Concussion/mTBI Lab – Vision Assessment and Treatment

The purpose of this lab is to introduce assessment of the vision and vestibular systems and teach ideas for treatment of mild traumatic brain injury.

The instructions for each station are included here. Please read them over prior to the lab to prepare. At each station practice the assessment skills and treatment ideas on each other.

Lab Room #1 – Vision Assessment

Ocular Alignment:

Ocular alignment is crucial to the coordinated function of both eyes and visual processing in general. The term used for the condition in which the eyes are misaligned is called *strabismus*.
The 3 most common types of strabismus are:

1. esotropia (eyes turning in)
2. exotropia (eyes turning out)
3. hypertropia (one eye turns up or down).

Cover Test:

Procedure:

1. Head straight with no head turn or tilt and with the chin not elevated or depressed.
2. Have the patient look at a close target (ie a pen tip or small metal ball on a stick)
3. Cover one eye with your hand or a paddle and remove it to the side of the face. Perform this action 2 or 3 times. Does the eye move as it is uncovered? If the eye moves in (exotropia), out (esotropia), up or down (vertical) or has no movement (ortho), then note this.
4. Try the same technique on the other side. What happens on this side?
5. If both eyes show no movement, then there is no strabismus. If one eye moves, then it is that side that has strabismus. If both eyes move, then the test is incorrect or there is an alternating strabismus.
6. Try the same technique with a distance target. Evaluate the eye movements the same way as in the near test.

Visual Midline Shift Syndrome:

Padula Midline Shift Test:

Procedure:

1. Stand to the side of patient on an angle and ensure the patient does not have an object in front of their face to orient themselves to midline.
2. Patient to keep face looking straight ahead but eyes follow a wand as you move it across their vision at a consistent speed. Hold patient's head steady if necessary
3. Patient tells you to stop when the wand is directly in front of their nose.
4. Check left to right, right to left, anterior to posterior and posterior to anterior.
5. Draw a line on diagram representing patient's midline

UPMC Vestibular/Ocular Motor Screening (VOMS) for Concussion

Vestibular/ Ocular Motor Test:	Not Tested	Headache 0-10	Dizziness 0-10	Nausea 0-10	Fogginess 0-10	Comments:
BASELINE SYMPTOMS						
Smooth Pursuits						
Saccades- Horizontal						
Saccades- Vertical						
Convergence (Near point)						Near point in cm: Measure 1: Measure 2: Measure 3:
VOR-Horizontal						
VOR- Vertical						
Visual Motion Sensitivity Test (VOR Cancellation)						

Instructions:

Interpretation: This test is designed for use with subjects ages 9-40. When used with patients outside this age range, interpretation may vary. Abnormal findings or provocation of symptoms with any test may indicate dysfunction- and should trigger a referral to the appropriate health care professional for more detailed assessment and management.

Equipment: Tape measure (cm); Metronome; Target with 14 font print

Baseline Symptoms- Record: Headache, Dizziness, Nausea & Fogginess on 0-10 scale prior to beginning screening

- **Smooth Pursuits-** Test the ability to follow a slow moving target. The patient and the examiner are seated. The examiner holds a fingertip at a distance of 3 ft from the patient. The patient is instructed to maintain focus on the target at the examiner moves the target smoothly in the horizontal direction 1.5 ft to the right and 1.5 ft to the left of midline. One repetition is complete when the target moves back and forth to the starting position, and 2 repetitions are performed. The target should be moved at a rate requiring approximately 2 seconds to go fully from left to right and 2 seconds to go full from right to left. The test is repeated with the examiner moving the target smoothly and slowly in the vertical direction 1.4 ft above and 1.5 ft below midline for 2 complete repetitions up and down. Again, the target should be moved at a rate requiring approximately 2 seconds to move the eyes fully upward and 2 second to move fully downward. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. ***(Figure 1).***

- **Saccades-** Test the ability of the eyes to move quickly between targets. The patient and the examiner are seated.
    - **Horizontal Saccades:** The examiner holds two single points (fingertips) horizontally at a distance of 3 ft. from the patient, and 1.5 ft. to the right and 1.5 ft. to the left of midline so that the patient must gaze 30 degrees to left and 30 degrees to the right. Instruct the patient to move their eyes as quickly as possible from point to point. One repetition is complete when the eyes move back and forth to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. ***(Figure 2).***

    - **Vertical Saccades:** Repeat the test with 2 points held vertically at a distance of 3 ft. from the patient, and 1.5 feet above and 1.5 ft. below midline so that the patient must gaze 30 degrees upward and 30 degrees downward. Instruct the patient to move their eyes as quickly as possible from point to point. One repetition is complete when the eyes move up and down to the starting position and 10 repetitions are performed. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. ***(Figure 3)***

- **Convergence-** Measure the ability to view a near target without double vision. The patient is seated and wearing corrective lenses (if needed). The examiner is seated front of the patient and observes their eye movement during this test. The patient focuses on a small target (approximately 14 point font size) at arm's length and slowly brings it towards the tip of their nose. The patient is instructed to stop moving the target when they see two distinct images or when the examiner observes an outward deviation of one eye. Blurring of the image is ignored. The distance in cm. between the target and the tip of the nose is measured and recorded. This is repeated a total of 3 times with measures recorded each time. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. Abnormal: Near Point of Convergence ≥ 5 cm from the tip of the nose. ***(Figure 4)***

- **Vestibular-Ocular Reflex (VOR) Test-** Assess the ability to stabilize vision as the head moves. The patient and the examiner are seated. The examiner holds a target of approximately 14 point font size in front of the patient in midline at a distance of 3 ft.
    - **Horizontal VOR Test:** The patient is asked to rotate their head horizontally while maintaining focus on the target. The head is moved at an amplitude of 20 degrees to each side and a metronome is used to ensure the speed of rotation is maintained at 180 beats/ minute (one beat in each direction). One repetition is complete when the head moves back and forth to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. ***(Figure 5)***.
    - **Vertical VOR Test:** The test is repeated with the patient moving their head vertically. The head is moved in an amplitude of 20 degrees up and 20 degrees down and a metronome is used to ensure the speed of movement is maintained at 180 beats/minute (one beat in each direction). One repetition is complete when the head moves up and down to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. ***(Figure 6).***

- **Visual Motion Sensitivity (VMS) Test (VOR Cancellation)-** Tests visual motion sensitivity and the ability to inhibit vestibular-induced eye movements using vision. The patient stands with feet shoulder width apart, facing a busy area of the clinic. The examine stands next to and slightly behind the patient, so that the patient is guarded but the movement can be performed freely. The patient holds arms outstretched and focuses on their thumb. Maintaining focus on their thumb, the patient rotates, together as a unit, their head, eyes and trunk at an amplitude of 80 degrees to the right and 80 degrees to the left. A metronome is used to ensure the speed of rotation is maintained at 50 bpm (one beat in each direction). One repetition is complete when the trunk rotates back and forth to the starting position, and 5 repetitions are performed. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. ***(Figure 7).***

Figure 1. Smooth Pursuits

Figure 2. Horizontal and Vertical Saccades

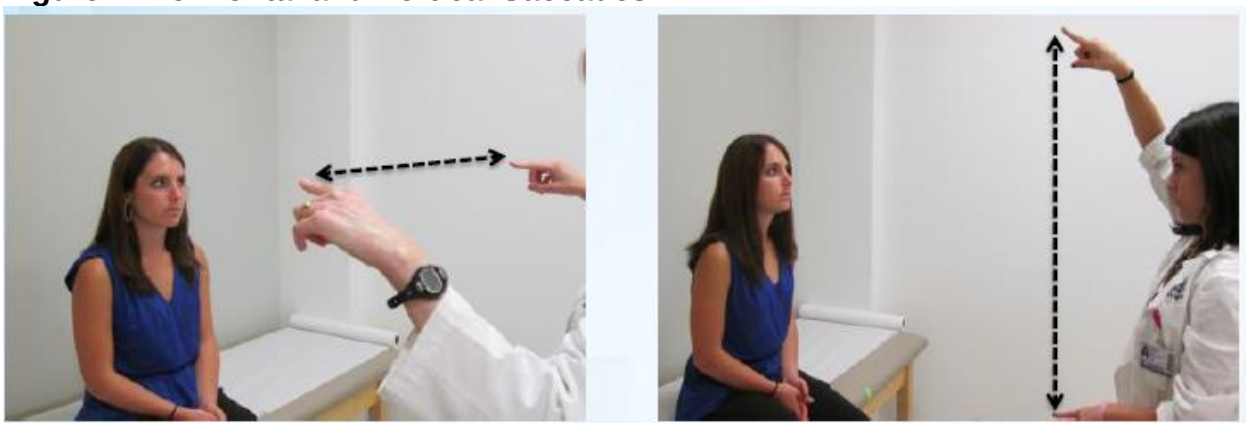


Figure 3. Near Point Convergence (NPC) Distance

Figure 4. Vestibular-Ocular Reflex (VOR): Horizontal and Vertical

Figure 5. Visual Motion Sensitivity (VMS)/ VOR Cancellation

Mucha A, Collins MW, Elbin RJ, Furman JM, Troutman-Enseki C, DeWolf RM, Marchetti G, Kontos AP. A brief vestibular/ocular motor screening (VOMS) assessment to evaluate concussions: preliminary findings. Am J Sports Med, 2014, 42(10): 2479-86.

Lab Room #2 – Vision Rehab Strategies

Binasal Occlusion

Purpose: to remove portion of our vision where the images from the two eyes overlap; this reduces visual 'background' noise. To help our eyes to work independently, rather than struggling with working together. Our brains tend to focus on the overlapping part of the images that are misaligned, that it can't focus on anything else.
Also, eliminating portions of central focal vision causes our spatial visual system to kick in and do some of the work.

Materials Required:

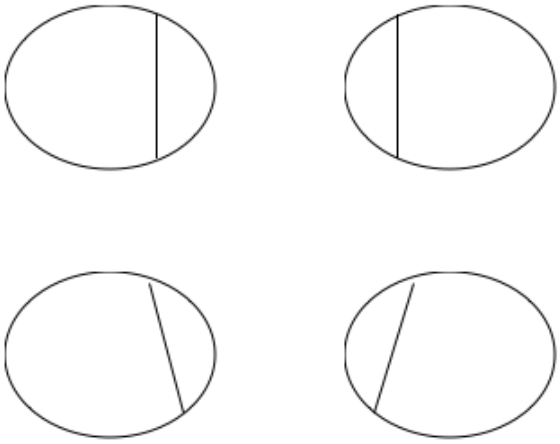
- Dollar store frames, with lenses popped out; or the patients' own reading/regular glasses.
- Opaque scotch tape (cloudy); transpore tape works well.

Step 1: Have the patient read something out loud without tape on the glasses.

Step 2: Apply tape to glasses, approx. 1cm on either side of the nose. Tape may be angled slightly (thicker at top) to facilitate.

Step 3: Have patient read again, see if there is a change. Ask patient to report any differences in the clarity of the images they see.

Step 4: Try reading with a blinder and coloured overlays to see if that is easier.



Eye Tracking Exercises

Purpose: To practice eye movements and following a target to improve efficiency of eye movements.

Starting Position: Sitting comfortably in a chair with back supported.

Exercise: Hold onto a pen or a popsicle stick or just use your finger as a visual target. Hold it out at arm's length and move it right and left and up and down in an 'H' pattern. Do this as slowly as you need to in order to keep your eyes on the target and the target in focus.
How to make it easier: Perform task lying flat on your back, start training with one eye covered and progress to using both eyes at once. Make sure the visual environment in front of you is as minimal as possible, wear a weighted compression vest.
How to make it harder: a) move target more quickly, b) add diagonal movements and circular movements (both directions), c) add a balance task such as standing on one leg, in tandem stance, on a cushion, d) add noise distractions in the background

Near Far Accommodation

Purpose: To improve speed and efficiency of focusing on objects both near & far in combination with auditory processing.

Starting Position: Can be done in sitting or standing. Hold a page with vertical line of letters and place same page on the wall about 12-20 feet away at eye level.

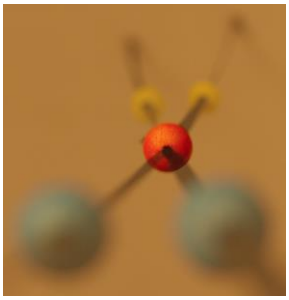
Exercise: Set a metronome to 50-60 bpm with 2/4 timing and try to complete this task to the beat of the metronome. Keeping head still shift eyes down to paper in hand and say first letter at top of page. Then shift eyes to paper on wall and find and say the same letter. Move eyes back down to the page in your hand and say the next letter below and then back up to the wall. Continue repeating this task to the beat of the metronome moving vertically down the page.
Progression: Increase the speed of the metronome up to 120 bpm, increase the amount of letters on the page, stand on one leg or in tandem stance, or stand on unstable surfaces.

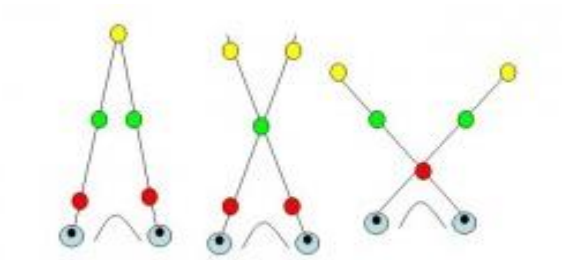
Brock String

Purpose: The Brock string is commonly used during treatment of **convergence insufficiency** and other anomalies of binocular vision. The Brock String is used to develop skills of convergence (eyes pointing inwards to bring an object into focus) as well as to disrupt suppression of one of the eyes (one eye will not move inwards because the eyes aren't working well together).

Starting Position:
A **Brock string** consists of a white string of approximately 3-10 feet in length with 3-6 wooden beads of different colors located at different distances along the string.
One end of the Brock string is held on the tip of the nose while the other is tied to a fixed point or held by a therapist String should be taught, and pointed slightly down. The patient is asked to focus on the closest bead; it will be in focus, and there will only appear to be one bead. All other beads along the string will be doubled. It will appear as though the string is making a 'Y'. Patients will then shift the

focus to the next bead along the string; now the original bead will be double, the bead in focus will be single, and the rest behind the focal bead are going to be double too. Now the string will take on an 'X' like appearance with the focal bead being where the two lines of the "X" intersect.
Techniques may be made more difficult by bringing the beads closer to the nose and by employing lenses and prisms.





Percon Saccade Training

Purpose: To increase ability to move eyes efficiently across a page of text in preparation for reading. To integrate sound with vision and hand movements.

Starting Position: Sitting comfortably in a supported chair

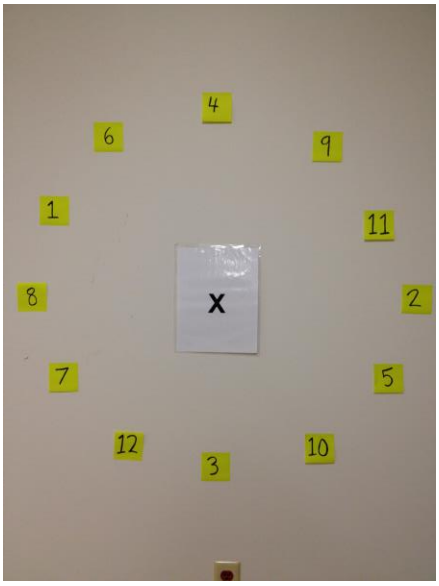
Equipment: percon saccade sheets in a clear, plastic sleeve, dry erase marker, metronome (can use a website or an app on smartphone)

Exercise: Set metronome to 60 beats per minute (bpm). At each beat of the metronome touch the marker to a dot on the sheet moving left to right for each square. Once able to complete this easily and accurately then increase the speed of the metronome until you can complete it at 120 bpm. After completing 120 bpm, move to the next sheet in order of level of difficulty. Decrease speed of metronome to the speed you can easily and accurately perform each time you start a new sheet then progress back up to 120 bpm.

Order of Sheets:

1. 4 stars
2. 3 stars
3. 2 stars
4. Scattered 2 stars
5. Scattered 3 stars
6. Single letter
7. 2-3 rows of letters
8. Full lines of letter
9. Scattered double letters

Wall Clock Saccades



Purpose: To practice quick movements of the eyes in all directions.

Starting Position: Stand in front of a wall. Place 12 visual targets (post it notes work well) in a circle like a clock. Place an X in the middle of the clock.

Exercise: Move your eyes as quickly as you can from each post it note to the centre X moving in a clockwise and then counter clock wise direction.

How to make it easier: Perform task sitting down in chair with back supported, wear a weighted compression vest.

How to make it harder:
a) Add a balance task such as standing on one leg, in tandem stance, on a cushion.

b) Replace the X in the centre with numbers in circle worksheet. Move your eyes around the clock again but when you bring your eyes to centre find the numbers in order from 1–12 with each eye shift. Do this counter-clockwise from 12-1.

c) Replace the X in the centre with the Multicoloured numbers worksheet from 1-24. Move eyes clockwise from 1-12 o'clock when you shift to the centre worksheet find the number that is double. (ie, 3 o'clock = find # 6, 11 o'clock = find #22)

d) Change the numbers on the wall clock so they are not in order and repeat b) & c).

Lab Room #3 – Visual/Vestibular Integration Exercises

Padula Cube

Purpose: To improve the ability to shift spatial relationships and release from fixation.
Starting Position: Sitting or standing with Padula Cube placed on wall at eye level.
Exercise: Patient keeps a soft focus on E in centre of chart. Ask them what square is forward red or green. Ask them if they can flip it so that the opposite colour is forward. Then see if they can flip it back. They should try to do this task without blinking to make it flip. If they are having trouble then ask them to work on releasing one colour and allow the opposite colour to come forward. If they still have trouble use your finger to trace the colour you want to move forward.
Progression: decrease base of support, stand on unstable surfaces, time the flip with the patient's breathing pattern, throw and catch a ball on the wall and make the cube flip with each throw.

VOR Exercises

Purpose: To train the Vestibular Ocular Reflex to be able to navigate more efficiently in the environment and during tabletop tasks.
Starting Position: Have patient sit in a firm chair with back support for increased sensory input. Head should be tilted down about 20 degrees. This activity can be progressed to sitting unsupported, then standing. Patient should be positioned about 3 feet from target. The target should be smaller print like a business card.
Exercise 1: *Substitution Exercises:* Have 2 targets on wall that are at eye level about 2 feet apart. First move eyes to left target, maintain eyes on target and then move head to face the target. Then moves eyes to the right target followed by the head. Repeat for 30-60 seconds as tolerated.
Progression: Increase speed when changing between targets. Can also do this with targets lined up vertically so patient is looking up/down.
Exercise 2: *VOR Exercises:* Place one target on wall at eye level. While keeping eyes on target and *target in focus*, the patient should rotate head left and right at a consistent speed. A metronome can be used to help this up to a maximum of 120 bpm. Stop once they are unable to maintain eyes steady and target in focus. (this is often a very provoking exercise so use caution)
Progression: Can also move head up/down. Try to increase time patient can perform exercise, increase speed (~2 Hz maximum) Change base of support so that patient is sitting or standing on uneven surfaces. Hold target at arms length, move target the opposite direction of head movements.

Rainbow Bean Bag Toss

Purpose: To help the eyes move separately from and together with the head. Improves visual/vestibular integration. This is a good exercise to do in preparation for reading.
Starting Position: Sitting or standing with a bean bag or small ball held in one hand. Repeat each exercise 10 times.
Exercise:
Step 1: Keep head still and eyes on the bean bag. Keep the bean bag in line with the centre of your body and gently toss the bean bag up in the air and catch it. Follow the path of the bean bag with your eyes.
Step 2: Repeat task from step 1 but move eyes and head together to follow the path of the bean bag.
Step 3: Keeping head still and eyes on the bean bag. Lightly throw the bean bag from one hand to the other in the shape of a rainbow. Your eyes should follow the path of the bean bag. Take your time when throwing the ball.
Step 4: Repeat task from step 3 except move head and eyes together to follow the path of the bean bag.

Ball Tracking

Purpose: To work on balance while focusing on a moving target and trying to engage the spatial visual system. Improves visual/vestibular integration.

Starting Position: Standing with a medium size ball held in both hands.

Exercise: Raise ball up in both hands to eye level, maintain focus on ball and follow ball with eyes and head. Keep ball in left hand and bring arm out to the side while still looking at the ball. Bring back to centre and repeat with right arm. Encourage patient to use peripheral system to help maintain balance.

Progression: Same activity but standing on one leg, using an Airex mat, standing on a BOSU. Track ball up overhead or using diagonal movements. To make activity more dynamic do forward lunges while tracking ball up overhead and then down and to the side.

Walking and Looking

Purpose: To be able to walk and move head and eyes without symptoms of dizziness or unsteadiness.

Starting Position: Standing in a space where the patient can walk in a straight line without bumping into anything.

Exercise: Have patient walk at a comfortable pace. Start by having them move eyes right/left or up/down either at your instruction or at their own pace while *maintaining their walking speed* then progress to moving head and eyes together to look right/left or up/down.

Progressions: walk beside patient and throw and catch a ball, add a cognitive task like counting backwards by 3's, increase walking speed, do task on the treadmill, move head diagonally (up & left/down& right). If task is too difficult then try with theraband compression and walk more slowly.

Walking and Turning

Purpose: to be able to efficiently turn and negotiate the environment.

Starting Position: Standing

Exercise: Have a patient walk forward and at your instruction make a 180 degree turn. The turn should be initiated with the eyes and head as practiced in the Blind Spot Check. Practice turning right and left and walking smoothly in and out of the turn.
Progression: Have patient do a 360 degree turn, have them navigate smoothly around obstacles using their peripheral vision, add a cognitive task such as talking or counting.

Infinity Walk

Purpose: To be able to walk and turn body and head without symptoms of dizziness or unsteadiness.

Starting Position: Standing in front of a wall with a target taped to the wall at eye level. Leave enough space to walk in a figure of 8 without hitting anything.

Exercise: Walk at a comfortable but continuous pace. Look at visual target on the wall. Walk in a sideways figure of 8 or infinity symbol (see picture below) while maintaining visual target. When you are turning around bring head and eyes back to the target as quickly as possible. Repeat several times as symptoms allow.

Progressions: add a cognitive task like counting backwards by 3's, increase walking speed, use the Padula cube and try to flip from red to green, increase the visual complexity of the target or add background noise for distraction. If task is too difficult then try with theraband compression or a compression vest and walk more slowly.

Visual Target