 21st 2015
  • Today Norma was instructed to hit ring one with her eyes fixed on the T scope and not move her head. This same strategy was used on ring one and ring two. Norma did center 3rings on Norma were worn. The focus of this session is to end scanning the board for the lights. With prisms today she scored 74 lights at a .81 average reaction speed without prisms or turning her head.

• September 2nd 2015
  • Norma did all runs on the Dynavision today without prisms. She did 4 runs on the D2 while standing and then did 3 minutes of Infinity walking. She repeated this pattern 3 times. Next Norma did 10 minutes of seated exercises using body weight and resistance bands. Norma finished this session doing Brain Gym double doodles.
  • September 4th 2015
  • Today Norma worked on scanning the room without prisms on. Objects were scattered on the floor. She navigated these items and called out what she saw as she walk by them. She was tentative about this at first but after a short amount of time she wanted to do it without any assistance and wanted me to walk behind her as she did it.

• August 24th 2015
  • “I can tell that my eyes are working better because they feel tired.” Norma did 3 bottom half proactive runs seated to warm up and then did the rest of the runs standing. She did all runs with yoked base left prisms except for her last 2 full board proactive runs. New runs were introduced during today’s session. These runs included full board proactive. On full board her scores ranged from 31-42 lights. On full left proactive scores were 45 and 44. On full right proactive scores were 39 and 41. Without prisms on for her 2 last full board runs Norma scored 39 and 38.

• August 25th 2015
  • Sessions have been extended to 30 minutes following Norma’s SLP. Today Norma wore yoked 10 base left prisms on all runs on the Dynavision. Her first 8 runs were seated using the board and her last 13 runs were done standing today. A week ago on mid board proactive Norma scored 23 lights, today she scored 55 lights on the same run.

• September 14th 2015
  • Norma cancels appointments due to bronchitis and is not back again until September 24th 2015.
  • September 14th 2015
  • “I can see!” was the first thing that Norma said as she walked into our building. Today was the first day that Norma looked at me and made eye contact. She was excited when she realized that her right eye was seeing so much peripherally. Norma said, “I am only used to having one working eye and only seeing as much as a straw hole.” Today is the last day of SLP and Norma will start training 3 times a week for 45 minutes after the holiday.
• September 16th 2015
  Today two new runs were added for visual multitasking, working central vision and peripheral awareness. Norma worked on mid board at a .90 speed with 3 digits in the T-scope. Her high score was 52 lights. Next she worked on 4 rings at a 1.50 speed with 3 digits in the T-scope. Her high score was 54 lights. Norma will see Doctor Fitzgerald this Friday, September 18th for her 30 day follow up to S.L.P.

• September 21st 2015
  "I’ve been telling everyone how wonderful my exam went with Doctor Fitzgerald!" Norma was so excited about regaining her vision. She talked about being able to go outside and take a walk, about seeing her grandchildren and being able to play catch with them.
  On the Dynavision today Norma scored a new high score with full board. She scored 67 lights at a .90 speed. Again, Norma worked on visual multi-tasking. Norma hit mid board at a .90 speed with 3 digits in the T-scope. Norma has also been doing Marsden ball drills at home on a regular basis.

• September 23, 2015
  Today Norma began with 10 minutes of standing toss and catch using the rebounder. She did well with this but by 10 minutes she was fatigued and asked to switch activities. On the Dynavision, she worked on reading a small Hart chart that was taped in the center of ring one while hitting lights in rings one and two. Norma did this drill 3 times. It was challenging for her and her scores ranged from 48-60 lights as her high score.
  Next, Norma was seated in a chair with a Hart chart positioned three feet in front of her. I stood to the right side of Norma and tossed a small ball back and forth to her as she read the Hart chart. The second time we did this I stayed on the right side but moved a little more in front of her.

• 62 days she got performed the previous visual field
• 85 days later she had a drivers license with NO restrictions
• 100 days I got a call from her family physician wanting to know what we did to Norma, in the last 15 years Norma has never gone to the exam room unassisted
• 1000 days later Norma took her family out to California to see her daughter—who still believes her mom is not telling the truth!!