Neuro Plasticity for the Stroke Survivor
A Practical Approach for Primary Care Optometrists
(course #5015)

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Private Practice
Bellflower, CA
2019 AOA Optometry’s Meeting
Sunday June 23, 2019

Course Description
• As the incidence of cerebrovascular accidents (strokes) increases, more primary care optometrists are seeing stroke patients at their offices. This course will present a broad view into understanding the brain’s ability to heal and introduce practical approaches to identify the functional visual problems resulting from a stroke, and examination strategies and treatment approaches, including appropriate referrals for vision rehabilitation. Several case studies will be presented that will highlight the goals and outcomes of treatment and important collaboration with other rehabilitation members.

Course Objectives
• Know the prevalence and cause of stroke in your patient population
• Learn how the visual process affects other systems
• Identify commonly encountered visual deficits through assessment and observation
• Determine effective treatment strategies to improve outcomes and increase engagement in occupation
• Appreciate the interdisciplinary approach between optometry and occupational therapy

Disclosures
• Financial disclosures: NONE

My Stroke of Insight
• "Our human brain (has the) innate ability to constantly adapt to change and recover function"
Epidemiology of Stroke (CDC data)

• About 795K people in the U.S. suffer a stroke
  – Initial 610K
  – Subsequent 185K

• 5th leading cause of death in the U.S.
  – 1 of every 20 deaths (140K Americans)

• Financial costs
  – $34 billion annually for health care services, medications, time off from work (long term disability)

Causes of Stroke (American Heart Association)

• A cardiovascular disease affecting the blood vessels that supply blood to the brain (also known as a "brain attack")
• Occurs when the blood vessel "bursts" (hemorrhage) or is "clogged" (ischemia) depriving the brain of oxygen
  – Two types of hemorrhagic and two types of clots
    • Cerebral and subarachnoid hemorrhages (higher fatality rate)
    • Cerebral thrombosis and embolism (most common representing ~75% of all strokes)

Warning Signs

• Sudden weakness or numbness of the face, arm or leg on one side of the body
• Sudden dimness or loss of vision
• Loss of speech or difficulty talking or understanding speech
• Sudden severe headache (no apparent cause)
• Unexplained dizziness, unsteadiness or sudden fall.

Epidemiology of Stroke

• Highest among blacks
• Increasing in Hispanic population
• Although increases with age, it was reported in 2009 that 34% hospitalized were less than 65 yo

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Default Mode of the Brain

• Imaging studies reveal a persistent level of background activity that may contribute to the planning of future actions.
• 6 million bits of information transmitted via the optic nerve; 10K bits make it to the brain’s visual processing area; few hundred bits involved in formulating conscious perception
  – Too few for meaningful perception which suggests that the brain must make constant predictions

"The Brain’s Dark Energy" Marcus E. Raichle, Neuroscience, March 2010
“Vision is 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, perception and thought.”

William F. Padula, O.D., FNORA

Vision: “the Emergent Process” Skeffington (1950’s)

ATTENTION (magnocellular pathway)

COGNITION (parvocellular pathway)

Speech
Auditory

VISION

Identification

Anti gravity

Centering

Left Brain Right Brain (Springer & Deutch)

- Asymmetry of function
- Each cerebral hemisphere receives information from the opposite side of the body
  - Applies to vision, hearing, body movement and touch (somatosensory)
- Visual fields (contralateral rule applies)

Visual Fields

- Lesions and the corresponding visual deficits

Treatment for Visual Field loss

- Coordination of therapy (outpatient services, home health, caregivers) or in office therapy
- Examine response to visual field expansion devices
  - Full field
  - Hemi prism
  - Spot prism
  - Peli prism
- Impact on functional, independent living skills (perceptual skills)
Hemispatial Inattention/Visual Field Neglect

- Visual substrate
- Space (personal, peripersonal, extrapersonal)
- Common signs/symptoms
  - Visual screening tests
    - Clock face
    - House
    - Line bisection
    - Cancellation
- Therapy strategies
  - Occlusion
  - Lenses/prisms
  - Filters

Visual Neglect (Unilateral Spatial Inattention)

- CVA ➔ middle cerebral artery
  - Right inferior parietal lobe (ie posterior parietal lobe)
- Can occur due to a lesion to the posterior parietal cortex, frontal lobe, cingulate gyrus, thalamus and striatum
- Studies vary, occurrence ranging from 17-80%
  - Variation due to method of testing
- Presents as a hemianopsia but the patient is completely unaware of the defect

Dysfunctions in Space

- Personal
  - Body
  - Somatic dysfunction, including impairment of tactile perception and denial of the existence of the contralesional side of the body.
- Extra personal
  - Locating objects
  - Visual motor control dysfunction, visual localization, impaired representation of the outside world.
  - Subdivided into peripersonal space

Personal Space USI

- Anosognosia-failure to recognize the presence of a motor dysfunction
- Asomatognosia-failure to recognize one’s own body parts
- Akinesia-failure to move a body part

Behaviors

- Fails to groom one side of the body (eg shaving)
- Fails to read one side of the book (poor reading and comprehension)
- Fails to copy on one side of a picture
- Fails to find objects on one side (table, plate of food)
- Fails at self dressing (eg places one arm in a shirt sleeve)
Tests for Visual Neglect

- Drawings by a neglect patient

Other implications of USI

- Affects gait, ability to maneuver in the community
- Driving
- Visual acuity testing
  - Tends to miss the beginning of the line of Snellen letters

Therapeutic approaches

- Yoked prism
- Filters
- Neuro visual rehabilitation/vision therapy

Post Trauma Vision Syndrome (Padula)

- "A multifaceted condition caused by a disruption to the ambient process of vision. The dissociation of the ambient process from the focal process results in compromise of the visual system with orientation toward high focalization without spatial grounding."


Common Characteristics in PTVS

- Exotropia or High Exophoria
- Accommodative Dysfunction
- Convergence Insufficiency
- Low Blink Rate
- Spatial Disorientation
- Poor Fixations and Pursuits
- Unstable Ambient Vision

Common Symptoms in PTVS

- Diplopia
- Objects appear to move
- Poor concentration and attention
- Staring
- Poor visual memory
- Photophobia/glare sensitivity
- Asthenopia
- Neuro motor difficulties
- Balance
- Coordination
- Posture
Visual Midline Shift Syndrome

• A change in the orientation and concept of midline following a neurological event.
• Often found to cause visual balance disorders, oculo motor dysfunctions, nystagmus and disruptions in central/peripheral visual processing (NORA, “Overview of the Pathophysiology of Vision Problems following Brain Injury and Stroke”, 2000)

Characteristics

• Associated Neuromotor Difficulties
• Balance, Coordination, Posture
• Leaning Forward/Backward
• Leaning to One Side
• Seeing the Floor Tilted

Symptoms

• Dizziness &/or Nausea
• Spatial Disorientation
• Consistently walks to one side
• Bumps into objects
• Poor Balance &/or Posture

Visual Screening

• BIVABA (used in rehab facilities)
• Functional visual symptoms
  – Provided prior to initial visit

Behavioral Optometrist’s perspective

• Efficient vision guides action, when there are visual deficits, it interferes.
  – John Streff, O.D.
Occupational Therapist’s perspective

- “The client’s visual performance is not significant in terms of how it deviates from the norm but how it interferes with occupational performance”
  – Mary Warren, MS, OTR/L

Independent Living Skills

- Initial evaluation of ADLs completed by the occupational therapist

Your role as the optometrist

- The rehabilitation professionals (PM&R, Neurologist, and the therapy team) seek out optometrists when there are visual deficits that are impacting the outcome of rehabilitative therapy
- Optometrists are trained to:
  - Determine the visual system and process

“When to help them and when to refer them”

- Optometrists are the best at performing a visual analysis; evaluating the visual system and its process.
- When there seems to be more integrative systems (visual perceptual motor), the need for specialized treatment (therapeutic prescribing, therapy), then it may be time to refer to an optometrist who has experience in rehab.

Optimism in Treatment (Daniel G. Amen, M.D.)

- “Your mind is like a parachute: it works better when it is open...”
- “Before you can straighten out your head, you first need to straighten out your body”

My Stroke of Insight

- “I needed the people around me to believe in the plasticity of my brain and its ability to grow, learn and recover”
Neuroplasticity defined
• The ability of the brain to form and reorganize synaptic connections, especially in response to learning or experience following injury.

History
• Jerzy Konorski (1948)
• Santiago Ramón y Cajal (early 1900’s)
• Fuchs & Flügge (2014)

Types of Neuroplasticity
• Structural
  – Change in the strength of the connections between the synapses or neurons
• Functional
  – Permanent changes in synapses due to learning and development (Demarin, Morovic & Béne, 2014)

Neuroplasticity Rehabilitation for Stroke Recovery
• Ability to rewire functions
• Enhance other areas, memory ability, cognitive (learning)

• Two key methods (stroke-rehab.com)
  – Task repetition
  – Task-specific practice

Functional Vision Assessment
• Primary components for evaluation
• Integrity of visual pathway
  – Eye health, acuity, refractive status
• Visual efficiency
  – Oculomotor, accommodation, binocular function
• Visual information processing
  – Recognition, identification, discrimination, spatial awareness, memory, sensory integration
Examining the patient with stroke

- Type and date of stroke
- Subsequent care
  - Type and duration of therapy
- Functional difficulties following the stroke (Symptom questionnaire)
  - Occupational
  - Avocational
  - Social
  - Other

Functional Optometric Evaluation

- Visual acuities (distance, near, including functional working distance)
- Ocular motilities
- Posture (trunk, head/gait)—check for compensations
- Visual fields (confrontation, AVF)
- Binocular testing (CT, NPC, Phorometry)
- Prism testing (yoked prism)
- Ocular health

Visual Information Processing

**Visual Spatial Dysfunction**
- Difficulty w/ rhythmic activities
- Poor coordination/balance
- Tendency to use one side of the body
- Difficulty w. learning, following L-R directions
- Reversals

**Visual Analysis Dysfunction**
- Difficulty w/ recognition (forms, letters, words), concepts of size, position
- Discrimination difficulties (likes/differences)
- Poor recall

Supplemental testing

- Extended visual fields
  - Syntons (color fields)
- Functional fields
- Visual midline shift
- Visual spatial mapping
- Interactive metronome
- RightEye

RightEye

- Cloud based computerized vision screening.
Visual Spatial board

- Spatial perception
- Internal vs external?

Visuo Spatial Organization

- “What we observe is an external representation of the internal organization of the individual”
  – Aludea, G.B.

R.E., 43 yo

Coin pursuits
Visuo Spatial Organization

- “What we observe is an external representation of the internal organization of the individual”
  - AlSutton, O.D.

Optimal Prescribing Strategies

- Lenses
- Prisms
- Filters
- Occlusion

Spatial Characteristics of Lenses

<table>
<thead>
<tr>
<th>Plus Lenses</th>
<th>Minus Lenses</th>
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</thead>
<tbody>
<tr>
<td>- Reduces tonicity of postural musculature, back and neck</td>
<td></td>
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<tr>
<td>- Expands visual space volume</td>
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<tr>
<td>- Emphasizes background (as opposed to figure)</td>
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<tr>
<td>- More field dependent</td>
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<tr>
<td>- Increases tonicity of postural musculature, back and neck</td>
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<tr>
<td>- Reduces visual space volume</td>
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<tr>
<td>- More field independent</td>
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Spatial Characteristics of Prisms

<table>
<thead>
<tr>
<th>Base In</th>
<th>Base Out</th>
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<tbody>
<tr>
<td>- Moves visual space outward</td>
<td></td>
</tr>
<tr>
<td>- Reduces tonicity of postural musculature or upper back and neck</td>
<td></td>
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<tr>
<td>- Expands visual space volume</td>
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<tr>
<td>- Emphasizes background (as opposed to figure)</td>
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Spatial Characteristics of Yoked Prisms

<table>
<thead>
<tr>
<th>Base Down</th>
<th>Base Up</th>
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<tbody>
<tr>
<td>- Moves visual space upward, farther from one’s center of gravity</td>
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<tr>
<td>- Gives effect of looking “uphill”, relocating space away with objects seen as “larger”</td>
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<tr>
<td>- Creates postural change:</td>
<td></td>
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<tr>
<td>- Eyes move upward</td>
<td></td>
</tr>
<tr>
<td>- Chin moves upward and outward</td>
<td></td>
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<tr>
<td>- Center of gravity shifts forward</td>
<td></td>
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<tr>
<td>- Pelvis moves forward on toes</td>
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<tr>
<td>- De-emphasizes figure and emphasizes ground, enabling the individual to function more “peripherally”</td>
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<tr>
<td>- Moves visual space downward and in toward one’s center of gravity</td>
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<tr>
<td>- Gives effect of looking “downhill”, re-localizing space inward with objects seen as “smaller”</td>
<td></td>
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<tr>
<td>- Creates postural change:</td>
<td></td>
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<tr>
<td>- Eyes move downward</td>
<td></td>
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<tr>
<td>- Chin moves down and inward</td>
<td></td>
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<tr>
<td>- Center of gravity moves backward</td>
<td></td>
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<tr>
<td>- Pelvis shifts to tilt downward</td>
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<tr>
<td>- Body moves back on heels</td>
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<tr>
<td>- De-emphasizes ground and emphasizes figure, enabling the individual to function more centrally</td>
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Improving Orientation with Yoked Prism (Brandon Begotka, O.D.)
Filters Used with TBI

- FL-41
  (For light sensitivity, recommended for patients with migraines, post concussion syndrome)
- Filters blocking portions of the blue spectrum
- Anifra tint*
- Blue/green 20 to 30%
- Green/blue 20 to 30%
* SUNY study: Critical Flicker Frequency and Related Symptoms in MTBI. 2008
Note: filters should be ordered from a reliable source that controls the transmission and wavelength of the specific filter

Filters & Tints

- Changes the energy of the light hitting the retina
- Light sensitivity
- Confusion
- Contrast enhancement
- Reading improvements

Common Selective Occlusion Strategy

Rehabilitative Vision Therapy

- Earliest intervention
  - Inpatient
  - Outpatient
  - Coordinated treatment with periodic follow up at the facility or in office
- In-Office therapy

Optometric Vision Therapy

- A developmental and rehabilitative treatment prescribed to remedy visual dysfunctions. It involves the participation of the patient in a sequence of controlled visual procedures to modify specific visual functions under the direction of the doctor. The therapeutic application of lenses, prisms, filters, occlusion, and specialized equipment is used to normalize visual function. Vision therapy may be used in conjunction with other forms of management. The following conditions are amenable to treatment with vision therapy: amblyopia; strabismus, non-strabismic binocular disorders; ocular motor dysfunctions; accommodative dysfunctions; visual motor disorders; and visual information processing disorders. (AOA Joint Definition of Vision Therapy, 2003)

Bioness Dynavision
Visual Speed of Processing

- Interactive Metronome
  - strategy to improve visual speed of processing, visual attention, divided attention, multi-tasking, sensory integration
  - Problem-solving strategies, working memory

Case Studies

- Stroke patients seen at the rehab facility to demonstrate coordination of treatment
- Patients seen in office
  - Continue to coordinate treatment performed by therapists and care givers at home

Rehab Facility

34 yo female, cerebellar stroke

- Dizziness, nausea, HA
- Lived alone
- Worked at Farmer John on the factory line; aerospace company building/assembling interior of airplanes
- Financially supported her family
- Enjoyed being a “homebody” on the weekends, drawing, painting, and bike rides with friends
- Main goal: return to work

Initial screening

- At initial out-patient vision screen: (6 months after onset)
  - Subjective:
    - Wore glasses since childhood, has recent Rx
    - Intermittent blurry vision
    - Seeing/sensing movement on left side when nothing was moving
    - Walking crooked
    - Dizziness
    - HA (affecting her ability to volunteer, take public transportation)
    - Watery eyes
    - Got in the habit of moving her whole body instead of her head or eyes after the stroke to limit dizziness (therefore maintaining a central gaze)
  - No longer working, riding her bike, drawing, or painting

Visual screening

- Objective:
  - Disconjugate gaze (intermittent, inconsistent)
  - Ocular ROM
    - Full both eyes, but pt visibly uncomfortable (straining with effort, tearing)
    - Reported double vision primarily end ranges, all fields
  - Acuity
    - 20/20 both eyes, but with a lot of effort L eye
  - Peripheral fields: WNL
  - Near point convergence: WNL but straining
- Home program:
  - Monocular ROM (visibly easier then binocular ROM)

Neuro Optometric exam

- Neuro Optometry Clinic:
  - Much less tearing/strain noted with binocular ROM, after just a few days of doing monocular ROM
  - O.D. recommended working on increased peripheral orientation/awareness, pt too centrally focused
  - Prescribed a +2 diopter yoked prisms, base in for use with binocular ROM and dynamic activities
    - Warned dizziness might get worse before it gets better
- Treatment Phase 2:
  - Continue with monocular ROM
    - Binocular ROM with prisms (sitting, then standing)
  - Dynamic activities with prisms (walking, bouncing a ball back and forth, throwing/catching a ball, stationary, then moving, dribbling, etc.)
- Progress:
  - Decreased dizziness
  - Increased field of single vision
  - Increased amount of days volunteering at elementary school
  - Fewer HA
### E.T., 75 yo HA female

- **LCVA**
- **Cc:** Functional deficits: enjoyed cooking but frequently forgot about items on the stove ("unable to see them")

### M.W., 68 yo AA male

- **Initial RCVA in 2012, subsequent in 2013**
- **Came in for consultation in April 2017; family friend**
- **c/o "balance and coordination off", unable to tolerate crowds (movement)**

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### Treatment

**Treatment Phase 2:**
- Decreased, then discontinued use of prisms when pt no longer reporting dizziness and prisms made therapy activities too easy
- Began working on binocular ROM focusing on binocular fusion (focusing mostly on end ranges where pt still seeing double or blur)
- Continued with peripheral orientation activities without prism

**Progress:**
- No longer reporting double vision, but still has blur at end ranges, especially vertical ranges (superior/inferior)
- Dizziness resolved

**Follow Up in Neuro Optometry:**
- O.D. found hypotropia
- Prescribed 2 diopter yoked prisms base up or down during dynamic activities and binocular fusion (goal: to change the way the visual information is being interpreted – force the brain to re-structure itself)

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### Treatment

**Treatment Phase 2 (continued):**
- Followed same treatment plan but added in 2 diopter yoked prisms base up/down
- Discontinued prisms when activities became too easy with them (e.g., no blur, no eye strain)

**Progress:**
- No double, still with blur at end ranges (able to fuse)
- No dizziness, HA only when doing up close work
- Pt starts working as a community representative at the elementary school

**Considering discharge from OT soon**
- Trialed Brock string at distance (5 feet) – Pt reporting intermittent blur (especially after a few seconds of fusion, indicative of fatigue) and double at end ranges

**Treatment Phase 2 (continued)**
- Binocular fusion activities with Brock string, BHT with targets far away (first standing, then balance board, then while moving), Nerf gun target shooting with nephew

---

### Treatment

**Progress:**
- No more HA with computer work (without glasses)
- Visual fatigue at work slowly decreasing

**Timeline/Frequency:**
- Start of OT 6 months post CVA
- Initially: OT 1 x 1 x week, 1 x every other week
- Once HEP was established, OT 1 x every 2-3 weeks for follow up, update of HEP
- Near the end: OT 1 x week to address visual tx and cycling due to pt not participating in HEP consistently

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M.W.
- Habitual VA: 20/20 each eye
- VF (FDT): left visual field cut
- Refraction: R -8.00 -0.75x175 (20/20)
- L -8.25 DS (20/20)
- Add +2.00 RS
- VMT: left shift
- Spatial localization skills: inaccurate, esp in LF

C.M., 66 yo W female
- Cerebellar CVA March 2019
- Med Hx: HTN, Type 2 DM
- Occupation: PT architect/design project mgr
- H&P: acute onset of dizziness, nausea and vomiting on 3/28/19 while out of town. Went to Urgent Care, dx w/vertigo and discharged home. Upon returning home, symptoms worsened. Experienced L headache, slurred speech, difficulty w/word finding, difficulty swallowing.
- Admitted to hospital 4/1/19; imaging studies (MRI) revealed L cerebellar and L medula acute infarcts.
- Referred by rehab hospital therapist for functional visual deficits.
- Cc: Light sensitivity, eyes feel dry, double vision

M.W.
- Prescribe SV glasses
- Instructed spouse on working on his posture, awareness; loaned rotatable prism
- Provided options for therapy, preferred to go at own pace at home
- Spouse gave regular updates, coordinated modifications to therapy based on his attitude and motivation

Initial Consult on 5/23/19
- Unaided VA 20/30 each eye
- Refraction low hyperopic astigmatism, presbyopia
- CT 1-2 pd right hypertropia
- EOM full, symmetric, end point nystagmus in left gaze
- VM testing: left shift
- Right head tilt
- Visual spatial mapping
- RightEye testing

Interactive Metronome results
Recommendations

- Prescribe SV rx, apply binasal occlusion
- Discuss findings and recommendations w/ OT
- Return for supplemental testing

Change in posture and gait (courtesy of Dr. Carl Hillier, O.D.)

BASELINE / No prism

With yoked prism

Creating networks within the Rehabilitation Community

- Rehabilitation facilities
- Physical Medicine & Rehabilitation/Neurologists
- Nurse case managers
- Therapists (occupational, physical, speech)
- Stroke support groups

- All represent sources of referral for neuro visual rehabilitation services provided by optometry.

Neuro Optometry Clinics

Practical Clinical Pearls

- Request HPI to better understand the condition and prepare for what you would expect to see
- Request the therapist’s screening, evaluation or treatment notes; get a sense of what functional deficits are present
- Ask the patient for his/her goals for treatment
  - Provides useful info into their insight

How to develop your clinical skills to work with stroke patients

- AOA VRC
  - Attend the VR Forum and other AOA courses related to this area
  - Discuss cases with colleagues
- COVD
  - Become a member and attend the annual meeting
  - Look into their website, read their journal
  - Consider the Fellowship process
- NORA
  - Become a member and attend the annual meeting
  - Check out their website and informative links
  - Enroll in the Clinical Skills courses
How to develop your clinical skills to work with stroke patients

- OEP
  - Enroll as a Clinical Associate
  - Sign up for the Clinical Curriculum program (Art & Science of Prescribing, Visual Dysfunctions, Visual Perceptual Dysfunctions, Strabimus-Amblyopia, Traumatic Brain Injury courses)
  - Attend Regional Congresses
  - Read the “Journal of Optometry & Visual Performance”

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Acknowledgements

- American Optometric Association, Vision Rehabilitation Committee
- College of Optometrists in Vision Development
- Neuro Optometric Rehabilitation Association
- Optometric Extension Program Foundation
- Western University of Health Sciences, College of Optometry

Thank You!

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VISION REHABILITATION SAVES LIVES!