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# Visual Field Recovery - a Clinical Guide for Optometrists

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Vision therapy providers are being asked to treat patients with vision loss secondary to stroke, brain injury and other neurological disorders. This often puts a competent VTOD in the situation of using trial and error to try to help a needy patient. Optometrists specializing in neuro-optometric rehabilitation have been working with physiatrists, neurologists and other rehab specialist for decades, and have demonstrated that visual field recovery is possible for most patients with no set time limit to efficacy of recovery. The research proving that this is effective is being done by neurologists who have demonstrated re-wiring of neural pathways with improved performance after repetitive visual-motor tasks and recovery of somatosensory and motor awareness after virtual reality (visual) stimulation.

Visual field recovery follows basic principles of rehabilitation therapy:

1. Create demand
2. Provide afferent feedback
3. Increase demand incrementally
4. Integrate other sensory and motor functions
5. Integrate function bilaterally
6. Repetition

When dealing with visual field recovery the development of vision is followed from the most basic primitive reflexes: motion detection, ocular motor control, visual-motor integration, visual inter-sensory integration,

1. Create demands with techniques that require visual awareness that the patient can perceive. This should be at the patient's threshold, but must be possible for the pa-

tient. When there is loss of vision we always start with motion detection. This is the most primitive visual reflex, and is least likely to be totally lost. Many patients with measurable field loss will have motion detection. In any case stimulation of motion detection is primary to recovery and necessary for patients to move in space.

2. Afferent feedback - this was demonstrated by Dr. Edward Taub as the basis for neuro-plasticity and recovery from neurological damage. His research formed the basis for modern stroke recovery including constraint therapy and bilateral stimulation. Afferent feedback can be from another system and is most effective when multiple systems are stimulated simultaneously. This means that using the patient's own limbs for targets is more effective than asking the patient to watch you or using remote targets. They get more afferent feedback.
3. Increasing demand - starting at the patient's functional level and increasing demand incrementally as the patient succeeds is fundamental to all successful rehabilitative therapy. If demand is beyond the patient's ability to integrate, the patient either develops splinter skills or simply doesn't progress. Small increments introduced as the patient's performance improves to maintain demand just at the patient's threshold is the most effective way to stimulate neuro-plasticity.
4. Integration - Visual tasks are never neurologically simple. Vision is the guidance system for most motor functions. Using vision stimulates motor response, and motor responses stimulate visual recovery. Visual-auditory integration is also a powerful tool for visual field recovery. Specifically, we use vision, audition and kinesthetic feedback to perceive space. Paring these senses for therapy activities improves the patient's spacial awareness on multiple levels.
5. Bilaterality - many techniques for motor recovery use bilaterality to stimulate latent primitive pathways and improve motor function. Mirror therapy allows the patient to "see" a paralyzed limb move, and stimulates motor recovery. Constraint therapy forces use of a neurologically weak organ or system, but doesn't permit functional integration of the system. Bilateral stimulation does. We see this in the difference between opaque patching for amblyopia versus blur patch and binocular therapy. Bilateral stimulation causes more somatosensory integration across the corpus callosum. When we talk about vision, this actually means more overall stimulation and bilateral integration, creating a positive feedback system for recovery.
6. Repetition is necessary to integration function and create reflex systems that work automatically. Being able to force your eyes into alignment at near is not the same as having normal reflex convergence. Any athlete or musician knows that there is no substitute for repetition. Everything becomes easier and is more likely to become automatic with practice.

The procedures we use have been developed to stimulate visual field recovery using these principles. We use sensory and motor feedback starting with simple ocular motor procedures, and build visual spatial awareness based on this. We use field specific stimuli (i.e. right brain procedures and targets for left field loss, and left brain procedures and targets for right field loss). All patients must have binocular stimulation, early and as much as possible. Bi-nasal occlusion helps to stimulate bilaterality. Yoked prism is sometimes used based on the patient's response to trials. This can be a powerful tool to break through dense neglect. Visual field stimulation must address more than a few degrees in one direction at one distance to be effective.

The most basic visual field stimulation is motion detection. This is a primitive system seen in all animals. Human motion detection is a combination of subsystems; reverse motion and spatial frequency.[1] Akinetopsia is the loss of motion detection. These cases are rare, and the patient sees the world as a series of still frames.

First order motion perception is a series of still images that are perceived as moving. Second order motion detection is moving contrast or flicker. The greater the area of stimulation the more the brain is stimulated. Adding search targets creates a cognitive demand as well as an ocular motor task. Using anaglyphs forces binocular/bilateral input.

Movement through the environment produces deformations of the optic array, commonly referred to as the optic flow field. The computation of optic flow is fundamental for orientation and visual navigation in three-dimensional space, for the perception of object movement, for stabilizing the visual world and for the control of posture and locomotion.[2]

Moving targets combined with movement responses from the patient are most effective at stimulating visual field recovery. Contrary to generally accepted practice, there is no time limit on visual field recovery. Patients decades out from their neurological trauma have demonstrated visual field recovery.

In one UK study of 915 stroke patients 52% had visual field loss and 10% had no symptoms. Of the patients with visual field loss half had difficulty reading, blurry vision, diplopia, ocular motor and perceptual problems while half complained only of their peripheral vision loss. At followup 15 patients (7.5%) had full recovery, 78 (39%) had improvement, and 104 (52%) had no recovery. Two patients (1%) had further decline of visual field. Patients with visual field loss had lower quality of life scores than stroke pa-

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tients without visual impairment and patients with homonymous hemianopsia had worse overall prognosis for recovery.[3]

Despite proof of neuro-plasticity the prevailing standard of care maintains that visual field recovery is not possible.[4] Patients are encouraged to learn compensatory strategies at best and to make lifestyle adjustments to avoid visually challenging tasks.

Visual field loss is estimated at 1:20 community dwelling elderly people and is associated with many functional impairments including difficulty reading, watching TV and increased risk of falling. In patients over 85 the incidence is closer to 1:6. In one study in Rotterdam, Netherlands, glaucoma was the leading cause of visual field loss followed by other optic nerve disease and stroke.[5]

Neuro-optometric rehabilitation has demonstrated that visual field recovery is possible. Anecdotal reports are strong but research is needed, even patient reports demonstrating recovery for significant numbers of patients, to demonstrate the efficacy of therapeutic intervention.

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2. David C Burrab, Large receptive fields for optic flow detection in humans.Vision Research, 1998 June; 38(12)

3. Fiona J. Rowe, A Prospective Profile of Visual Field Loss following Stroke: Prevalence, Type, Rehabilitation, and Outcome. Biomed Res Int. 2013; 2013: 719096. Published online 2013 Sep 9. doi: 10.1155/2013/719096

4. A L M Pambakian, C Kennard, Can visual function be restored in patients with homonymous hemianopia? http://dx.doi.org/10.1136/bjo.81.4.324

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Activity: Chalkboard Activities

Purpose: To encourage binocularity, peripheral awareness, and hand-eye coordination.

Procedure: Place Numbers or letters in different spaces of a divided square on the chalkboard. Height should be so that the patient's nose is on the level with the center of the line.

| | | | |
|---|---|---|---|
| A | B | C | D |
| E | F | G | H |
| I | J | K | L |
| M | N | O | P |

The trainer calls out a number or letter and the patient should look at the letter or number called out without moving his head.

1. Do this with one eye covered, then with the other eye covered.
2. Holding a pointer or flashlight, point to and look at the figure called at the same time.
3. Hold a 3 x 5 card between the eyes. This should give the right eye a view of the right side of the board and the left eye the left view of the board.

Bimanual Circles:

Place an X mark at nose level on the chalkboard. Draw two twelve inch circles on either side of the mark. While looking at the X, the patient should attempt to trace over the circles with a piece of chalk held in each hand. Hands should move

1. Clockwise
2. Counter-clockwise
3. Both hands toward the X
4. Both hands away from the X

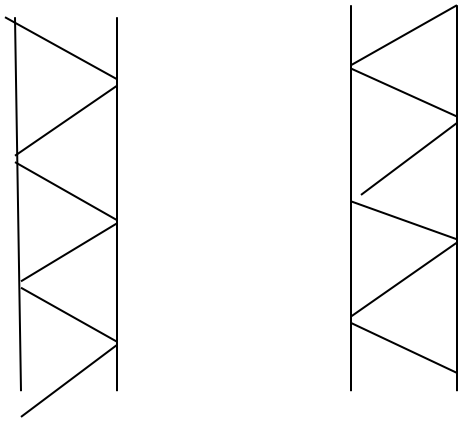
Clock:

Draw a large circle about 12-15 inches in diameter. Place the twelve digits of the clock's face in their proper positions and a small circle in the center. The patient

will take a piece of chalk in each hand. Next the patient will select two numbers such as 3 and 9, and simultaneously draw from each number to the center of the circle (bull's eye) and in the same continuous movement go from the center circle out to the same numbers. Do this for ten movements. Next select two more numbers and continue with the same procedure until all the numbers are used.

Vertical Lines:

Place an X at nose level on the chalkboard. Draw a set of vertical lines equal distance on each side of the X. The furthest line should be two or three inches within the reach of the patient. With a piece of chalk in each hand the patient will simultaneously draw a horizontal line from the outer vertical lines to the inner vertical lines. The patient keeps his eyes fixated on the X and should be aware peripherally of where he is moving the chalk. The lines should go back and forth and stop at the vertical lines each time. Each line should dip slightly from the one above so they do not overlap.



Activity: Flashlight Chase (Binocular Rotations)

Purpose: To aid in the development of ocular mobility and eye-hand coordination

Procedure: 1. The instruction and the patient hold a flashlight. Both stand and face a blank wall 5-6 feet away

2. To orient the patient, the instructor begins by moving the flashlight around in a circle. The patient is instructed to keep his beam on top of the instructor's light.

3. After the patient has become familiar with the procedure, the instructor may move the light in any direction, while the patient attempts to keep his light super-imposed over the instructor's.

4. The instructor may make numbers, geometrical figures, or letters with his flashlight and ask the child to identify, as well as follow with his eye and flash-light. Ask the patient to think up a game using the two flashlights to improve his eye movements.

Note: The patient should keep his head still, not to cut corners and try to make smooth eye movements.

Time: 10 minutes per day, stopping when fatigue is evident

Home therapy procedure: Can Roll

This procedure will require using both hands at the same time while following them with your eyes.

You will need a flat horizontal surface and 2 cylinders the same size. You can use cardboard tubing, cans or a wide roll of tape in place of a can. For patients will difficulty moving both hands, a rolling pin can be substituted.

With your elbows near your sides, place your hands one on each cylinder. Roll them away from you and back towards you, reaching as far out as you can. Try to move both hands at the same speed. If this is hard to judge, put strips of masking tape across the surface perpendicular to your arms so that you can reach each line at the same time. Now bring your hands back at the same time. Go out and back 10 times. Practice this 2 times daily.

When you have enough arm strength, you will do the same procedure up against a wall. Try rolling with both hands up the wall and back down to where you started. Do this 10 times, 2 times each day, watching your hands to see how high you can roll them. If it is fatiguing, start with 2 times, twice daily, and work up slowly until you can roll the cylinders up 10 times.

Activity: Matching Bilateral Motor Activity

Purpose: To break up motor patterns where one side of the body can only follow the other.

Materials: Two light weight hard cover books and two chairs.

Procedure I: Stand or sit opposite the patient and about eighteen inches apart so that you face each other. Have the patient raise both hands with the palms facing you.

Place a thin, light weight book (or piece of thick cardboard) against the patient's right hand and keep it in place with your left hand. Do not allow your or the patient's fingers to grip the book. The only thing that keeps the books from falling is the pressure of both of your hands on the opposite side of the book.

Explain to the patient that you are going to move your hand, and he has to move with you to keep the book from falling. *Slowly* move your hand in a circle. The patient must move his hand to keep the book from falling. After one minute, switch to your other hands and try this again. The hands not being used should be kept still.

Procedure II: Move both hands *at the same time* using different movements on each. One example would be the left hand going in a circle while the right hand would be going up and down.

Usually the patient does not have the same reach as an adult. If you extend your hands too far, he will not be able to reach.

Time: 5 minutes

Ambient/Focal Reintegration Therapy

The patient should be seated in a chair with a back and arms.

Start with both arms extended in front of you with your hands fisted and your thumbs extended upward. This will be the hand position for the first series of procedures. When starting a new procedure, practice sitting to be certain that you will not have problems with balance and fall while doing this. When you can safely stand and follow the movements, practice again standing.

1. Keep the left arm in position while slowly moving your right arm out to your right in an arc. Move your arm slowly, and keep looking at your extended thumb. The room beyond it will appear to be moving, and may make you uncomfortable. Follow your right thumb by moving your head. If you start to feel uncomfortable, stop and slowly bring the right thumb back next to the left thumb. Keep your extended arms at shoulder level.

Now hold your right arm extended while following your left thumb in an arc to your left. If this gets uncomfortable, stop and return the left arm to the starting position.

Repeat this 5 times on each side. Stop and relax your arms by shaking them out as needed. If one arm is too weak to hold up and move, ask someone to assist you by holding your arm up and moving it for you.

Note the following:
How far can you turn your head before this gets uncomfortable?
Can you go further on one side than the other?
Does this get easier or more difficult as you work?
Can you keep your arms level?
Can you keep one arm still while moving the other arm?

2. Start with the same arm position with your thumbs pointing towards each other. Slowly raise the right arm while looking at your thumb and following the movement with your head. Go as far as you can while holding the left arm in position. When you get uncomfortable stop and bring your right arm down.

Now hold your right arm in position while following your left thumb down. You will have to

stop when your thumb hits your lap. Then follow the thumb back up in to alignment with your right thumb.

On the second cycle, go up with your left thumb and down with your right thumb.

Do 5 cycles of up and down.

Note the following:
How far can you move your head before this gets uncomfortable?
Can you go further following one hand than the other?
Does this get easier or more difficult as you work?
Can you keep one arm still and level while moving the other arm?

3. As these procedures become easier, practice them standing.

Practice the procedures (laterally and vertically) standing until you have a good range of motion and arm control while standing. Then move on to the following procedures:

4. Use the same starting position. Slowly move your right arm in a circle going clockwise. Practice with small circles, about 12 inches in diameter, while following your thumb with your head movement. After 5 rotations, stop and switch to your left arm. Repeat the procedure making counter clockwise circles with your left arm, following your thumb with your head.

5. When the step above is easy, increase the size of your circles to 24 inches. Keep the other hand still and in position while the opposite arm is moving. Keep looking at your thumb.

6. Go back to small circles but in the opposite direction.

7. Increase to large circles.

8. Pick a spot across the room in line with the top of your extended thumbs. This time you will keep your head still. Keep looking at your fixation spot while moving both hands in small circles. The right hand will move clockwise, and the left hand counter clockwise. Make sure you can see both thumbs moving at all times.

9. Practice the same procedure with larger circles.

10. This will require you to move both hands in small circles, while following one with your head and eyes. Start making small circles with both hands in front of you as in step 8. Move your head to follow the right thumb for one rotation, starting where your thumbs are side by side. When you reach the starting point again, switch and follow your left thumb for one rotation. Go back and forth for 5 cycles tracking both thumbs.

As this becomes more consistent, do 5 cycles and then switch directions with both hands and do 5 more cycles.

11. Hold your arms out directly in front of you so that they are shoulder width apart. With hands fisted and thumbs extended upward, start making small (12 inch diameter) circles going clockwise with both hands at the same time. Follow your right thumb for 5 circles, then switch to your left thumb for 5 circles. Now reverse directions and repeat.

12. Practice procedure 11 with larger circles (24 inch diameter). Start with clockwise circles following one hand and then switching to the other for 5 cycles. Then go to counter clockwise circles.

The next set of procedures should not be practiced until all of the preceding activities can be done standing without significant discomfort. These will require a clear place to walk slowing without obstacles.

13. Start with your arms extended in front of you, hands fisted and thumbs up. Step forward with your right foot and swing your arms straight out to your sides with a slow steady motion, so that they are straight out from your shoulders. Now step forward with your left foot and bring them back together in front of you. Walk at least 10 steps forward while your arms swing in an arc from in front of you to your sides and back. Then turn around and walk back the other way. Practice 5 cycles of 10 steps, turn, and 10 steps.

14. When you can do number 13 easily, go forward 10 steps; stop, and now walk backward 10 steps using the same arm movements. As you step back with your right foot your arms will swing out, and as you step back with your left foot your arms will swing together.

15. Do not attempt this until you can do all of the above procedures without significant discomfort.

Stand with your arms extended in front of you and your thumbs up. As you step forward with your right foot, slowly swing your arm to your right in a level arc and follow this movement with your head. When your left foot comes forward swing your arm back to the front, and follow the movement with your head. If this is difficult, start by only swinging your arm and head in a short arc, about 12 inches. Walk at least 10 steps. Now turn around and come back, using your left arm to guide your head and eyes. Slowly increase the length of the arc as you are able.

Is it easier to track to one side than the other? If there is a significant difference between your ability to track to your left or right, please let Dr. Benshir, Dr. Haque or Sam Benshir know. If the difference is minimal, keep practicing until you have a wide range of movement, at least out to the side looking over your shoulder, on both sides. If possible, walk slowly and try to turn even further than your shoulder.

Activity: O.A.T. Squares

Purpose: To develop directionality, visualization, sequencing, and auditory visual integration.

Procedure: This game can be played by a group of patients, or with two patients. It can either be played on a chalkboard or with a paper chart. The chart consists of four rows with four numbers in each row, (1-16). As skill improves, the chart can be made harder by leaving out some numbers or by adding more rows of numbers.

| | | | |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 |
| 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 |

| | | | | |
|---|---|---|---|---|
| 1 | | 3 | | 5 |
| | 7 | | 9 | |
| 11 | 12 | | 14 | |
| | 17 | 18 | | 20 |
| 21 | | | 24 | |

This “game” involves giving and responding to directions. Hang the chart on the wall. One person should start by asking the other a directional question. An example might be: If you start at ten and go right two spaces, where would you be? The players take turns using this format with one or two directions.

Next try a more complex series of questions, such as “if you start at five and go down two spaces, then right two spaces, then down one space, where would you be?” Increase the number of directions according to the patient’s ability to follow consistently. If they find this too easy start adding more steps and require the patient to repeat the directions as well as reporting the final location. As skills improve, diagonals can be introduced. Be very clear and state, “diagonally down to the right,” or what ever combined direction you mean.

O.A.T. Squares

| | | | |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 |
| 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 |

# MIRROR WALK

**Purpose:** This activity is designed to stimulate peripheral vision in a missing field. It will also stimulate simultaneous awareness of focal and ambient information.

**Caution:** Practice this therapy procedure with supervision to prevent falling. Ask your physical therapist or neuro-optometrist before trying to practice this alone.

You will need a hand mirror and an area where you can walk forward and backward safely for at least 20 feet. Clear the area of any obstacles before starting. If you are working in a hallway without any visual details, place colored sticky notes with numbers written on them on the wall at various heights on the side where you are missing vision. Use brightly colored notes, not pale colors. Pieces of construction paper or can be taped to the wall if you need larger targets. Use at least 10 targets placed at variable heights every 2 feet. More targets can be used as this procedure becomes easier. Your aide should be walking close to you on your good side, ready to hold you if you become unsteady. Ask your physical therapist if you should be wearing a gait belt.

1. Stand in the center of the hallway, with the mirror held against your nose perpendicular to your face. The mirror should be facing right. If you look into the mirror you will see the wall on your right side.

2. Look straight in front of you down the hall. Can you still see images in the mirror? If not, tilt the mirror slightly towards you so that you do see those images at the same time as you see in front of you.

3. Take a slow step forward. Do you see images in the mirror moving?

4. Walk slowly down the hallway. Do you see the mirror images at the same time? Do you see movement in the mirror? Can you identify what you are seeing in the mirror?

5. Go back to the beginning position. Now walk down the hallway, trying to see and name the colors and numbers as they come into view in the mirror.

6. Change the direction of the mirror so that it is facing your left. Repeat the same procedures.

7. As this gets easy and your balance is judged adequate, go forwards and then backwards up and down the hallway.

Practice at least 5 minutes, twice daily. As your agility improves, this procedure can be practiced for up to 15 minutes at a time, 2-3 times daily.

**Patients who cannot walk should be pushed in a wheelchair.**

# Peripheral Awareness with Mirror

In addition to visual field loss, many patients suffer from neglect: the brain is not aware of one side of the body or even the world on that side. Mirrors can be used to make the patient aware of what they are not seeing, what they should be seeing, and where they are seeing.

A large mirror is needed for this procedure. It should be at least 15 inches wide, preferable wider, and at least 30 inches high. The patient must be able to see at least the top half of his body in the mirror. If possible, the patient should use a full length mirror or other large mirror. The patient may be sitting or standing.

1. Start with the patient in front of the mirror, looking at himself. What can he see? Looking at his face can he see both eyes? Both ears? Are any parts of his face missing? Can he point to them? Now look at both shoulders. Can he see both at the same time? If not, what does he have to do to see each shoulder? Can he see both hands? Does anything disappear? What makes things disappear and come back? If possible, raise both hands at the same time. Can you see them both? If you are in front of a full-length mirror, can you see both feet? Look at your face. Can you still see both hands and feet? If not, try moving the part that you cannot see. If your left hand does not seem to be there in the mirror, wiggle the fingers on your left hand. If you can't move your hand, have someone else move your hand for you.

2. Put stickers or small sticky notes around the edges of the mirror. These should be at the corners, top, bottom, and sides. If the mirror is large enough, put multiple markers across the top and bottom and down both sides. Start at the top left corner. What can you see? Is anything missing? Look at the top right corner? Can the patient still see all of his face and body? If anything is missing, go back to the center-top marker and work from side to side. Make note where the patient can see his whole face and where he cannot.

3. Start at the top left corner and number the stickers down both sides going back and forth across. The patient will start at number 1, make sure he can see himself with no missing pieces. Now go to 2, and check for anything missing. Now go back and forth down the sides from left to right, making certain that the patient can see himself from either side of the mirror. At some number is there a blind spot or parts of his body disappear? Make note of this.

4. When all of this is fairly consistent, start looking for other objects in the mirror. Can you tell what they are and where they are? Can you estimate how far from you they are? In what direction?