

BRAIN INJURY ELECTRONIC RESOURCE MANUAL

VOLUME I B

Traumatic Brain Injury Visual Dysfunction: Optometric Management and Advanced Topics

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Disclaimer

Recommendations made in this manual do not represent a standard of care. Instead, the recommendations are intended to assist the clinician in the decision-making process. Patient care and treatment should always be based on a clinician's independent professional judgment, given the individual's circumstances, state laws and regulations.

Section I: Assumptions and Intent

Allen Cohen, O.D.

As discussed in the Introduction Vol 1A of this manual, optometry's involvement in the overall management and rehabilitation of patients with TBI is extremely important and unique, encompassing the full spectrum of our scope of services. All doctors of optometry have the knowledge base to manage this patient population. Therefore, Vol 1 B is intended for the primary eye care optometrist as an overview of high yield optometric management protocols that are important to incorporate into the care of patients who present with visual sequelae of closed head trauma.

Optometric Visual Therapy, and more specifically Neuro-optometric Rehabilitative Therapy, is a unique, and specialized optometric service which specifically addresses the ocular health, oculomotor, visuomotor, binocular and accommodative and visual processing sequelae of TBI. It is beyond the scope of this manual to fully detail management and treatment procedures. The goal of this volume is to summarize the neuroscience foundations which support this specialty service, and more importantly, to provide the primary eye care optometrist with the awareness of the importance of co-managing this population with their colleagues who provide optometric rehabilitation visual therapy services.

Most optometric management procedures for visual dysfunction have already been described in various AOA Clinical Practice Recommendations. Where appropriate, specific topics are linked to these recommendations. Differences in technique and approach to TBI patients are noted. Other optometric management procedures have not been described in already published recommendations. These protocols are referenced and detailed in this volume.

Vol 1B also presents sections on advanced topics, sample case studies, and practice management considerations. An expanded glossary of relevant terms and complete bibliography can be found in Vol1 A.

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Section II: Optometric Management for Visual Sequelae of TBI

Allen H. Cohen O.D.

A. Introduction

Many visual symptoms/dysfunctions associated with TBI can be addressed with standard optometric modalities such as: lenses, prisms, tints, coatings, selective occlusion. However, optometric vision therapy¹ (OVT) is often necessary and the most appropriate for treating ocular motor (including fixation, ocular motility and binocular functioning), sensory motor and visual processing problems associated with TBI. The overall goals of OVT are to eliminate any diagnosed ocular motor, accommodative and binocular vision problems, and when appropriate, to add visual strategies to the treatment regimen of other rehabilitation professionals to enhance visual processing performance.

For decades, behavioral optometrists who provided OVT services reported that vision therapy improves patients' symptoms. At that time, they speculated that vision therapy induces changes in the brain.

During the 1850's, Dr. A.M. Skeffington utilized a schematic representation to define vision, which he termed "The Emergent".² This schematic representation demonstrated that one should look at the whole body and not just the eye when defining vision. He further stated that in order to be able to define vision as an "emergent", one should be able to answer the following three questions: What is it? Where is it? Where am I?

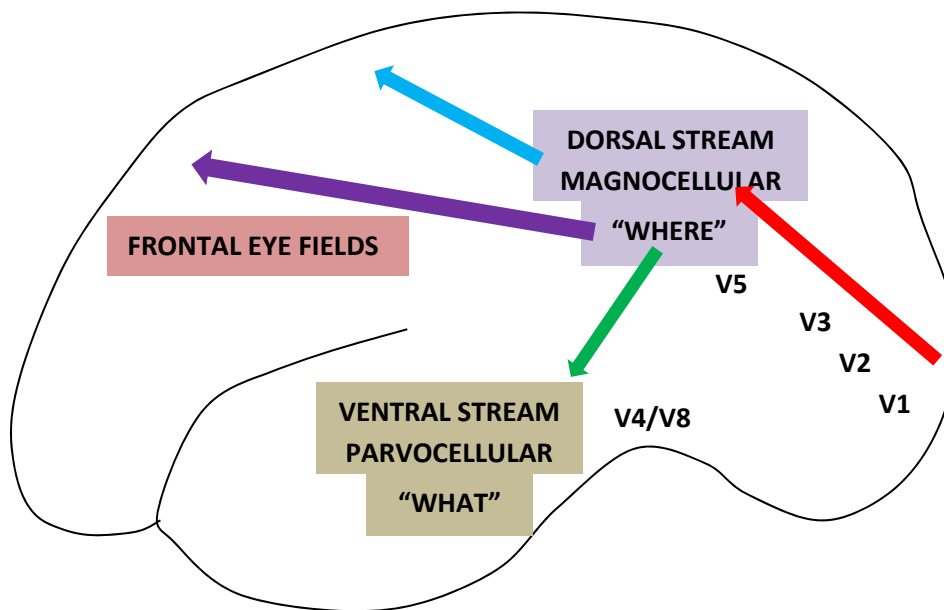
To be able to identify what an object is, one should have accurate sight, eye movements, accommodation, and visual analysis (form perception, visual-attention to detail, visual memory) skills. Efficient eye teaming and laterality/directionality are needed to perceive accurately where objects are. Auditory-visual integration and visual-motor integration are important for communicating to others what one sees or has seen and finally, normal reflexes, balance/vestibular functioning, bilateral coordination, gross motor and fine motor skills are important elements when efficiently reacting and interacting with our environment.

At the time, there was no evidence-based research to prove how this occurred or where the exact changes occurred in the brain. As advances in neuro-science research were made, contemporary research^{3,4} corroborated what optometrists have proposed over the past decades.

B. Overview of Neuroscience Research

The past few decades have resulted in an increase of neuroscience research demonstrating how rehabilitation can, through neuroplasticity⁵, facilitate neural changes⁶⁻⁸. This research, in conjunction with the existing body of knowledge regarding the use of prism lenses, tints and basic OVT protocols for the treatment of those with TBI, has provided more insight into how visual processing possibly occurs at a cortical level. Further research resulted in a better understanding of visual symptoms and deficits, allowing optometrists to apply this information in the development of more effective OVT procedures for the TBI population. Neuroscientists have demonstrated that there is the ability to modify and enhance the accuracy and speed of visual processing by affecting changes to synaptic organization in the cerebral cortex. This is commonly known as "Brain Learning" through neuroplasticity⁶. Neuroscience literature has documented many of the important tenets which influence these changes^{6,9}. Recent research in neuroplasticity has demonstrated that therapy which enhances top-down processing¹⁰ results in recovery of function and reduction in symptoms^{2,7,11-13}.

The concept of top-down processing via the dorsal and ventral streams was a major contribution to our understanding of how the brain utilizes, organizes, integrates and directs movement and sensory and intermodal information providing yet another strong foundation for OVT in brain injury vision dysfunction. Over the last several years, neuroscience research has documented that the dorsal stream (fig 1) extends from the occipital-parietal circuit and encompasses several other streams which neurologically link to pre-motor, pre-frontal, and medial temporal portions of the brain. These streams make up a major conduit for integrating the complex act of processing intermodal input with coordinated outputs. The application of this information to our knowledge base enables the optometrist to help patients with visual sequelae of TBI to function better through OVT³.



1. Occipito-parietal circuit: source for all 3 pathways, integrates information from peripheral and central visual fields (magnocellular cells)
2. Parieto-prefrontal pathway: initiation of eye movements and crucial for spatial working memory. Top-down executive control of visuo-spatial processing
3. Parieto-premotor pathway: coordinated maps of space and body position. Important for visually guided reaching and grasping
4. Parieto-medial temporal pathway: involved in encoding object centered reference frames and updating position during navigation

C. Overview of Neuro-Optometric Rehabilitative Therapy (NORT)

NORT is a unique, specialized optometric service which addresses the symptoms and deficits associated with TBI (SUNY's Post Trauma Vision Survey, Goodrich/Martinsen Delphi Study)¹⁴ by modifying classic OVT procedures based upon the knowledge from the newly understood mechanisms of top-down visual processing and studies that demonstrate neural changes after practice. Cohen¹⁵ has utilized the research of Eric Kandel⁶ on brain learning and the suggestions of Kleim⁹ in developing his model for enhancing and developing NORT procedures. Cohen refers to six components which he feels should be incorporated in all visual therapy procedures: motivation, feedback, repetition, sensory-motor mismatch, and intermodal integration^{6, 9, 15}. Each component involves some degree of top-down processing. By incorporating these components into NORT, neuro-plastic changes can be enhanced, resulting in a more effective treatment program. Each component is discussed in detail along with the associated neuroscience foundation.

1. Provide Repetition: Repetition is achieved by using several procedures which address a specific therapy goal. Therapy is performed several times per week in office and out of office.
2. Provide feedback: Feedback is achieved with procedures such as: anti-suppression techniques, physiological diplopia, stereopsis, laser lights, buzzers and other alert systems.
3. Incorporate multi-sensory (inter-modal) tasks for the patient to respond to: NORT procedures often incorporate multisensory input and output requiring looking, touching, listening (metronome) and proprioceptive control such as balance (balance board).
4. Encourage active patient participation and motivation: NORT procedures involve presenting the patient with a problem solving task which involves active participation by the patient. Various specialized equipment is used to provide levels of difficulty thereby motivating the patient to improve performance. Other behavioral modalities are used to increase motivation.
5. Incorporate procedures which require a motor match to a sensory miss-match: Convergence/divergence techniques require a motor match to a sensory mismatch such as the appreciation of SILO and localization with Vectogram procedures. The utilization of yoked prism lenses, polarized lenses and red/green glasses provide tasks which require a motor response to a sensory mismatch.
6. Create and modify therapy procedures which require top-down processing: Procedures have been developed which require neural control stressing voluntary integration of ocular motor, visuomotor, vestibular and spatial relations.

The following overviews a typical NORT protocol for the management of the most common visual problems associated with TBI:

a) Phase I: Enhance the stability of the visual input system

Brain injury results in different levels of decreased information processing and most specifically, intermodal sensory processing. For this reason, it is important that the visual input is as accurate as possible providing the neural processing system with fewer conflicts and challenges. The important ocular motor functions which make up the visual sensory input are:

1. Clarity of vision.
2. Accommodative amplitude and facility.
3. Quality of fixation.
 - a. Intrusion fixation
 - b. Nystagmus
 - c. Range of ocular motility

- d. The quality of the ocular motor system to sustain a match to the visual input
- e. Accurate saccades with high level motor planning
- 4. Binocular stability.
- 5. VOR Stability: The integration of ocular saccades and pursuits with balance and visuomotor performance.

b) Phase II: Enhancing binocular control alignment and sustenance

It is well documented that patients with TBI and other neurological conditions have a significantly higher prevalence of binocular vision, accommodation and ocular alignment dysfunction¹⁶. (Vol 1A: I introduction) The quality, stability and consistency of the visual input has a significant impact on the efficiency of neural decoding/encoding of intermodal sensory information and the resulting integrative performance; cognition and/or movement. Diplopia, blurred vision, unstable vision and visual stress are all possible results of unstable binocular vision and alignment dysfunctions, adding stress to the higher level processing system which is already to some degree affected by TBI. Additionally, because of the innate neurologic relationship between the visual processing system and the vestibular system, unstable binocular vision may affect the vestibulo-ocular reflex (VOR) with resultant symptoms of disequilibrium. Unstable binocularity and the inability to sustain clear, comfortable vision for reasonable periods of time will affect one's ability to read and comprehend. All of these symptoms are delineated as components of such surveys as SUNY's Post Trauma Vision Survey and the Goodrich/Martinsen Delphi Survey Study¹⁴ and are experienced at a high prevalence level by patients with TBI.

Optometrists have been successfully treating/managing binocular vision dysfunctions for decades and have developed effective procedures and protocols. More recently, OVT procedures have been developed which utilize digital, computerized and integrative technology advancing effectiveness of therapy for the treatment/management of binocular vision disorders. In a subsequent section, we discussed optical and non-optical treatment modalities for enhancing the sensory input. The following represents the usual sequence of this phase.

1. Develop adequate fusional alignment, control, stability and facility of accommodative convergence: NORT at this level enhances the neuro-muscular and visuomotor control of sustaining ocular alignment for clear, comfortable single vision. Procedures utilizing prisms, lenses, stereoscopes, filters and computerized programs effectively increase the facility of the synkinetic linkage between the vergence system and the accommodative system (accommodative convergence).
2. Enhance speed of recovery of fusion: The maintenance of both static and dynamic ocular alignment is under control of a neurological feedback system which ensures that for change of gaze the lines of sight for the two eyes are quickly brought to the fixation target and that this fixation can be sustained. Procedures utilizing dynamic targets, with prisms and lenses, and feedback such as physiological diplopia are utilized to re-establish adaptive control of the alignment as the eyes change gaze.

The following summarizes NORT protocols for treating the most common binocular vision problems associated with TBI.

(1) Vertical Deviations:

1. Create a centration point by prescribing vertical prism lenses. Centration is a point or area in space where true sensory fusion such as luster is achieved.
 - Prescribe prism lenses to allow for more effective out-of-office therapy.
 - Prescribe the minimum lens power for sensory motor fusion.
2. Develop horizontal fusion ranges especially out of instrument.
3. Enhance speed of fusion recovery.

(2) Divergence insufficiency:

1. Prescribe an appropriate near point lens prescription to reduce over convergence and to establish a centration range.
2. Prescribe prism lenses to help stabilize fusion at distance if appropriate.
3. Expand peripheral awareness.
4. Increase relative ranges of fusion stressing divergence.
5. Enhance step jump duction recovery especially recovery of fusion.
6. Enhance binocular stability with associated head movement.

(3) Convergence Excess:

1. Prescribe the appropriate near point lens prescription to reduce over convergence and establish a centration range.
2. Prescribe prism lenses to help stabilize fusion at distance if appropriate.
3. Expand peripheral awareness.
4. Increase relative ranges of fusion stressing divergence.
5. Enhance step jump duction recovery especially recovery of fusion.
6. Enhance binocular stability with head movement. Prescribe the appropriate near point lens prescription to reduce over convergence and establish centration.

(4) Convergence Insufficiency:

1. Stress proprioceptive feel of convergence.
2. Stabilize convergence: both motor and sensory motor.
3. Increase flat fusion ranges and facility of accommodative-convergence fusion ranges.
4. Develop speed of sensory motor fusion recovery.

(5) Strabismus:

1. Prescribe the appropriate prism lenses in order to eliminate diplopia and provide an optical centration point. Prism can be used to partially compensate for the degree of misalignment of the eyes and allow for some degree of single vision to improve function and hasten recovery. The smallest amount of prism that allows a moderate range of single vision is determined. The amount will vary from patient to patient. Prism lenses are usually prescribed in conjunction with therapy to help aid in recovery of binocularity. The prism power is gradually reduced as the deviation of the strabismus decreases over time.
2. Increase the range of motion and quality of ocular motor control. Develop fusion ranges and modify the prism lens power as fusion ranges are increased.
3. Develop dynamic fusion and speed of recovery stressing sensory motor fusion control.

c) Phase III: Developing Speed of Visual information Processing; Stability of Output

Each time we shift our gaze, our eyes are flooded with information from our visual world. In order to manage this tremendous array of sensory information, our brain processing system should selectively attend to specific objects or areas of our visual space world and utilize this information in order to construct a representation of the 3 dimensional world including the spatial orientation of objects. The speed and accuracy of this task is facilitated through a process commonly known as top-down processing, and for vision, is facilitated by two parallel streams;

Dorsal and Ventral processing streams. The identified object/scene will be processed in parallel and simultaneously by the two streams. They work at an interconnected neural level^{4, 17}.

Throughout our waking day, we identify and often need to manipulate objects in our environment by initiating a visually guided movement. Often the response to a target or the resultant movement requires a re-calibration of sensory motor control. The extended dorsal stream integration with the frontal lobes is important for “on-line” learned response programming and calibrated control of visually guided movements.

The ventral stream facilitates the recognition of objects, form and detail, and their relations. Processes in the ventral stream attend to the relevant object and its details in the scene. Once the objects are identified, networks in the dorsal stream with integration with the premotor cortex, frontal lobe, medial temporal and basal ganglia and brainstem, can be activated to perform a desired top-down initiated motor act.

There is a body of literature which demonstrates that the speed by which information is processed, calibrated and recalibrated via these streams can be enhanced through training (neuroplasticity)^{9, 11-13}. “Top down” processing translates into speed of information processing (decoding) and performance (encoding)¹⁹.

D. NORT interventions addressing visual perceptual processing disorders

The following section provides an overview of optometric interventions commonly prescribed to address visual perceptual processing disorders experienced by patients with TBI. Disorders of visual perception/processing are defined as cognitive processes attributable to dysfunction within cortical networks related to the interpretation of visual stimuli as well as processing speed of vision and other intermodal sensory information. Speed and facility of processing requires the recruitment and interconnection of many brain areas including vision, memory, attention, emotion, and action. Substantial evidence¹⁸ exists to suggest speed and facility of perception can be enhanced in normal and TBI and stroke patients through practice. Neuro-plasticity in the visual processing centers of the brain, such as the occipital lobe and dorsal and ventral neural pathways, occurs through “perceptual learning”.

Visual perceptual disorders are often diagnosed by optometrists and other health care professionals utilizing neuropsychological tests, neuro-optometric assessment and computer software programs. It is important to realize that any pathology within the visual system can masquerade as neurological perceptual disorders. For example, uncorrected refractive error could cause subnormal scores on neuropsychological tests of visual perception, as could retinal disease or binocular vision problems, such as convergence insufficiency. It is essential that the optometrist first treat these ocular/oculomotor conditions prior to prescribing the perceptual learning-type therapies that will be discussed here. It is equally important that optometrists communicate with neuropsychologists involved with managing these patients so that the impact of the visual problems on the neuropsychological testing is taken into consideration.

Visual perceptual skills related to speed and facility of processing are: 1) Speed and Span of Perception, 2) Visual Figure-Ground, 3) Visual Closure, 4) Visual Sequencing, and 5) Visual-Motor Integration.

a) Speed and Span of Perception:

Span of perception can be defined as the amount of visual information acquisition during an eye fixation. Span of perception is probably best known for its importance in reading, but is also important for tasks such as driving, visual search, and mobility. Patients with TBI frequently have reduced perceptual span.

Substantial evidence exists to suggest speed and span of perception can be enhanced in normal and stroke patients through practice on computer software programs, which then generalizes to improvements in everyday tasks such as reading speed and mobility or driving. There are software programs (PTS II, PVT, CPT)²⁰ some developed by Sidney Groffman OD, which use tachistoscopic¹⁸ (flash) presentation of letters or targets that should then be correctly identified by the patient. Difficulty is increased in a stepwise fashion by decreasing the time of presentation or by increasing the number of objects/letters.

b) Figure-Ground Visual:

The term visual figure-ground (VFG) is used to describe the visual perceptual process whereby a scene or pattern is separated into the main figure and background. Without figure ground perception the individual derives little meaning from what they are seeing, resulting in visual confusion. Visual function is often highly variable in brain injury patients with VFG problems, frustrating the patient and therapist. Successful treatment of VFG problems requires a combination of perceptual therapies to restore as much VFG perception as possible, and strategies to help the patient minimize visual confusion. For example, the patient might be instructed to use a visual search strategy of breaking the scene into 4 parts and exploring each section visually and tactilely starting on the left and feeling for objects going from the top to bottom. This strategy can then be practiced with various activities of daily living such as locating a toothbrush on a cluttered bathroom sink. Another example would be improving page navigation by using black construction paper to block out 3 quarters of the page. If successful, the amount of the page occluded would be gradually decreased. It is typically also helpful to have the patient touch the objects they are trying to identify since the extra sensory input reinforces the information being obtained visually. In terms of attempting to restore perception, there are visual perceptual workbooks²¹⁻²³ which do a nice job of isolating the specific perceptual skills at a level these patients can handle without becoming overwhelmed. In milder cases, commonly available games and puzzles can be used.

Other Treatment Considerations for VFG Problems:

More traditional OVT procedures that target the accommodative/convergence system and ocular motor control will enhance attentional processes recommended for visual figure-ground analysis. Plus lenses for near or bifocals can enhance visual attention by relieving neurological overload from excessive accommodative and or fusional stress. Isolating items to be viewed using line guides and typoscopes is also recommended. Providing large print is often helpful.

c) Visual Closure:

Visual Closure is a visual perceptual skill facilitating the recognition of objects when there is incomplete visual information. Neurologically, closure occurs in the lateral occipital or posterior temporal lobes and corresponds to processes related to object recognition in the ventral stream. It is also influenced by the cognitive processes of memory and object familiarity through top-down processing and the spatial processing attributes of the dorsal stream. Patients with visual closure problems will have to study a scene more carefully to get the information needed resulting in slower processing speed and cognition. Rehabilitation specialists should make recommendations for extended time for work or school projects.

Visual Perceptual Workbooks and Software programs²⁰⁻²³ are available to practice visual closure skills. These tools isolate the specific perceptual skill at a level these patients can handle without becoming overwhelmed. In milder cases, commonly available games and puzzles²¹⁻²³ can be used. Compensatory strategies are used for persistent problems to improve independence and function by teaching the patient to work within a familiar environment at a slower pace. This allows their memory for common objects to compensate for perceptual deficiencies. The rehabilitation specialist might advise job placement agencies towards an occupation characterized by repetitive tasks lenient for speed and error rate. Obviously, ensuring the stability of the visual image is a priority aspect for this

higher level of processing and the importance of the full scope of optometric involvement as discussed in other sections of this manual is extremely important.

The optometrist that provides NORT utilizes specialized equipment and procedures based on the neuroscience of neural plasticity to enhance the ability to more efficiently process visual sensory information.

d) Visual Sequential Memory:

Visual Sequential Memory (VSM) implies the ability to remember the sequence of visually presented forms or characters. Where span of perception is more influenced by attention, visual sequencing is influenced more by memory. Patients with deficiencies in VSM often have associated saccadic eye movement dysfunction. TBI patients with VSM deficiencies will have problems following written instructions, transcribing data, and spelling. Disorganized behavior is characteristic and can affect future employment potential and have a negative social impact.

Successful treatment of patients with VSM problems requires a combination of perceptual therapy and compensatory strategy implementation. A compensatory strategy which is effective and should be encouraged is sub vocalization. Memory books are a useful tool to help with personal schedule and organization. Perceptual workbooks and software programs²⁰⁻²³ are used for TBI patients with Visual Sequential Memory problems to attempt to restore abilities and to allow them to practice and automate compensatory skills. Most training activities use a serial presentation of shapes or numbers where the patient is required to reproduce the sequence either from a multiple choice list or by writing or keying it in. Difficulty is increased either by making the patient wait longer to give the answer, or by introducing a mask (another symbol or character that is not part of the sequence) before allowing them to answer. Practice with mental imagery might also be helpful as it trains the patient to hold the image in their working memory longer to account for any slowed processing speed.

e) Visuomotor Integration:

Visuomotor integration refers to the combination and coordination of visual information with proprioceptive information for the purpose of planning and executing an appropriate movement. This is commonly referred to as eye-hand or eye-body coordination. Visuomotor integration is primarily a function of the parietal premotor stream through the Dorsal Stream. Damage to the posterior parietal lobe, particularly on the right or bilaterally, can cause problems with VMI resulting in problems maintaining upright posture, inaccurate reaching and grasping, and poor balance, ambulation, navigation, and handwriting. These problems can be devastating to function and interfere with physical therapies needed for the overall rehabilitation of the patient.

Any activity requiring repetitive reaching and grasping is very effective to restore visuomotor integration. Therapies can include but are not limited to computerized wall-mounted gel light boards, occupational therapy peg boards, rotating pegboards, tracing and drawing activities in perceptual workbooks, and computerized perceptual therapy programs and other procedures which integrate intermodal stimulus-response tasks for enhancing the re-calibration of this important process. For example, the optometrist who provides NORT may apply yoked prisms to a procedure which requires the patient to initiate an ocular motor match to the optical shift created by the prism, and then a motor response such as touching the object in order to recalibrate sensory motor match.

E. Vestibular Ocular Reflex Stability: The integration of ocular saccades and pursuits with balance and visuomotor performance

Dizziness and symptoms of disequilibrium, vertigo, and the effect they have on one's sense of balance, are among the most common complaints by patients seeking medical attention. This is especially true for patients who have traumatic brain injury and concussion.

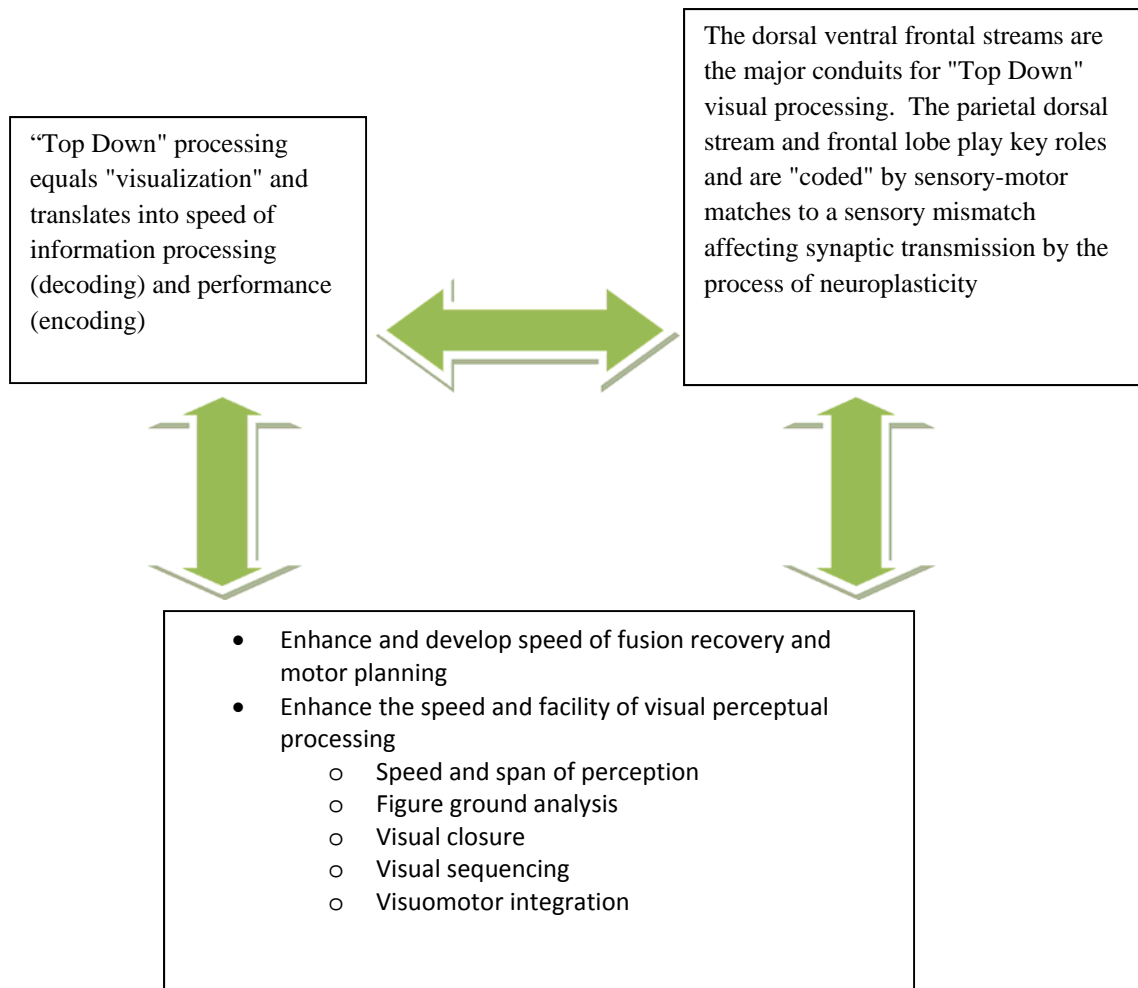
The human balance system has three afferent systems: vestibular, visual, and somatosensory, and the efferent system consists of multiple neurological pathways that to some degree overlap and are redundant. In order to maintain balance during changing situations, all of these pathways should ultimately play a role in coordinating motor responses of the limbs, trunk, and eyes to the incoming sensory stimuli.

There are three major systems contributing to the perception of a stable space world and the sense of balance. At the most basic level is the reception of sensory information. The process of integration occurs at several levels of the neurosensory pathways and it is most likely that at the level of the thalamus and cerebellum the first integration and processing of parallel information from the visual, vestibular, and somatosensory systems occurs. Finally, the primary visual cortex and the primary somatosensory cortex process information, which is then integrated with information from other association cortical regions. Sensory conflict or mismatch, which may take place at any stage along the sensory pathway, may and often does result in vertigo, dizziness and imbalance.

The maintenance of a stable space world, which influences balance, is significantly influenced by how visual information is processed and integrated with the vestibular and somatosensory systems. The most dominant connection between the visual and vestibular systems is the vestibular ocular reflex, also referred to as gaze stabilization. This reflex is the fastest reflex of the body, with the principal purpose to maintain a steady image on the retina during head movement and therefore the vestibular ocular reflex (VOR) is important for maintaining a stable visual spatial world when head and body movements are involved. For example, the VOR is dependent on a stable, bifoveal retinal image. Thus, uncompensated binocular deviations such as fixation disparity, heterophorias, convergence insufficiency and accommodative convergence dysfunctions are commonly associated with symptoms of vestibular dysfunction. In a broad sense, any mismatch of visual information could potentially exacerbate a vestibular problem. Many patients have moderate vertical and horizontal heterophorias that may have been well compensated for most of their lives. However, an illness or other stress factors can result in a breakdown of fusional control, and a decompensation of binocularity adding to the mismatching of afferent information affecting the VOR and ultimately balance.

Oculomotor deficits and binocular dysfunction may have a negative effect on the VOR resulting or exacerbating symptoms of disequilibrium and discomfort in multiply-visually stimulating environments with or without motion. The brain is a mediator between information from the visual system, vestibular system and proprioceptive system. In a sense, the joints, eyes and ears make up the "keyboard" to the "computer," the brain. As with a computer, the efficiency and accuracy of the brain's performance is only as good as the information it receives. The visual problems discussed earlier in this article can add to neurological conflict thereby exacerbating symptoms associated with vestibular and balance problems. The very nature of vestibular treatment modalities often is dependent on stable visual information. Thus, in many cases, eliminating the visual problem is often the key to significant progress in vestibular rehabilitation; while other times treating the vestibular dysfunction enhances gains in visual therapy.

Patients with vestibular and balance problems would benefit from a comprehensive optometric evaluation which encompasses the management and treatment of ocular disease to optical strategies and NORT²⁴.



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Co-management with your NOR colleague

Optometrists are the gatekeepers for eye care and the most ubiquitous choice of eye care providers. As the general public becomes increasingly aware of visual dysfunction following concussion, the scope of the primary care optometrist's practice is blooming and responsibilities are increasing. There are now a greater number of patients who suffered mild TBI seeking relief from visual symptoms. Far from your average eye care patient, those requiring TBI visual dysfunction assessment and rehabilitation do take more time to evaluate and can be challenging to rehabilitate. The average primary eye care practice can be overbooked and understaffed to offer full services for OVT/NORT and other support for patients with TBI.

Optometrists for years have co-managed ocular health conditions, difficult contact lens fittings, pediatric and low vision cases with colleagues and other professionals who dedicate their practices to a specific specialty. As athletic directors and brain injury rehabilitation centers become more knowledgeable about visual problems associated with concussion and TBI, it is important that optometrists co-manage these patients with their optometric colleagues who provide NORT. Co-management is based on mutual respect between the primary care optometrist and the consulting doctor. For more information on co-management of OVT/NORT access: aoa.org/optometrists/education-and-training/clinical-care/vision-therapy/optometric-co-management-of-vision-therapy. Also see websites on pg. 92-93 of this volume.

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Section III: Practical General Considerations for (OVT/NORT)

Management of Patients with Visual Sequela of TBI

Chrystyna Rakoczy, O.D.

Acronyms and definitions used:

- OVT: Optometric Vision Therapy: aoa.org/Documents/optometrists/QI/definition-of-optometric-vision-therapy.pdf
- NOR: Neuro Optometric Rehabilitation: aoa.uberflip.com/i/225867 BIERM Vol 1A, pg 104
- NORT: Neuro Optometric Rehabilitative Therapy: (BIERM Vol1B, pg. 8)

A. Introduction

Managing the visual dysfunctions of patients with TBI can be both challenging and rewarding. You will encounter patients who had their injury years prior, had seen many doctors, and were told that their symptoms were delusional and were referred for psychological help or treated with psychotropic medications. Other patients with recent injury may have been told they see just fine, and that their symptoms would go away. Still others may have been told that nothing could be done for their symptoms and they should just live with them. Many patients with TBI suffer for years, thinking they could not be helped. They have unique visual dysfunctions that take time and patience to diagnose and manage. Being aware of the common TBI-related ocular dysfunctions, asking the pertinent questions during the case history, assessing/testing and often retesting specifically for those dysfunctions will help formulate the diagnosis and treatment plan. Management can be as simple as prescribing the appropriate spectacle prescription or as complex as incorporation of OVT and vestibular rehabilitation. The primary care optometrist has the basic knowledge to treat the optical visual problems and uncomplicated ocular motor and fusion dysfunctions by initiating OVT when dedicated NOR practices are not available for your patient.

The full scope of optometric services should be considered when providing NOR for the TBI patient. Ocular health, cognitive function, perceptual awareness, multisensory deficits, vestibular dysfunction, physical disabilities, medications, mobility/transfer/transport issues, and family support should be evaluated and addressed before starting NOR. The management plan should be tailored to the individual's needs, ability to perform and the ability to attend OVT sessions. Optometric practices dedicated to NOR are prepared to meet those needs, especially for moderate to severe TBI patients. Many NOR dedicated optometrists will travel to rehabilitation facilities to examine and manage patients with TBI visual dysfunctions. If the patient has mild TBI ocular dysfunction or if a NOR dedicated office is not located with convenient access for the patient, the primary care optometrist (OD) may want to proceed with basic NOR until the patient can attend sessions at a more focused practice.

B. Pearls for primary care optometry managing the TBI patient population:

- Ocular health issues should be addressed first. Anterior segment and surface dysfunction symptoms from lagophthalmos, tear dysfunction, dry eye, keratitis and others will impede NOR progress. Treat to gain patient comfort and control of signs and symptoms. Surface dysfunction is a major contributor to the TBI patient's discomfort. Posterior segment and neuro-ophthalmic issues should be appropriately addressed with ophthalmology and/or neuro/retina specialty before proceeding with NOR. Please refer to aoa.uberflip.com/i/225867 BIERM Vol 1A, pg. 67 for information on common ocular diagnoses associated

with TBI. Clinical Practice Recommendations on the care of patients with ocular disease can be accessed at the following AOA web pages:

Care of the Patient with Ocular Surface Disorders (CPG10):

aoa.org/documents/optometrists/CPG-10.pdf

aoa.org/Documents/optometrists/QRG-10B.pdf

Care of the Patient with Conjunctivitis (CPG11)

aoa.org/documents/optometrists/CPG-11.pdf

aoa.org/documents/optometrists/QRG-11.pdf

Care of the Patient with Retinal Detachment and Related Peripheral Vitreal-retinal Disease

aoa.org/documents/optometrists/CPG-13.pdf

aoa.org/documents/optometrists/QRG-13.pdf

- On rare occasions, a patient may request a second opinion evaluation for their visual difficulties. They may have been involved in a minor accident with a resultant mild TBI. Financial motivation may be their guide and these patients may attend their appointment with legal counsel. Note that some visual dysfunctions of TBI can be simulated. Careful evaluation of these conditions and the ruling out of true dysfunction is discussed in detail in the section on “Non-organic ophthalmic manifestations” (BIERM Vol1B pg 61).
- Before prescribing for refractive correction, consider the patient’s medications. Patients with TBI are often medicated, at times to calm disruptive behavior and at others to allow better cognition. Many TBI medications will affect refractive error, accommodative effort, vergence, and ocular motility. Others heighten sensitivity to light, produce color vision defects or haloes. For a detailed discussion on drug induced ocular side effects please refer to the Advanced Topics of this volume. (BIERM Vol1B pg. 44).
- Address refractive inaccuracy, vertical misalignments, and sensitivity to light. Some patients with TBI can have myopic shifts or accommodative spasms that need be addressed. Induced myopia may require more minus and once rehabilitation starts the overcorrection can be reduced. Patients with TBI are very sensitive to small changes in refractive error. Prescribing 0.25D of plus, minus or cylinder uncovered in retinoscopy commonly relieves asthenopic complaints. Small changes make a big difference presumably due to the hypersensitivity nature of TBI. Managing uncompensated, unbalanced vertical heterophoria (aoa.uberflip.com/i/225867 BIERM Vol 1A, pg. 40) with as little as 0.25^Δ vertical prism often takes care of the “I know I can see but something is off” complaints. Recall that the most common cranial nerve injury in TBI involves superior oblique function (aoa.uberflip.com/i/225867 BIERM Vol 1A, pg. 72). You may want to prescribe “temporary” glasses with horizontal/vertical prism to get a patient through a difficult situation in work or school, explaining that NORT will address their problem in a more stable and permanent manner and that after therapy they may not need glasses or at least have glasses without prism. All of these unique yet vision-disturbing issues should be corrected or the benefits of NORT will not be fully attainable. Clinical Practice Recommendations on the care of patients with refractive inaccuracy can be accessed at the following AOA web pages:

Care of the Patient with Myopia (CPG15)

aoa.org/documents/optometrists/CPG-15.pdf

aoa.org/documents/optometrists/QRG-15.pdf

Care of the Patient with Hyperopia (CPG16)
aoa.org/documents/optometrists/CPG-16.pdf
aoa.org/documents/optometrists/QRG-16.pdf

Care of the Patient with Presbyopia (CPG17)
aoa.org/documents/optometrists/CPG-17.pdf
aoa.org/documents/optometrists/QRG-17.pdf

- When prescribing lenses, be mindful of the patient's vocational and avocational activities, patient's limitations and limitation of the prescription itself. Bifocals, or multifocals, including progressive addition lenses may not be appropriate especially if the patient has difficulty with balance or requires different amounts of prism for distance versus intermediate versus near tasks. Some patients with ocular paresis may not be able to look down to read and will need to hold reading material in the primary gaze position. Multiple glasses for multiple tasks are not always convenient but can keep a patient safe and active. But again, patients with TBI can have memory issues and may not remember to switch glasses. Training and frequent reminders from a caregiver or personal assistive device such as a smart phone may be required.
- Patients with TBI can be hypersensitive to lighting. A low percentage of indoor tint and antireflective coating helps to reduce light sensitivity and glare. For indoor use, 15-20% light blue slightly reduces contrast but calms down glaring, bright fluorescent and confusing environments. Slight amber tint increases contrast and helps with dim, low contrast of cloudy days. Dark grey lenses work well in bright sunlight without changing the perception of color. Transitional lenses are good for in-and-out mobility but do not get dark enough in a car. Polarization works well outdoors and in a car, but is not always convenient as many navigation screens, smart phones, and computer tablets are also polarized; thereby creating crossed polarization and poorer contrast. The important point to remember is: know your product and know your patient's needs and abilities. Please refer to "Management of Photosensitivity in Patients with TBI" in the Advanced Topics section of this volume for more detailed information. (BIERM Vol1B pg. 39)
- Choosing the appropriate spectacle frame is paramount. Patients with TBI who have undergone craniotomy/cranioplasty may have swelling in the temple regions. Others who experienced facial fractures/reconstruction may have nasal bridge sensitivity. Spring hinges, flexible silicone nose pads, temples that can easily be curved to match yet not touch a swollen temple area of the head are desirable properties of a light weight frame that can easily be adjusted. Pressure points should be avoided. Your optician should be alerted to your patients' needs and be able to adjust the frames for optimal comfort.
- Patients with TBI with known vestibular dysfunction (uberflip.com/i/225867 BIERM Vol 1A, pg. 55-58) such as Benign Paroxysmal Positional Vertigo (BPPV) should have otolith correcting procedures completed before starting OVT or NORT. Take care to optically correct any vertical ocular misalignments. Some patients require compensating vertical prism to progress with vestibular and/or gait therapy. Your vestibular physical therapist will let you know if vestibular treatment has stalled and poorly compensated ocular misalignment is suspected. Coordinate/consult with your rehabilitation therapist and an optometric practice which provides dedicated NOR or OVT. Co-management is not unusual. (BIERM Vol1B, pg16).

- Before referring for OVT or NORT for more complex interventions, consider the patient's ease of attending in-office sessions. Typically, frequent transport of patients in wheelchairs is not only wearing on the patient but also taxing for the caregiver. The OD providing NORT may consider co-treatment with physical, occupational and/or recreational therapy to reduce the number of visits a patient should travel to. Some NORT lends itself well to enhancing and developing oculomotor compensatory skills in conjunction with other disciplines' therapy (i.e. speech therapy). Co-treatment can save the patient and the caregiver time and unnecessary stress.
- If dedicated NOR or OVT practices are not available and OVT is appropriate for the patient, consider basic OVT in your office as a start. OVT for patients with mild TBI does not require expensive equipment or lengthy treatments. Even providing instruction for ocular motility is of great benefit and an easy start. It is important that the patient receives the correct therapy. Given that the patient's other skills are intact, the primary care OD may wish to proceed with simple OVT procedures. Long distance consultation with an OD knowledgeable of NORT can guide and direct your chair-side care.
- Some patients with brain injury have difficulty understanding instructions and have loss of memory. They may have perceptual dysfunctions and/or aphasia that will not allow them to recognize or "see" the target that is presented to them. Auditory processing can also be an issue. To proceed with OVT, you may need to be creative in selecting targets and in your approach to the patient. Large print instructions may be all that is required. Assistive devices such as smartphones can remind patients to do their OVT. Patients with cognitive and perceptual deficits/dysfunctions can have challenges with communication. Ask the caregiver which method works best. Also ask if the caregiver would be willing to help the patient with the home-based skills. Do not be shy to ask a NOR OD for tricks of the trade.

Things to keep in mind with OVT for TBI:

- Be mindful of the patient's physical limitations.
- Determine the patient's ability to understand instruction. Respectfully speak in terms they understand.
- Try to provide a visual and auditory distraction-free zone for OVT.
- Start below the patient's visual function ability to build confidence. Be success oriented.
- Use positive reinforcement.
- Be in tune with patient's frustration level. Redirect/change tasks if needed.
- Encourage the patient to recognize changes in their visual system and the ability to perform skills of increasing difficulty.
- Patients with mild TBI will be aware of their visual dysfunction (i.e. known difficulty reading). Their goal/endpoint should be to perform that task effortlessly.
- Use feedback to encourage proper performance of a skill. Feedback should consist of signs such as unwanted diplopia, blur or suppression.
- Use feedback to define goal attainment. Signs of luster, localization and kinesthetic awareness should be recognized.
- Provide breaks when needed. Some patients with TBI will get headaches during OVT. If the headache is a six on the scale of ten, stop OVT because it becomes counterproductive. Give the patient a five-minute break then if the headache has dissipated, continue.
- Help patients overcome obstacles. Be creative.

C. Basic Optometric Vision Therapy

OVT is divided into three sequential phases. (BIERM Vol1B, pg. 8-11) Within each phase, ocular motility, accommodation and vergence are slowly integrated, easiest to more difficult, single skill to combined and complex. Each phase builds on the skills performed in the previous phase. Typically, non-TBI patients can successfully complete all three phases of OVT in about 15-25 sessions weeks of in-office therapy. Patients with TBI require more attention to their physical and cognitive needs, take much longer as they perform at a much slower rate and at times, miss sessions due to other difficulties. Some experience headaches during OVT and require frequent breaks. Others lose concentration focus and should be redirected. Forty to fifty sessions of OVT, start to finish, is very common. Each patient is unique and will require more or less attention and intervention.

We present basic OVT for skills that the general optometrist can direct without investing in expensive equipment and much practice time.

Equipment:

- Occluder/patch
- Tongue depressor target/Brightly colored sponge ball
- Small flash light
- Accommodative rock cards
- Post-It notes
- Hart chart (newspaper or magazine works just as well)
- Brock string: 3ft and 10ft
- Barrel cards
- Transparent lifesaver cards
- Opaque lifesaver cards
- Pointer or sharpened pencil
- Loose lenses: +0.50D to -3.00D in 0.50D steps
- Lens flippers: ± 1.00 , ± 1.50 , ± 2.00 , ± 2.50 , ± 3.00
- Prism flippers: 8^{Δ} BO/ 4^{Δ} BI
- Polaroid glasses
- Vertical striped bar reader
- Random dot stereograms (for fun: see appendix, print your own on line or use ours)

Phase I skills:

- Ocular motility/Fixation/Tracking
 - Eye rotation
 - Fixation training
 - Fixation and tracking
 - Sequential fixation
 - Spoon pursuits
 - Corner saccades
 - Post-it saccades
 - Hart Chart saccades
- Accommodation:

- Loose lens accommodative rock 1
 - Hart Chart 1
- Gross Convergence:
 - Brock String 1
 - Barrel Card
- Fusional Vergence:
 - Life Saver cards 1

Phase II: additional skills:

- Gross Convergence:
 - Brock String 2
- Accommodation:
 - Loose lens accommodative rock 2
 - Hart Chart 2
- Fusional Vergence:
 - Life Saver cards 2
 - Random dot stereograms with loose prism jumps/facility: modification- 6^Δ, 8^Δ, 10^Δ, 12^Δ

Phase III: additional skills:

- Fusional Vergence:
 - Life Saver cards jump facility
 - Random dot stereograms with loose prism jumps/facility: modification- 6^Δ, 8^Δ, 10^Δ, 12^Δ, 15^Δ, 20^Δ, 25^Δ
- Accommodation:
 - Binocular accommodative facility.

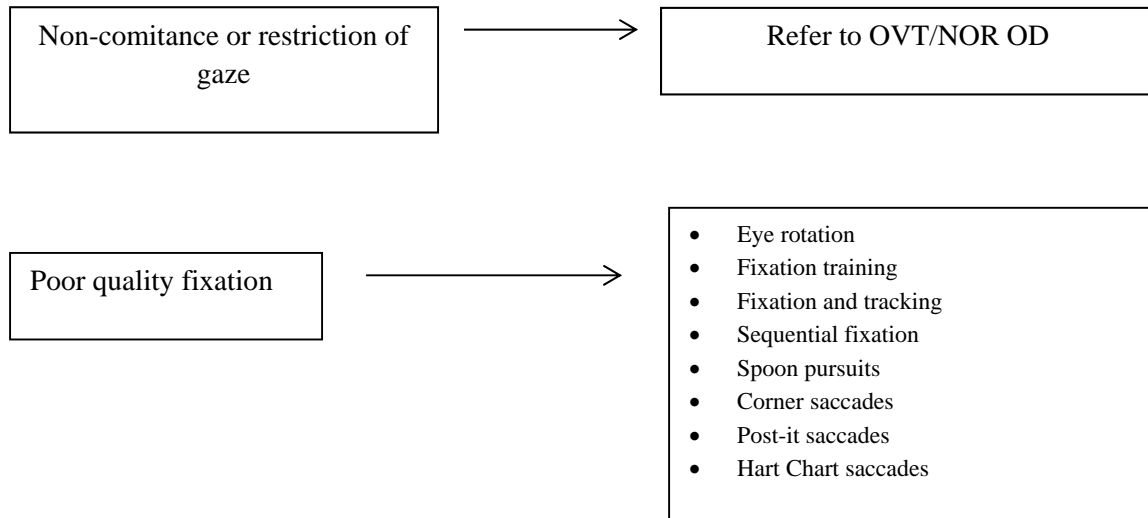
Therapy Pearls:

- Provide a quiet distraction free zone for OVT.
- Each phase starts with reintroduction/recall of fixation then proceeds to motility (smooth pursuits and saccades) building on the skills of the previous phase.
- Enhance accommodation and both, positive fusional vergence (PFV) and negative fusional vergence (NFV) at each phase regardless of original diagnosis. Emphasize the dysfunctional skill.
- Emphasize amplitude first and then facility.
- Emphasize quality, not quantity.
- Be aware of patient position and posture.

Use the following recommendations for the most common oculomotor dysfunctions associated with brain injury to formulate your basic OVT plan. Strabismus, vertical heterophoria, divergence insufficiency and convergence excess are more complex to treat with basic OVT alone. Small amounts of compensating prism are often needed to eliminate diplopia and other symptoms so that the patient can start OVT. Like suppression and amblyopia therapy, some of these conditions are best left to ODs with more experience in NORT or OVT for TBI. The flow charts present only suggestions to guide basic OVT. AOA Clinical Practice Recommendations and Quick Reference Guides are noted where appropriate. Specific instructions for each skill along with modifications for the sequential phases, goals, and YouTube video links are listed in Appendix 1.

D. Basic Optometric Vision Therapy Management Recommendations

Management of ocular motility disorder: recommendations and basic OVT

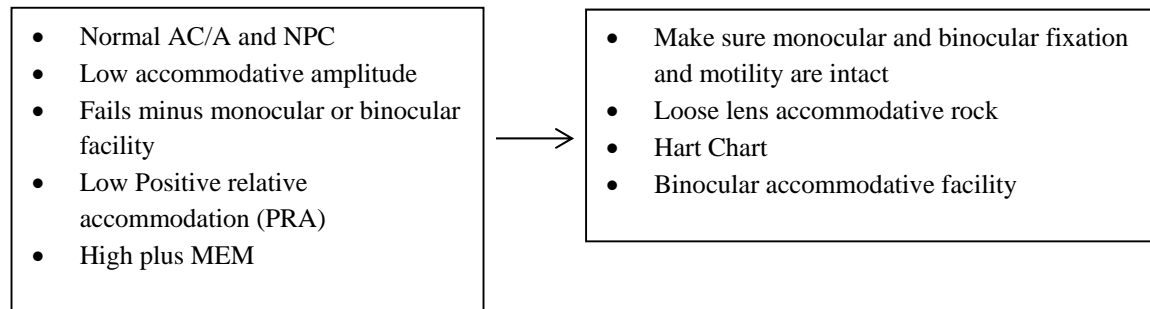


Notes: Always start with monocular fixation in primary gaze. Proceed to secondary then tertiary gaze. Patient should be able to hold fixation for 10 seconds in each position of gaze. Next, work on monocular fixation while tracking a moving target. Once tracking is smooth and accurate, proceed to saccades. Start with shorter saccades then slowly increase distance between targets. When monocular fixation, pursuits and saccades are accurate, move on to binocular motility skills.

Clinical pearls: Using a hand held mirror in front of his or her face will always interest a sighted TBI patient. The patient's own reflection can be used as a "target" for motility skills. You can also use a very brightly colored ball or toy. Often, children's toys that make sounds also serve to generate interest.

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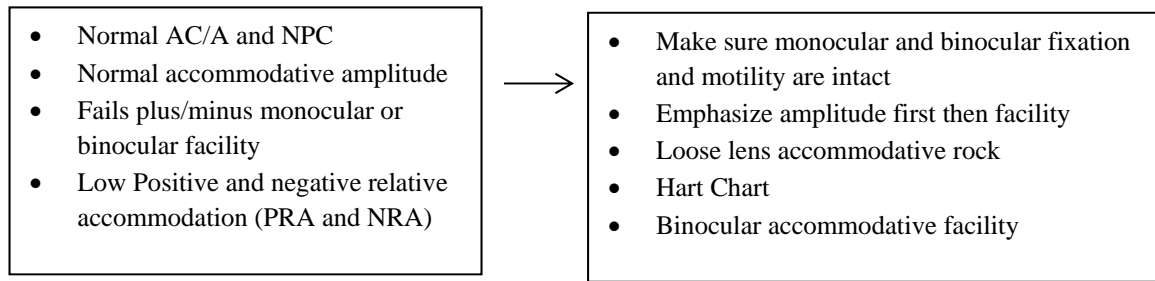
Management of accommodative insufficiency: recommendations and basic OVT



[Care of the Patient with Accommodative and Vergence Dysfunction \(QRG-18\)](http://aoa.org/documents/optometrists/QRG-18.pdf)
aoa.org/documents/optometrists/QRG-18.pdf

[Care of the Patient with Accommodative and Vergence Dysfunction \(CPG18\)](http://aoa.org/documents/optometrists/CPG-18.pdf)
aoa.org/documents/optometrists/CPG-18.pdf

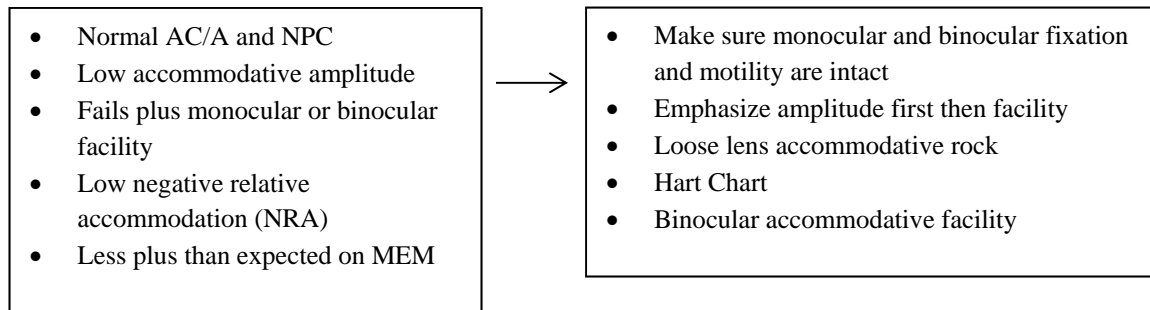
Management of accommodative infacility: recommendations and basic OVT



[Care of the Patient with Accommodative and Vergence Dysfunction \(QRG-18\)](http://aoa.org/documents/optometrists/QRG-18.pdf)
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[Care of the Patient with Accommodative and Vergence Dysfunction \(CPG18\)](http://aoa.org/documents/optometrists/CPG-18.pdf)
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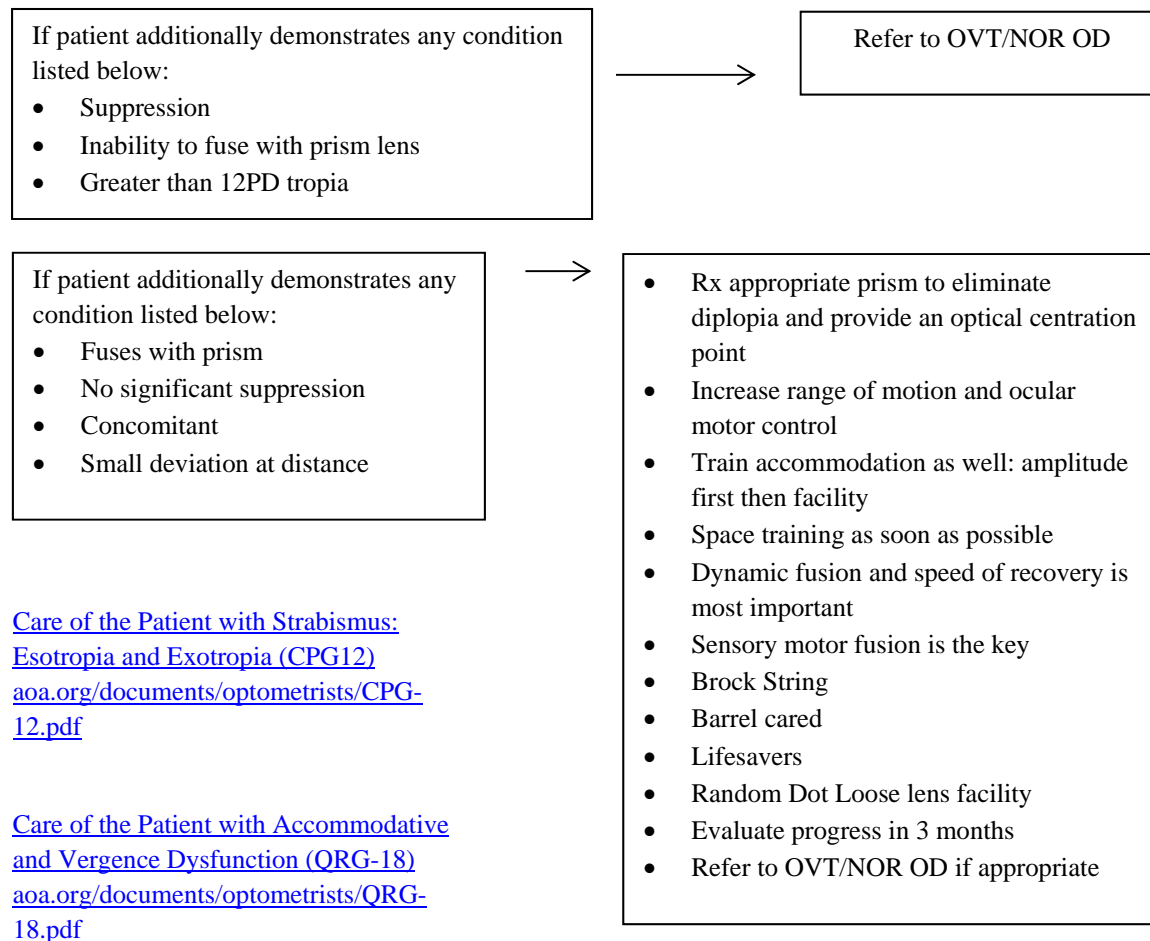
Management of accommodative excess: recommendations and basic OVT



[Care of the Patient with Accommodative and Vergence Dysfunction \(QRG-18\)](http://aoa.org/documents/optometrists/QRG-18.pdf)
aoa.org/documents/optometrists/QRG-18.pdf

[Care of the Patient with Accommodative and Vergence Dysfunction \(CPG18\)](http://aoa.org/documents/optometrists/CPG-18.pdf)
aoa.org/documents/optometrists/CPG-18.pdf

Management of low fusional ranges: recommendations and basic OVT

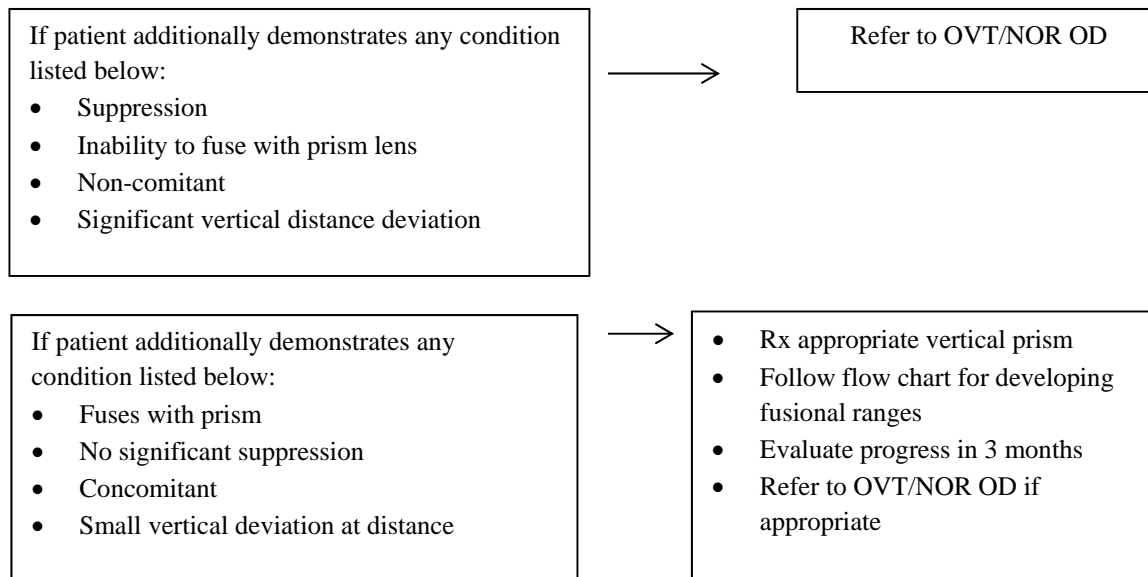


[Care of the Patient with Strabismus: Esotropia and Exotropia \(CPG12\)
aoa.org/documents/optometrists/CPG-12.pdf](http://aoa.org/documents/optometrists/CPG-12.pdf)

[Care of the Patient with Accommodative and Vergence Dysfunction \(QRG-18\)
aoa.org/documents/optometrists/QRG-18.pdf](http://aoa.org/documents/optometrists/QRG-18.pdf)

[Care of the Patient with Accommodative and Vergence Dysfunction \(CPG18\)
aoa.org/documents/optometrists/CPG-18.pdf](http://aoa.org/documents/optometrists/CPG-18.pdf)

Management of vertical deviation: recommendations and basic OVT

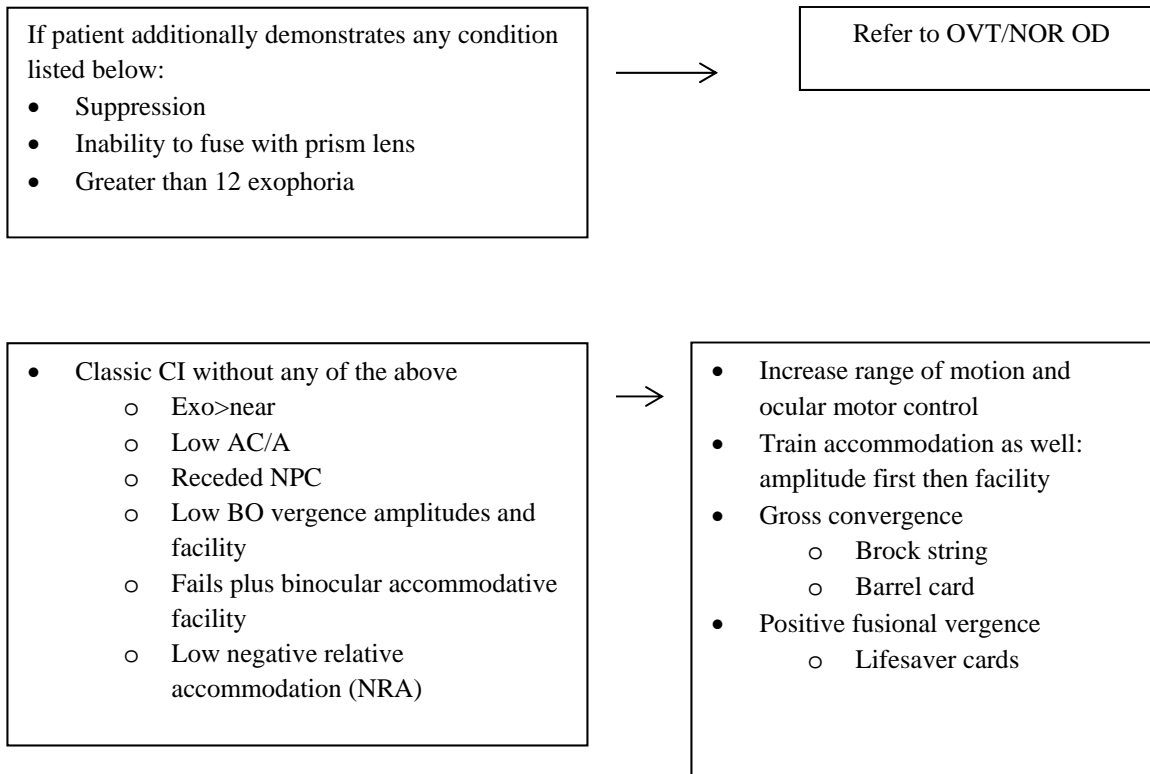


[Care of the Patient with Accommodative and Vergence Dysfunction \(QRG-18\)](http://aoa.org/documents/optometrists/QRG-18.pdf)
aoa.org/documents/optometrists/QRG-18.pdf

[Care of the Patient with Accommodative and Vergence Dysfunction \(CPG18\)](http://aoa.org/documents/optometrists/CPG-18.pdf)
aoa.org/documents/optometrists/CPG-18.pdf

Notes: Always treat vertical misalignments first with appropriate vertical prism. Some horizontal fusional dysfunctions occur or are greater because of weak vertical fusion. Use enough prism to just balance vertical amplitudes in each eye (uberflip.com/i/225867 BIERM Vol 1A, pg. 40). Then recheck horizontal fusional ranges. If horizontal ranges are still not adequate with the vertical correcting prism, go to appropriate horizontal flow chart.

Management of convergence insufficiency: Recommendations and Basic OVT

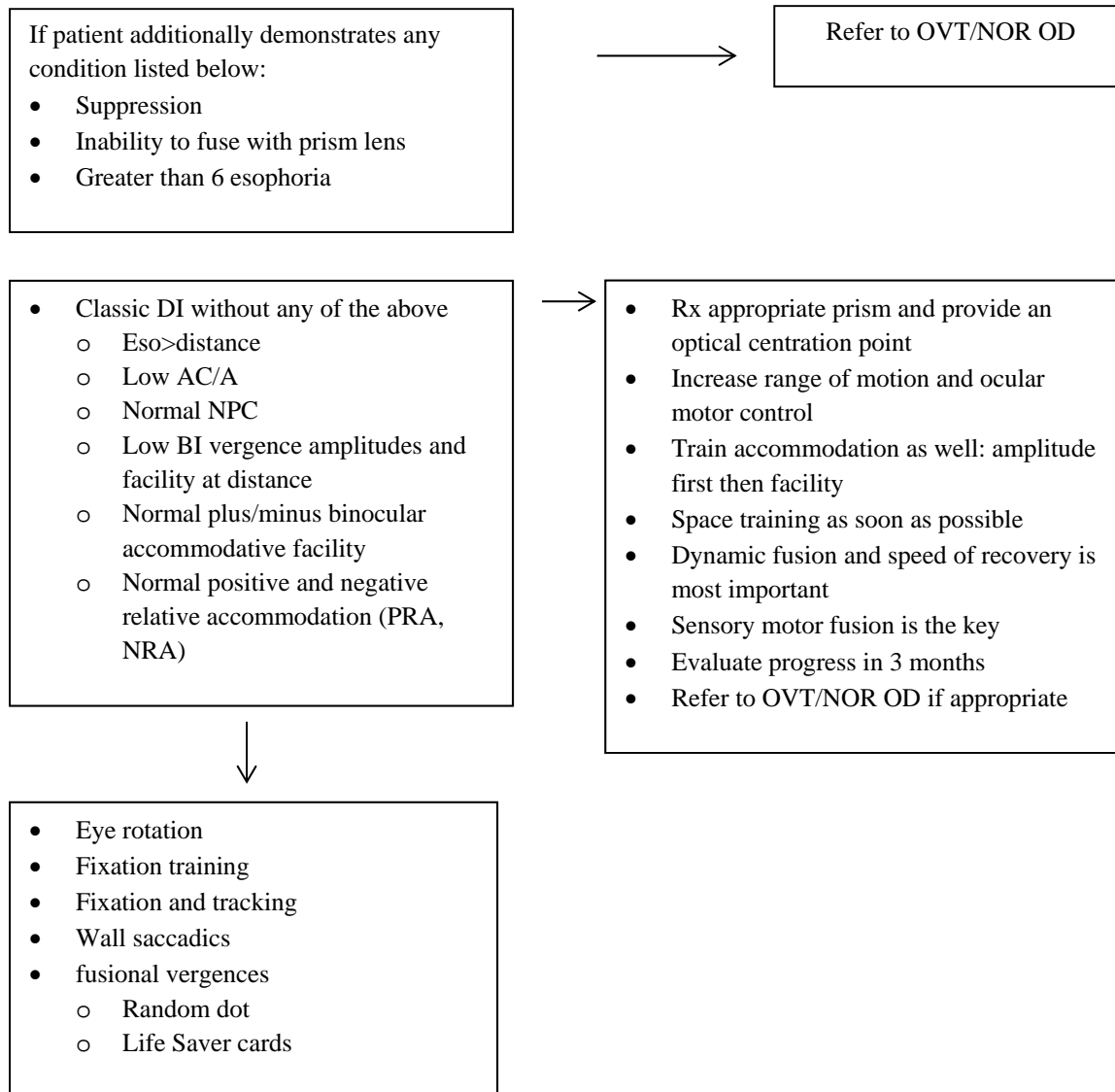


[Care of the Patient with Accommodative and Vergence Dysfunction \(ORG-18\)](http://aoa.org/documents/optometrists/ORG-18.pdf)
aoa.org/documents/optometrists/ORG-18.pdf

[Care of the Patient with Accommodative and Vergence Dysfunction \(CPG18\)](http://aoa.org/documents/optometrists/CPG-18.pdf)
aoa.org/documents/optometrists/CPG-18.pdf

Notes: Office-based OVT plus home reinforcement such as computer orthoptics and Vectograms works best (Scheiman CITT). Make sure vertical vergences are equal in both eyes. If OVT for CI is not progressing, re-evaluate vertical fusional ranges and treat appropriately.

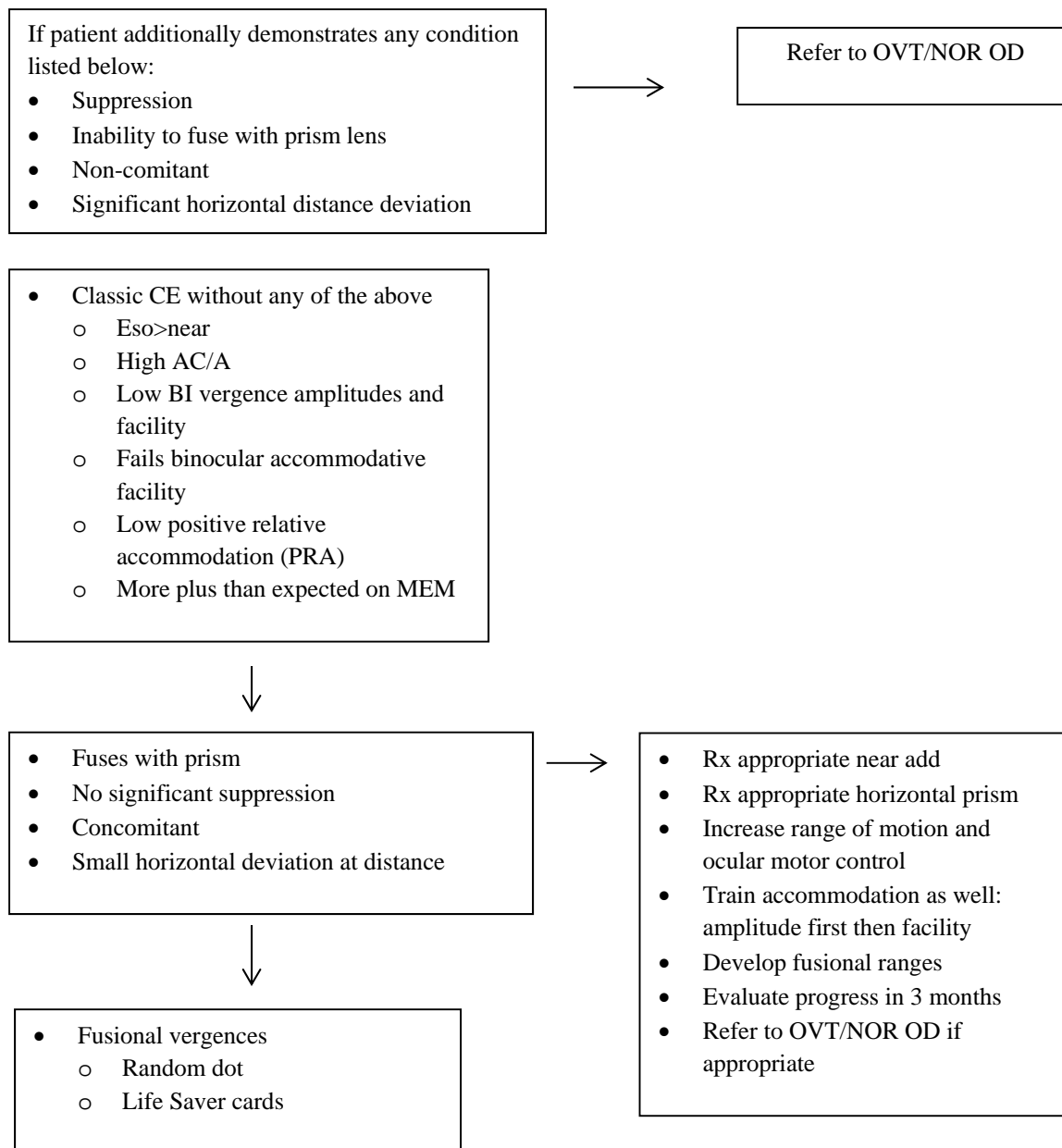
Management of divergence insufficiency: recommendations and basic OVT



[Care of the Patient with Accommodative and Vergence Dysfunction \(QRG-18\)](http://aoa.org/documents/optometrists/QRG-18.pdf)
aoa.org/documents/optometrists/QRG-18.pdf

[Care of the Patient with Accommodative and Vergence Dysfunction \(CPG18\)](http://aoa.org/documents/optometrists/CPG-18.pdf)
aoa.org/documents/optometrists/CPG-18.pdf

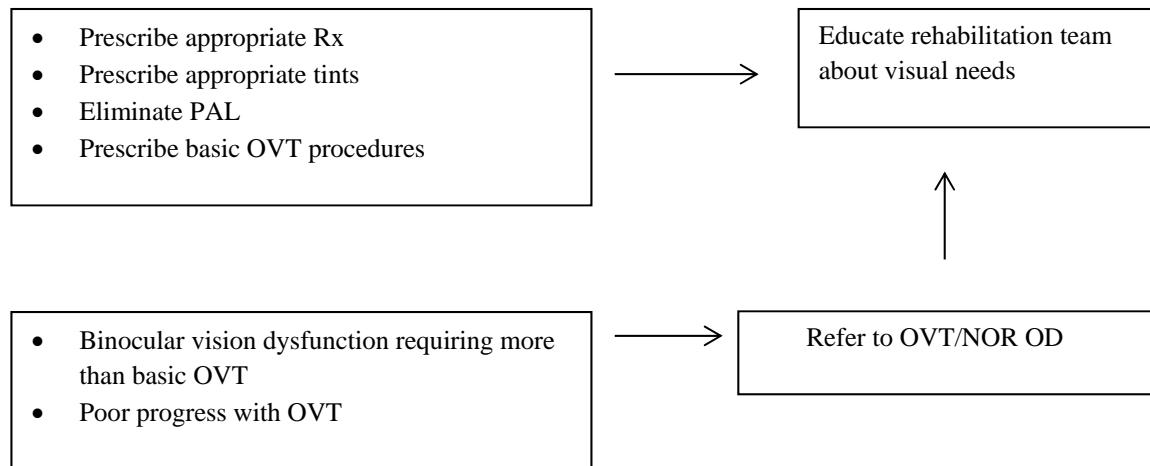
Management of convergence excess: recommendations and basic OVT



[Care of the Patient with Accommodative and Vergence Dysfunction \(QRG-18\)](http://aoa.org/documents/optometrists/QRG-18.pdf)
aoa.org/documents/optometrists/QRG-18.pdf

[Care of the Patient with Accommodative and Vergence Dysfunction \(CPG18\)](http://aoa.org/documents/optometrists/CPG-18.pdf)
aoa.org/documents/optometrists/CPG-18.pdf

Management of vestibular symptoms: recommendations and basic OVT



Notes: Some patients with vestibulopathy or symptoms of disequilibrium have minute vertical heterophorias that are poorly compensated or unbalanced. Correct with vertical prism. As little as 0.25^Δ can be prescribed and accurately ground. Once spectacles are received, reevaluate. Train fixation, motility accommodation and vergence with the spectacles if needed.

Management of perceptual symptoms

Some patients with TBI will have had a neuropsychological work up and their perceptual issues will have been addressed by a neuropsychologist. Even though management of visual perceptual symptoms is beyond the scope of primary eye care (and this manual), communication with the neuropsychologist about the patient's visual status and needs is essential. Awareness of near prescription, oculomotor condition and/or progress in OVT, and/or visual field deficit will help guide the therapist in developing and succeeding with therapy.

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Section IV: Advanced Topics

We have included several original articles for those who wish a bit more detail on select topics regarding optometric management of patients with TBI.

A. Prescribing Lenses for Patients with Traumatic Brain Injury

Brenda Heinke Montecalvo, O.D., Michael Peterson, O.D., Candice Elam, O.D.

Prescriptive optical treatments are valuable tools for the optometrist. When treating patients with brain injury chair-side, prescriptions allow for immediate intervention. Some patients require additional modes of rehabilitation, such as Neuro-Optometric Rehabilitative Therapy (NORT), low vision rehabilitation and coordination with other members of the rehabilitation team. Consider holding off on changing the patient's prescription if planning to consult or refer to an optometrist who specializes in treating brain injury. There are a variety of prism, lens and occlusion combinations that may need to be applied for the best outcome.

Understanding the difference between compensatory and therapeutic prescriptive lenses may aid management decisions made by the optometrist. When a device is used for a specific diagnosis and only works successfully when being used, it is a *compensatory* device. A *therapeutic* device is designed to try and resolve the diagnosed problem, thus making the device no longer required.

- Compensatory Lenses
 - Correction of refractive error
 - *Myopia*
 - *Hyperopia*
 - *Presbyopia*
 - Convergence Excess
- Therapeutic Lenses
 - Added Plus Lenses
- Compensatory Prism
 - Hemianopsia
 - Diplopia
 - Convergence Excess
 - Convergence Insufficiency
- Compensatory Occlusion
 - Diplopia
- Therapeutic Occlusion
 - Binasal Occlusion
- Therapeutic Yoked Prisms

Compensatory Lenses

- **Correction of Refractive Error**

In order to assess the binocular vision, accommodation, and oculomotor skills of a patient, the optometrist should first perform an accurate refraction with binocular balance in order to determine refractive error. This needs to be the first step in the treatment process, as providing the best possible visual acuity is essential

for accommodative and binocular management.^{1,2} Additionally, patients with brain injury may be hypersensitive and symptomatic to small refractive errors now that they have multiple problems to overcome. Therefore, correcting small amounts of refractive error is recommended for this population.¹

Since accommodative dysfunction is more common in brain injury, patients exhibiting signs of accommodative spasm or latent hyperopia may require a cycloplegic refraction to determine the refractive error. If full cycloplegia is obtained, 0.75D should be subtracted from the overall findings (unless the patient is myopic) to allow for the normal tonus of the ciliary muscle.¹

Myopia:

Myopic shifts are not uncommon after brain injury.³ Although the etiology for this is not clear, it is possible this may be due to increased eye strain when trying to use a compromised visual system.

A few categories of myopia common among the brain injury population include:

- *Night myopia*, which is blurred distance vision that occurs in dim illumination and is believed to be the result of low levels of light inducing an increased accommodative response.³ Less illumination does not allow enough contrast to adequately stimulate accommodation. As improper levels of illumination have adverse effects on patients with brain injuries, blurred distance vision at night is a frequent complaint among this population. Therefore, it is important to consider refracting these patients in dimmer lighting conditions than normal to see how they respond. Dark room retinoscopy can often demonstrate more minus lens power than was found during conventional retinoscopy.
- *Pseudomyopia* is an overstimulation of the accommodation mechanism resulting in an increase in myopic refractive error.³ On examination, fluctuations in accommodation may be observed as variations in visual acuity, retinoscopic reflex or changes in pupil diameter. One theory of pseudomyopia suggests that accommodation is an ability, which develops when a child moves through the spatial world and learns to focus differently depending on the distance of an object from the eye.⁴ It is suggested that trauma to the brain may cause this ability to be unlearned.^{5,6} The goal of treatment for pseudomyopia is to relax the accommodative spasm or accommodative excess. Although prescribing minus lens power may improve distance visual acuity, it will not reduce the accommodative response and should be avoided. NORT to relax accommodative spasm, increase accommodative amplitudes and increase positive fusional vergence would be the ideal solution. Another option would be plus lenses during near work.

Hyperopia:

Most commonly, patients with brain injury can measure an increase in hyperopia as a result of accommodative paralysis. Individuals with uncorrected hyperopia may experience many symptoms, including: blurred vision, asthenopia, binocular dysfunction, amblyopia and strabismus.⁷ Correcting even low amounts of hyperopia is important to eliminate neurological compensation for inaccurate visual input.

As accommodative insufficiency is very common in TBI, patients who have small to moderate amounts of uncorrected hyperopia pre-injury, may exhibit visual symptoms post injury.⁸ This may be due to the accommodative reserve decreasing to the level of pre-injury hyperopia and is too low to prevent symptoms.

There is no one management strategy for hyperopia. The clinician should take into account the age of the patient, the degree of hyperopia, the severity of the symptoms, visual acuity and the patient's visual efficiency when performing near tasks.⁷ The goals of treatment are to reduce the accommodative demand and to provide clear, comfortable vision with normal binocularity.⁷ When considering treatment for patients with TBI who measure hyperopia, the clinician has different options, from NORT to increase accommodative amplitudes and facility to full (or part time) spectacle correction, or a combination of both.

Presbyopia

Keep in mind that presbyopic patients with brain injury may benefit from switching from a multifocal to single vision reading glasses if there are motility issues or binocular disorders that vary from distance and near. Single vision reading lenses also benefit patients with brain injury who perform better when placing reading in the primary gaze position, as may happen with CNIV palsy.

- **Convergence Excess**

Added plus lenses may be beneficial in patients exhibiting a significant esophoria at near (convergence excess) if they have a high AC/A ratio.¹

Therapeutic Lenses

- **Added Plus Lenses**

Accommodative Dysfunction

Added plus lenses may be helpful due to the high incidence of accommodative insufficiency and infacility in the brain injury population.^{1,9}

Paralysis of accommodation after brain injury may be temporary or permanent. Added plus lenses can provide a temporary solution while the underlying condition is treated or the causative problem resolves.^{1,7} Unequal accommodation may require adds of unequal plus lenses.¹

Accommodative excess and accommodative infacility do not respond as well to added plus lenses^{1,9} and typically require NORT.

Compensatory Prism

- **Hemianopsia**

Prisms can be used to aid in visual field awareness for patients with hemianopsia. Several systems are available. The most commonly used systems are:

- **Fresnel Press on Prism**

A trial of base out Fresnel prisms can be applied to the patient's existing glasses to determine if visual field awareness can be improved. Base out prism is applied temporally to the eye that coincides with the side of the visual field defect. Prism placement and patient training with the appropriate scanning techniques, orientation and mobility are critical to acceptance and success with these types of systems.¹⁰

- **Peli Lens™**

The Peli prism uses a 40 prism diopter Fresnel prisms placed above and below fixation on the lens of the eye toward the defect, oriented base out.¹⁰ This placement causes displacement of images from up to 20 degrees in the area of field loss into the sighted field without eye movement. The patient is instructed not to look into the prisms.¹⁰ Two randomized clinical have been completed demonstrating the effectiveness of this method.^{11,12}

- **Visual Field Awareness System™**

The Gottlieb Visual Field Awareness System is a large dioptric (18.5 prism diopters) base out round prism button mounted on the temporal side of the patient's lens toward their hemianopic field defect.¹⁰

The patient should scan into their field defect and look through the prism in order to move images toward midline. Patients are taught to quickly scan into and out of the prism as the view will be diplopic, in patients who are binocular.¹⁰ Fitting kits and training instructions are available from Rekindle™.

- **Diplopia**

Due to a higher prevalence of vertical heterophoria and noncomitant deviations in the brain injury population, prism is often a necessary treatment.¹ When fusion can be obtained, brain injury patients may require smaller amounts of prismatic correction than patients in the general population.¹ Frequent follow-up is indicated during the first year after injury to ensure the amount of prism correction required is accurate.

- **Convergence Excess**

Patients with esophoria at distance and a normal to low AC/A ratio may benefit from horizontal relieving prism oriented base out.⁹ The amount of prism prescribed may be determined using fixation disparity analysis, Sheard's criterion, and/or Percival's criterion.¹

- **Convergence Insufficiency**

Convergence insufficiency has been shown to be effectively treated in children through the use of Optometric Vision Therapy.¹³ In the literature, horizontal relieving prism has not been clearly demonstrated as an effective treatment for CI.¹ However, the results of NORT are more variable and less predictable in the brain injury population so base in prism may be indicated as an aid to begin vision rehab, in lieu of vision rehab (when it is impractical or inappropriate), or at the end of vision rehab when symptoms persist.^{1,2}

Compensatory Occlusion

- **Diplopia**

Occlusion may be utilized if diplopia cannot be eliminated by correcting refractive error or utilizing added lenses and/or prism. However, it is preferable to restore binocular vision, fusion, and stereopsis, if at all possible.¹ In cases of significant non-comitance, refer to an optometrist that specializes in neuro-optometric rehabilitation.

Therapeutic Occlusion

- **Binasal Occlusion**

Binasal occlusion (BNO) consists of adhering opaque or translucent material on the nasal portions of the spectacle lens. BNO blocks the nasal field of each eye which is the crossed visual field located in the near center portion of the entire visual field. It has been described as a treatment for esotropia¹⁴, amblyopia, non-strabismic functional vision conditions and peripheral visual field awareness.^{15,16} For example, in esotropia, it is suggested that BNO inhibits any sensory maladaptations and promotes divergence of the eyes.^{15,16}

Visual motion sensitivity is a condition where normal motion of objects in the visual field has adverse physiological and perceptual effects on patients with TBI. BNO may help by suppressing the visual interaction between the central and peripheral visual fields, thus reducing the visual confusion.¹⁷ To date, successful claims that BNO reduces visual motion sensitivity is only supported by case reports.

Clinical case reports suggest that BNO may have some value in improvement of several asthenopic symptoms common in patients with brain injury. Accurate application and assessment is important to achieve optimum results.¹⁸ (see Abnormal Egocentric Localization in Advanced Topics of this volume for application procedure)

Therapeutic Yoked prisms

Yoked prisms are arranged with the base of each prism pointed in the same direction (such as base left or base up) and are used for certain conditions in the TBI/ABI population, such as homonymous hemianopsia

(HH), visual neglect/unilateral spatial inattention (USI) and abnormal egocentric localization (AEL).^{19,20} The mechanism of action is non-compensatory and is intended to work by altering spatial awareness. In HH, the yoked prisms are used with the bases directed towards the side of the defect (base left for left hemianopsia). The side of the field defect acts as a compression of that visual field and the base expands visual space which improves the patient's ability to align visual information accurately. Although the prisms in USI are applied the same way as HH, the difference is an individual with USI is not cognitively aware of the missing visual field, where one with HH is. The aim of treatment is to make the patient more aware of the missing field, in hopes that there will be a development of compensatory strategies, such as increased visual scanning and head movements, which come more naturally with HH.¹⁹ Yoked prisms in patients with an AEL are used to reduce the mismatch between their abnormal subjective and objective perception of the visual-spatial sense of direction.²⁰ The intent is that a patient will re-equilibrate, change body posture and eventually change visual posture.¹⁹ To date, minimal scientific evidence or long term studies of prism therapy in TBI patients exists in the literature, mostly case reports and anecdotal clinician experience. Also, there is always a concern that prism adaptation will occur and that gains made during prism therapy will be lost once the prisms are removed.

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B. Optometric Management of Photosensitivity in Patients with TBI

Chung To, O.D.

Photosensitivity is a common complaint seen in TBI patients. Current retrospective studies have found that the symptom, described as visual discomfort to otherwise normal light levels, affects more than 50% of patients with TBI.¹ The symptom can persist for months to years post injury and can occur outdoors and indoors. Despite its prevalence, photosensitivity remains to be poorly understood and difficult to manage due to its complex neurophysiological mechanism. A review of recent literature suggests that the sensation of pain and photosensitivity may be inextricably linked via the trigeminal nerve and its nuclei, both of which are the primary mediators of pain sensation in the head.^{2,3,4} Acute TBI has been suggested to cause displacement, irritation, and/or injury to the pain sensitive intracranial structures independent of the central visual pathways.² Other studies suggest that the retinal ganglion cells and the melanopsin photoreceptors of the iris are actively involved in the activation of the pain circuit.^{5,6,7} Regardless of the mechanisms involved, careful diagnosis, treatment, and management are critical as this debilitating symptom can have a significant impact on the overall management and rehabilitation of the TBI patient.

Before photosensitivity treatment and management are to be initiated, the clinician should rule out any underlying etiology that may provoke the symptom. The most common causes are anterior segment dysfunctions including dry eyes, conjunctivitis, blepharitis, pterygium, and any corneal abnormalities.² Generally, the more superficial the ocular involvement, the more significant the light sensitivity as this is likely due to direct irritation of the trigeminal afferents innervating the anterior surface.⁸ Ocular inflammation of any kind along the visual pathway, including the optic nerve, chiasm, thalamus, and occipital lobe can also contribute to the complaints. Non-inflammatory posterior segment diseases, such as retinal dystrophies, retinitis pigmentosa, and cone dystrophies have also been found to be associated.² Disruptions beyond the visual pathway, including certain neurological conditions, particularly migraine headaches, have been shown to be independently associated with photosensitivity. Noseda et al was able to demonstrate a neural mechanism for exacerbation of migraine headache by exposure to light.⁵ There is such a strong correlation that the International Classification of Headache Disorders listed photosensitivity as one of the major diagnostic criteria for migraine headaches.⁹ The prevalence of migraine headaches is found to be more than 50% in the TBI population.^{10,11} This number has been found to be even higher, up to 74%, in veterans suffering from confirmed diagnosis of blast related TBI exposure.¹² It is of no surprise that the post-traumatic light sensitivity, especially in patients suffering persistent and chronic symptoms, may be largely contributed to the comorbidity of migraine headache after TBI. It is imperative that these ophthalmic and neurological conditions be addressed and treated accordingly.

In the TBI patient with complaints of light sensitivity, despite normal ophthalmic examination, different treatment modalities are available, which include: ophthalmic lenses, colored tints, anti-reflective glare coatings, transitions lenses, polarized filters, mirrored coatings and unconventional alternatives.

When prescribing ophthalmic lenses for photosensitivity, the practitioner should give special consideration to the absorption characteristics of the lens material, i.e. glass vs. plastic vs. polycarbonate vs. high index. This becomes an important factor, as there is a significant body of literature that supports ultraviolet (UV) radiation's harmful effects on the eye, particularly UV from solar radiation.^{13,14} Short-term exposure to these UV wavelengths can significantly worsen the symptom of light sensitivity in both normal and TBI patients, while long-term exposure without adequate protection can result in physical changes and damage to the ocular structures. Newer research has also suggested UV induced fluorescence may affect visual function in normal individuals.¹⁵ Fluorescent lights emit a high UV and short wavelength light that is more prone to scatter, resulting in reflected glare. These effects on visual function are likely exacerbated in the TBI patient when there is underlying binocular and accommodative visual dysfunction. A clear spectacle lens without any additional coatings should ideally absorb all of the harmful UV radiation while transmitting the complete wavelengths of the visible spectrum. Crown glass, previously the standard of spectacle

eyewear, has now been replaced by CR-39 plastic due to its lack of UV protection. Clear CR-39 alone does not provide complete UV protection and requires an additional dye.¹⁶ Clear polycarbonate, high index and Trivex are the only materials that can completely absorb the harmful UV radiation without any use of additional coatings.^{17, 18} As an additional bonus, polycarbonate and Trivex are the only materials that meet the ANSI high impact protector requirements, providing an extra layer of safety protection.^{18, 19} For the photosensitive TBI patient requiring spectacle eye wear for any reason, a polycarbonate lens material or Trivex would be an adequate choice as an initial step towards functional recovery.

An ophthalmic tinted colored lens has been widely supported by some practitioners and remains to be the most common approach to the management of photosensitivity. When prescribing for indoor tints, it is important to gradually decrease the dark-adapted state by reducing the degree of light sensitivity. Dark adaptation refers to a physiological response that aims to maintain a constant level of light sensitivity in the presence of changing levels of illumination. Elevated dark adaptation threshold have been commonly found in the TBI patient.²⁰ Clinically, it is not uncommon for a TBI patient to present with darkly tinted lenses to reduce light exposure while indoors. This type of behavior should be strongly discouraged, as chronic darkness will facilitate further dark adaptation and increase the perception of pain from light sensitivity. Truong et al, found that neural adaptation to photosensitivity appears to be a long-term process and that darkly tinted lenses may act to inhibit this natural adaptive phenomenon.²¹ As a clinical guideline, indoor tints are typically prescribed at 15% intensity and no more than 30% to prevent further elevated dark adaptation threshold. Above the 30% intensity, transmission percentages are too low and can impair the patient's ability to function in normal level light illumination. As the patient shows an increased tolerance to normal light exposure, a gradual decrease in tint intensity should be considered to allow for normal neural adaptation to occur. The goal of treatment should be to allow for clear and comfortable functional vision in normal light settings with the least amount of visual disturbance to otherwise normal visible light spectrum.

A wide variety of ophthalmic tinted lenses are available commercially. Of important note: there is little scientific rationale to support prescribing a specific colored filter for a specific condition. Therefore, the best approach should be based on the patient's subjective response. Neutral grey, blue, green, yellow, and rose tints have all been documented to reduce light sensitivity in symptomatic patients. When significant reduction of light is required, neutral gray lenses provide the most satisfaction. Additionally, gray is the only tint that does not distort color by allowing an even transmission of light throughout the visible spectrum.¹⁷ This becomes especially useful when the patient requires good color distinction in their specific occupation. Blue tints have become popular as there are some case reports documenting its positive effects on patients with motion disturbance, particular post brain injury.^{22,23} Anecdotal reports from TBI patients who use light blue tinted indoor glasses state they provide less contrast therefore decrease the level of hypersensitivity. A randomized controlled trial of short wavelength (blue) light therapy vs yellow light therapy for fatigue following traumatic brain injury concluded that blue light appears to be more effective in alleviating fatigue and daytime sleepiness following TBI.²⁴ This is the first study to demonstrate use of light therapy in the TBI population though more research is needed in this area. Green tints have transmission curves that mimic the color sensitivity curve of the visual system but it alters the perception of colors by absorbing red and blue light.¹⁷ Green tints are typically avoided, especially for patients with color deficiency, because it narrows the visual spectrum. Yellow and amber tints absorb heavily in the blue region and serve as good haze filters to enhance contrast. In a TBI patient, this may not be the ideal situation. Bohnen has suggested that a decrease in tolerance to light after mild brain injury may be due to cortical and subcortical lack of inhibitory control.²⁵ Enhancing the visual stimuli may therefore cause further cortical hyper-excitability and confusion resulting in visual neurons firing inappropriately. Yellow and amber tints tend to do better in the low vision population but may worsen light sensitivity in the TBI patient in normal light environments. The use of yellow and amber tints may be considered in more dim light situations. Brown tints have the same characteristic as yellow and amber tints in that there is a higher absorption of shorter visible blue wavelengths but tend to induce more color distortion. Rose tints do not absorb much of the shorter wavelengths of visible light and are minimally protective against UV radiation; however, some patients claim they reduce glare.¹⁷ Clinical pearl: if a patient has been wearing a particular tinted lens

and claims to be doing extremely well with it, make an effort to include the same tint in any new prescription. Any lightly tinted lens that reduces visible light transmittance performs the same function by reducing the internal multiple reflections within a lens. The subjective responses and personal inclination towards a particular color may be more psychological. Other cosmetic tints are also available in a wide array of pastel colors but their absorption is unpredictable and should be avoided.¹⁷ When selecting a particular lens, the clinician should consider the patient's environmental conditions; e.g. bright vs dim illumination, familiar vs dynamic environments, influence of fluorescent vs incandescent lights vs LED vs halogen, and driving vs ambulating under various weather conditions. It is not uncommon to prescribe multiple lenses with different tinted colors and in varying amounts of intensities to meet the patient's goals and needs.

Outdoor tints, in addition to a specific color, are also given a number that indicates the approximate luminous transmittance of the tint.¹⁹ The lightest, #1 tint, provides transmittance of about 75% to 85%. At this level, comfort is provided appropriately for indoors but minimum relief is provided for outdoor use. At 50% transmittance, #2 tints become too dark for indoors but not dark enough for outdoors to be used effectively as sunglasses. The darkest, #3 tints, has a transmittance of 20% and is the most commonly prescribed tint for outdoor use.¹⁹ Anything below 20% transmittance may be too dark for everyday needs. In special circumstances, i.e. winter sports at higher altitudes, lower transmittance up to 8 to 12% can be considered. As a cautionary measure, any tinted lens with a transmittance less than 80% should not be used for driving at night due to the decrease in visibility of objects.¹⁷

Light reflections from surfaces can contribute to functional glare and photosensitivity. Anti-reflective glare coatings can help eliminate both external and internal reflections and additionally increase light transmittance by up to 8%.¹⁶ The coating has also been known to alleviate the disturbing multiple image reflections caused by oncoming headlights. The use of an anti-reflective glare coating alone can significantly improve functional vision, especially during nighttime driving and prolong near visual activities. When used in combination with a selective colored tint, the anti-reflective glare coating creates even more reduction of photosensitivity for the TBI patient.

Polarizing filters are also effective in reducing reflective glare, more specifically sunlight glare reflecting off a surface, i.e. water or highway. Polarizing filters are best used in conjunction with an absorptive coating, commonly a dense neutral gray coating that transmits 21% of the visible spectrum. This combination reduces the reflective glare and also decreases the transmitted light to about 10% of the incident light, making it an effective sunlight filter.¹⁶ Polarization works by dissipating sunlight energy in the horizontal meridians and selectively reducing those light rays and much of the glare from surface reflections. Polarizing materials reduce the overall transmission to less than half of the total un-polarized incident light.¹⁷ When choosing an outdoor lens, it's important to choose a frame that is large enough to reduce the amount of light entering from the sides.

For the TBI patient who needs additional reduction in reflective glare when outdoors due to intense sunlight exposure, a mirror coating can be considered. The mirror coat is applied to the front surface of a lens by a vacuum process giving it properties of a reflecting filter.¹⁷ This significantly reduces the amount of light transmitted to the eye and is often used in conjunction to other tints to provide darker lenses than are normally available. These are commonly used in patients who are actively involved in snow sports like skiing or mountain climbing.

Another option for consideration is the transitional lens, which offers an advantage to those who adapt poorly to differing levels of illumination. The transitional effect is achieved by the addition of certain organic compounds that when exposed to UV radiation, undergo molecular rearrangement resulting in the combination of two or more small chromophores present within the lens material absorbing visible light causing a darkening of the lens.¹⁶ This chemical reaction reverses itself when the exciting wavelengths are removed, resulting in a reversion of the lens back to its colorless state. The limitation of the transitional lens is that they do not darken inside automobiles because windshields absorb much of the UV light necessary to trigger the physio-chemical lens change. When the lens does turn dark, unfortunately for the TBI patient, it does not turn dark enough that is satisfactory. And when rapid changes are needed, the delay may become problematic. For patients who insist on the use of transitional lens

for convenience of mobility but do not get enough darkening in a car, can consider the addition of a polarized clip-on filters with neutral grey tint that can be placed over the transitional lens when they travel by car or need additional darkening.

Non-optical aids should also be considered in the photosensitive patient. Several non-optical aids that may be helpful in controlling illumination include visors and hats or caps with broad brims. There are also clip-on visors and side shields for spectacle frames to further reduce ambient lighting. When the patient cannot wear spectacle lenses, either due to physical limitation from skull/facial injury and/or personal election due to cosmetic or psychological sensitivity, methods in controlling light exposure can be considered. Control of room lighting with use of light bulbs and lamps that have special spectral and light intensity characteristics can be implemented. Additionally, use of color corrective or neutral density acetate overlays for reading can also be considered.²⁶

Unconventional treatment modalities have also been suggested to relieve light sensitivity. Truong et al found that patients who wore non-tinted contact lenses exhibited decreased photosensitivity over time.²¹ The author postulated that this might be due to the biomechanical aspects of the contact lens causing trigeminal nerve desensitization. If this hypothesis is correct, then the use of color tinted contact lenses can also be applicable for the acute management of light sensitivity in patients who cannot tolerate spectacle wear. In cases where non-physiological mydriasis is present, contact lenses with an artificial pupil may be extremely beneficial. Further research is needed in this area before further clinical application can be considered. Manifestations of light sensitivity secondary to visual stress from binocular and accommodative visual dysfunctions have also been suggested.²⁷ Treatment goals for these patients should be aimed at rehabilitating the binocular and accommodative visual function through active visual rehabilitation therapy. Some practitioners have also advocated the use of binasal occlusion for the relief of binocular vision related disorders, including light sensitivity. Binasal occlusion, inherently, is a form of sector occlusion originally used for patient with strabismus, particularly esotropia, but has now been suggested for other visual disturbances.²⁶ There are a limited number of case reports documenting the use of binasal occlusion, but the neurophysiology behind this treatment option has not been fully documented in the literature. Ciuffreda et al studied the effect on bi-nasal occlusion on the visual- evoked potential on TBI patients and found an increase in amplitude.²⁸ Additional research and controlled clinical trials are necessary to validate the use of binasal occlusion.

Photosensitivity remains to be the most common complaint in the TBI patient and management and treatment can be extremely challenging due to the lack of understanding of the condition. It is important to identify the causative agent, as there are many associations from ophthalmic to neurological conditions, which should be treated accordingly. Colored tints, filters, polarization, anti-reflective coating, mirror coatings, and non-optical aids should all be considered to provide the patient maximum relief for functional and comfortable indoor and outdoor vision.

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C. Ocular and Visual Side Effects of Medications Commonly Prescribed in the Treatment of Traumatic Brain Injury

Matthew Rhodes, O.D.

Introduction

Many of the medications prescribed to treat conditions associated with TBI can have one or multiple unintended and undesirable effects on the eye or visual system. While the eye is reportedly the second most frequent body organ to manifest drug toxicity^{1,2}, evidence suggests that most vision symptoms and ocular diagnoses associated with brain injury are primarily related to the brain injury itself, and not the medications used to treat TBI sequelae³. Still, clinicians involved in the treatment and management of TBI related vision deficits and oculomotor dysfunction should be aware of the potential for, and be able to identify, medication-induced vision and ocular side effects. When visual or ocular effects of a medication impair rehabilitation efforts or pose a threat to vision or eye health, it is critical that eye care practitioners promptly communicate to prescribing providers the need to consider alternatives to or cessation of the inciting medication.

This chapter will provide a basic overview of the documented ocular and visual side effects associated with the medications most commonly used in the treatment of TBI and associated sequelae, grouped by drug classification. Table 1 presents the classifications of drugs as they are addressed in the discussion. Additionally, Appendix F (BIERM Vol1B pg. 123) contains a list of vision and ocular defects that may manifest during the care of the brain injured patient and the drugs used in TBI treatment that have a probable or well-established association with those defects.

Vision and Ocular Side Effects

The human eye is sensitive to drug toxicity because it has a small total mass, has a rich blood supply, and its tissues have a high metabolic rate². Highlighted here are a few of the most common and prominent ocular and vision side effects of each of the major categories and classifications of medications used in the treatment of TBI.

Psychotropic Medications

Psychotropic drugs target chemical interactions in the brain. Because the retina is an extension of the brain, the eye may be particularly susceptible to adverse effects from these agents.

Because of their favorable safety profile, Selective Serotonin Reuptake Inhibitors (SSRI's) are the most commonly prescribed antidepressant drugs in the world. SSRI's as a class have been associated with mydriasis, increased IOP, glaucoma, and oculogyric crisis^{1,2}.

The Benzodiazepines only rarely cause significant ocular or vision side effects at therapeutic levels, and these effects are reversible⁴. Disturbances of saccadic and smooth pursuit eye movements are probably the most well-established², and these effects may confound the diagnosis of TBI related eye movement disorders.

Tricyclic Anti-depressants can have an ocular anticholinergic effect that results in some degree of mydriasis and cycloplegia that may result in disturbances of accommodation and blurred vision^{2,4}.

Trazodone has been reported in association with palinopsia in multiple cases^{2,5}, and has been linked to cases of visual disturbances including ghost images and strobe-light effects⁴.

Very few and rare ocular or vision side effects have been reported in association with Bupropion use, but at least one case of diplopia has been reported⁶, and at least one case of bilateral uveal effusion and angle closure glaucoma⁷. The Phenothiazines, Apiprazole, and Haloperidol are included among the typical antipsychotics. Phenothiazines can have significant anticholinergic effects, which may result in decreased accommodation and may increase the risk of

angle closure glaucoma. They are also known to cause corneal and lenticular opacities¹. Apiprazole and Haloperidol, because of powerful anti-dopinergeric action, can cause eye movement disturbances². Haloperidol has also been observed to cause bilateral pupillary dilation and myopia⁴.

Like typical anti-psychotics, atypical antipsychotics have anticholinergic properties and tend to block dopamine pathways. They have been reported to cause oculogyric distonias².

Valproic acid and the chemically related compounds Sodium Valproate, Divalproex Sodium can have a reversible subclinical effect on color vision, but no other certain ocular or vision effects have been described⁸.

The most common side effects of Carbamazepine are transitory diplopia, blurred vision, and a “heavy feeling in the eyes.” Cataractogenic potential of this medication has also been suggested but not proven⁴.

Like other sulfa-derived medications, Topiramate can rarely cause an idiosyncratic reaction that presents as bilateral acute angle closure glaucoma and an acute bilateral myopic shift. The effects are reversible and the condition resolves after cessation of the medication^{1,9}.

The most well-established effect of vision from Gabapentin use is blurred or decreased vision in various forms^{4,8}.

Pain Management Medications

Therapeutic dosages of narcotics and medications used for the treatment of neuropathic pain generally do not produce ocular or visual side effects.

Non-steroidal anti-inflammatory medications (NSAID’s) can cause blurred vision, changes in color vision, photophobia, conjunctivitis, Stevens Johnson syndrome, and vertigo¹⁰.

Motor System Medications

Baclofen is used in the treatment of nystagmus and with no common vision or ocular side effects, though abrupt withdrawal from this medication has reportedly caused visual hallucinations¹¹.

Cyclobenzaprine alone generally doesn’t cause vision or ocular side effects. Mydriasis has been noted as a feature of a syndrome that can occur when used with pro-serotonergic medications such as the MAOI’s or SSRI’s¹².

Memory and Cognition Medications

Donepezil has been shown to reduce intraocular pressure and induce miosis¹³, while Modafinil has not been reported to cause significant ocular side effects¹⁴.

Though Methylphenidate and Dextroamphetamine only rarely cause side effects⁴, the latter has been reported in association with blurred vision, mydriasis, and visual disturbances¹⁴.

Table 1. **Classification of Oral Medications Used in the Treatment of TBI**

Psychotropic Medications

Drug Classification	Generic Name	Brand Name
Anti-anxiety	bupirone	Buspar
Benzodiazepines	diazepam alprazolam clonazepam lorazepam zolpidem	Valium Xanax, Niravam Klonopin Ativan Ambien, Edluar, Zolpimist, Intermezzo

Anti-depressant	trazodone bupropion	Desyrel, Oleptro Wellbutrin, Zyban
Tricyclic	amitriptyline imipramine	Elavil Tofranil
SSRI's	sertraline fluoxetine paroxetine citalopram escitalopram	Zoloft Prozac, Sarafem Paxil, Pexeva Celexa Lexapro
Typical Anti-psychotic	apiprazole haloperidol	Abilify Haldol
Phenothiazines	chlorpromazine promethazine	Thorazine Phenergan
Atypical Anti-psychotic	quetiapine risperidone ziprasidone HCL	Seroquel Risperdal Geodon, Zeldox, Zipwell
Anti-convulsant/Mood Altering	sodium valproate divalproex sodium valproic acid carbamazepine topiramate gabapentin levetiracetam	Depacon Depakote Depakene Tegratol, Carbatrol, Equetro Topamax Neurontin, Horizant, Gralise Keppra

Pain Management Medications

Drug Classification	Generic Name	Brand Name
Narcotics/Pain Killers	tramadol oxycodone/acetaminophen hydrocodone	Ultram, ConZip Percocet Vicodin
Treatment of Neuropathic pain	pregabalin gabapentin	Lyrica Neurontin
NSAIDS	meloxicam indomethacin ibuprofen acetaminophen naproxen sodium	Mobic Indocin Advil, Midol, Motrin Tylenol Naprosyn

Motor System Medications

Drug Classification	Generic Name	Brand Name
Anti-spastic	baclofen tizanidine cyclobenzaprine	Kemstro Zanaflex Flexeril, Amrix
Other	bromocriptine amantadine	Parlodel, Cycloset Symmetrel

Memory and Cognition Enhancing Medications

Drug Classification	Generic name	Brand Name
Memory/Cognition Enhancing	donepezil modafinil methylphenidate dextroamphetamine	Aricept Provigil Concerta, Daytrana, Methylin, Ritalin Dextrostat

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D. Management of Low Vision in Patients with TBI

Candice Elam, O.D.

Some patients with traumatic brain injury will have low vision. Low vision, as defined by the National Eye Institute, is a visual impairment not correctable by standard glasses, contact lenses, medication or surgery that interferes with the ability to perform activities of daily living.¹ Visual impairment not only includes reduced visual acuity or visual field loss but may also result from reduced contrast sensitivity, visual distortion, diplopia, impairment from perceptual dysfunction and/or ocular photosensitivity. Visual impairments can affect an individual's ability to perform any number of activities of daily living and work-related tasks.² In the brain injured population, vision impairment can create additional challenges related to independence and employment. This is compounded by the cognitive, psychological and motor problems often seen in these patients. Due to the high prevalence of vision problems in the brain injured population it is vital that visual rehabilitation, incorporating optometrists and a low vision team, is a component of the patient's general rehabilitation plan.

Optometric low vision rehabilitation is defined as "the process of treatment and education that helps individuals who are visually disabled attain maximum function, a sense of wellbeing, a personally satisfying level of independence, and optimum quality of life."² Management should be individualized for each visually impaired patient with specific considerations made for the patient's cognitive ability to participate in rehabilitation, the patient's goals, and their expectations and motivation.³

The rehabilitation process begins with the optometrist prescribing treatment options which may include:

- Specialized optical systems (magnifiers, telescopes, spectacle microscopes, prisms, tinted lenses) or video magnifiers (also known as CCTVs), for the improvement of visual function.
- Use of non-optical devices such as line guides, enlarged keypads, tactile markings on appliances and many others.
- The latest in cutting-edge technology including computer screen enhancement to enhance home, employment, education, and/or leisure activities.
- Training to maximize visual functioning and performance of a wide variety of activities of daily living.
- Coordination of care with related health and rehabilitation professionals as indicated.
- Education and counseling regarding the visual impairment and its implications.

Reduced Visual Acuity

Patients with reduced visual acuity should be assessed for appropriate magnification for specific tasks.

Magnification for near may include spectacle-mounted reading lenses (microscopes), telemicroscopes, hand magnifiers, stand magnifiers, and electronic devices such as closed-circuit television systems (CCTVs), adaptive computer software, or head-mounted devices (HMDs).² Magnification for distance includes both Galilean and Keplerian telescopes and electronic devices. Factors to consider when prescribing near and/or distance devices include ease of use, hands-free requirement, lighting, contrast, and cosmesis.

Visual Field Defects

Management of patients with visual field defects depends on the location of vision loss. Central scotomas are best addressed through eccentric viewing training. This involves development of a new preferred retinal locus near the scotoma.² Eccentric viewing training includes teaching awareness of the scotoma and may utilize prism to aid in the perceived relocation of the image. Large-print materials and/or low power magnification may be introduced to further promote reading. Patients with peripheral visual field defects should be evaluated by a certified orientation and mobility specialist for environment navigation.² Prisms may be useful when patients have either generalized constriction of visual fields or hemianopia. Minifying the entire visual field using reverse telescopes or minus lenses is an alternative for patients with good visual acuity.² These devices should be used briefly for orientation, to locate objects, or to read larger print. Training is essential for success with the use of visual field enhancement devices.

Contrast Sensitivity and glare

Reduced contrast sensitivity and glare sensitivity can be addressed in visually impaired patients by determining optimum lighting, using tints or filters, recommending non-optical devices (hats, side shields, etc. See BIERM Vol1B pg. 39-43) or prescribing electronic devices.² Photophobia is commonly associated with traumatic brain injury and many patients report sensitivity to fluorescent lighting commonly found in grocery stores or workplaces.⁴ Keeping this in mind, glare sensitivity should be assessed in different lighting environments.

Non-optical aids may help low vision patients by using relative size magnification, contrast enhancement, or tactual or auditory cues.² These devices may include large print materials, reading stands, writing aids, typoscopes, tactile or visual markers (for microwave buttons, stove dials, etc.), talking watches or clocks, and audio/taped materials. Many electronic devices like computers and cell phones have built-in accessibility options for users with impaired vision. Determining the appropriate ambient and task lighting is essential to help visually impaired patients use their residual vision more efficiently as well.

In-office training on the optical systems prescribed is often necessary for patients with visual impairment. This may include reviewing the most efficient use of the devices, care, cleaning and maintenance of devices (including changing batteries and bulbs), and safety.² Reading speed and duration typically improves with practice; however, further in-office training and/or at home activities may be needed to teach patients how to use their residual vision more efficiently. Keep in mind, the amount of time needed for training depends on the cognitive level of the patient and their motivation and expectations.² In addition to eccentric viewing, other training can focus on scanning, fixating (saccadic eye movements), pursuits, blur interpretation, memory and word recognition. Additional rehabilitation therapies may be indicated to improve visual functioning. The optometrist can arrange for additional therapies as indicated.

The optometrist providing low vision rehabilitation works with an interdisciplinary team including orientation and mobility services, occupational therapy, counseling services, and technology evaluations (computer and other assistive technology). Low vision patients may warrant referral for other resources such as state blind rehabilitation services, vocational rehabilitation services, educational services, or U.S. Department of Veterans Affairs Optometry Service and Blind Rehabilitation Service (for military veterans).²

Low vision rehabilitation is a dynamic, ongoing process that requires patient counseling and education for successful management. Visually impaired patients (and their families) should be educated on the ocular diagnosis, disease course, prognosis and functional implications. Discussing the treatment options and importance of compliance and motivation for effective rehabilitation in the visually impaired brain injured population is imperative. The cognitive ability of the patient can significantly affect the development and revision of low vision rehabilitation goals. Consideration should be given to the level of family support available as well. Patient counseling may include referral to individual or family support groups available for those with brain injuries and/or low vision. Comprehensive optometric low vision rehabilitation can significantly improve the quality of life for visually impaired patients and is particularly essential for effective rehabilitation of the brain injured patient as a whole.

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E. Advanced Dynamic Retinoscopy to Determine Optimum Near Lens for Brain Injured

Brenda Heinke Montecalvo, O.D.

Dynamic retinoscopy is a valuable procedure for all age groups of the brain injured population. Individuals with brain injury often suffer from extreme visual stress when reading or performing near tasks. The visual stress can be increased with digital displays. Dynamic retinoscopy will determine the optimum near point lens for these individuals that can relieve visual stress. The exact lens prescription is dependent on the working distance of the near demand.

Dynamic retinoscopy, with the exception of the Monocular Estimate Method (MEM), is a binocular procedure performed at near viewing distances. With static retinoscopy, the patient is thought to be passive, while dynamic retinoscopy requires varying levels of patient cognitive activity. Dynamic retinoscopy provides the optometrist with information and insights regarding the patient's abilities and level of visual processing at the chosen distance.¹⁻³

The two common dynamic retinoscopy procedures used to determine the optimum visual process with the brain injured population are Book and Monocular Estimate Method (MEM). Book retinoscopy emphasizes evaluating visual and reading performance with lenses and MEM retinoscopy determines the lag of accommodation.¹⁻¹³ Nott, Bell or Stress Point are other forms of dynamic retinoscopy that may be used. Details of these procedures can be found in the Optometric Extension Program archives.⁴

Book Retinoscopy

The optometrist places reading material at the patient's near working distance. The reading material is held in front of the retinoscope in one hand and the lenses in a flipper holder are held in the other hand. Wearing the habitual distance correction, the patient is asked to read the material while the optometrist observes the retinal reflex for color, brightness, size and motion. The optometrist places binocular low plus lens in front of the patient's eyes while the patient reads the material presented. The optometrist observes changes of the reflex and determines which lenses create the optimum reflex. By definition the best reflex is neutral, bright, evenly colored orange of medium size.¹⁻⁸



Getman used Book Retinoscopy to assess near visual function while the patient was reading and concentrating. While observing the reflex when reading he noted that the brightening and dulling of the reflex was directly correlated with the varied levels of cognitive demand.⁷ The following functional observations have been noted with book retinoscopy:

Optimum current level of reading

The preferred working distance

Eye movement control

Binocular control
Accommodative posture
How well concentration can be held
Level of stress with reading
Rapport with reading material

When lenses are placed before the patient the observer evaluates changes in the reflex and determines if the reflex is improved or deteriorated.¹⁻⁸ Getman noted that the reflex changed based on how comfortable the patient was with the reading demand. Below is a list of his categories of reading efficiency and how they are determined.⁸

1. Free-reading level: When the individual exerts little effort in order to comprehend the material with minimum stress. The reflex motion varies from "neutral" to "with" of approximately +0.50D. The color of the reflex is pinkish-orange and is bright and sharp. This is a very desirable reading level as it indicates attendance to the reading material without being too difficult. This reflex is more commonly observed when participating in desirable enjoyable reading such as popular magazine or novel.⁸

2. Instructional level: This reading level requires a higher cognitive demand and thus is slightly more stressful than the free-reading level. The reflex motion varies from fast "against" to a fast "with". A range from -0.25 to +0.75 can be observed. The color of the reflex is a very bright pink/orange and almost fluid. This reflex might be observed when reading to learn new material such as a textbook.⁸

3. Complete frustration level: This is essentially a non-reading level where the individual is reading the page but is not receiving any meaning from the material or not "cognitively" involved. You would see a very slow "with" motion which can be as high as +3.00. The color of the reflex would be a dull brick red. This situation is observed when the patient is required to read beyond his ability.⁸

Book Retinoscopy Procedure

Materials:

- Retinoscope (spot is preferred)
- Gray Oral Reading Cards (Fig.1)
- Normal room illumination
- Habitual distance lens (contacts or glasses)

While the most convenient targets to use are the Gray Oral Reading Test paragraphs standardized for the different grades, any reading material designed for different levels can be used. The Gray Oral cards have the material printed at the top of the card, so when you scope over the card you are not misaligned with the visual axis. The goal is to have the patient read something at his level of comfort.¹⁻⁸ This is different from MEM where a series of words, letters or pictures are read on a card with a hole in the center.⁵

Step 1: Hold the retinoscope just above the reading card so the retinoscope beam is just at the top of the card. The beam is at the visual axis. Determine the quality of the reflex while the patient reads. Observe if the reflex changes when the reading material is made easier and more difficult. Once you have the best reflex with the optimum reading material, binocular flipper lenses are introduced to determine if the quality of the reflex can be improved.¹⁻⁸

Step 2: To probe the effect of lenses, use flippers with various strengths ranging from +0.12D to +2.00D. As in Step 1, the lens to begin with is near the amount creating neutrality. Have the patient read one or two sentences with the different lenses slightly above and below the estimated neutral plus lens. With the different lens probes, observe any change in color, size, motion or brightness. The lens that has the most improved reflex is the desired lens for near.¹⁻⁸

Step 3: With the optimum near lens, increase difficulty of reading material to observe if a better reflex can be

maintained. Besides measuring the reflex with more difficult reading material the OD can re-measure eye movements, accommodative amplitude and near point of convergence with the optimum lens in place. Any improved function with this lens can help determine the level of prognosis, effectivity and need for additional OVT. Immediate improvement in visual motor skills is seen as a positive effect with a good prognosis. Minimal change indicates the need for OVT in addition to use of the lens for all near activities. ¹⁻⁸

Note: The optimum near lens may be different for the reading distance versus the computer distance. The above procedure can be modified to simulate the computer working distance. The optimum lens should be chosen which reduces the reading effort and stress. If an "against" motion is seen initially and by adding plus this "against" motion is either increased or does not reduce, then a near plus lens will not be indicated. Re-check the subjective refraction, binocular status and over-accommodating possibility. Do not prescribe minus lenses at near. ³ This type of patient will need to be referred for OVT before benefiting from a near lens. Also, it is important to note the patient with brain injury can fatigue quickly which can change the results of this procedure. Clinically the lens determined in the first five to 10 minutes is the easiest to adapt to for patients with brain injury. ³

Monocular Estimate Method (MEM)

MEM retinoscopy is a near retinoscopy technique that is done differently than Book Retinoscopy. Most other near retinoscopy techniques depend on the insertion of a lens to determine the effect of the lens on performance. MEM is unique since lenses are used to verify the motion observed by the optometrist. MEM depends only on the amount of motion of the retinoscopy reflex. Although color and brightness changes will be apparent to the majority of observers they are discounted and not considered as significant findings of this technique. ⁹⁻¹¹

In general, the patient is asked to look at a near stimulus while the observer watches the retinoscopy reflex from the plane of the stimulus. Most often there will be a "with" reflex corresponding to the accommodative posture being located farther from the patient than the presented stimulus. The difference of the distance is termed "lag of accommodation." The lag of accommodation is the amount of plus lens corresponding to the movement seen. The amount of lens needed for neutrality is estimated based on the amount of movement observed. Insertion of a lens is optional and with experience is less necessary. When needed the examiner inserts a suitable trial lens briefly in front of **one** eye to verify the amount of movement, taking care that the lens does not change performance. The lens is only inserted to verify the optical information to help quantify the amount of with movement observed and again only if needed. ⁹⁻¹⁰

MEM Retinoscopy Procedure

Materials:

- Retinoscope
- MEM Hole Cards 12"x12" (figure 2 & 3)
- Slightly dimmed room illumination
- Habitual near lens

With the hole card clipped to the retinoscope, the examiner is positioned on the patient's visual axis at the working distance. Do not scope off axis or more "against" motion will be observed. ^{9-10, 12} The MEM cards have a series of printed letters, words of varying difficulty or pictures depending on the level of literacy. These letters, words or pictures are printed around the central hole to ensure that the reflex is as close to the visual axis as possible. The beam of the retinoscope passes through the central aperture of the card. Choose a card with printed material appropriate to the literacy level of the patient. If they cannot read, use the picture MEM card. ⁹⁻¹⁰

The retinoscope beam is projected on the bridge of the patient's nose and the child is asked to read the words on the card or to name the pictures. As they are reading the retinoscope beam is moved across the horizontal meridian of one eye and then the other. An estimate is made of the direction and power of reflex seen. A loose trial lens is then placed in front of one eye that approximates the power of the movement seen. The lens is only held in position for

two seconds or less so as not to change the accommodation. If the estimate of the lens power was correct, neutrality will be observed. If the estimate was incorrect a new lens is briefly inserted until neutrality is observed. Usually a slight "with" motion is observed. A plus lens would then briefly be placed in front of the eye which approximates the amount of "with" seen. The power is modified as required. The procedure is then repeated with the other eye.⁹⁻¹⁰

A MEM value of +0.50 to +0.75 is considered normal. This lag of accommodation is an indication of the index of accommodative accuracy. If more than +0.75D of lag is observed, some form of correction should be considered for near work. A negative value on MEM indicates that the patient is over-accommodating.⁹⁻¹⁰ Clinically, this has been observed to be more common with the brain injured population. When this is the case, binocular plus are placed in a trial frame to be worn for approximately fifteen minutes giving the patient time to adapt. Then follow the above MEM procedure to assess what effect the plus lenses are having on the accommodative system. This technique can be enough to relax the accommodative system and a normal MEM value will then be observed. If this does not occur, do not prescribe plus lenses.⁹⁻¹⁰ Refer for OVT with an emphasis on accommodative flexibility.

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Figure 1: Gray Oral Reading Card

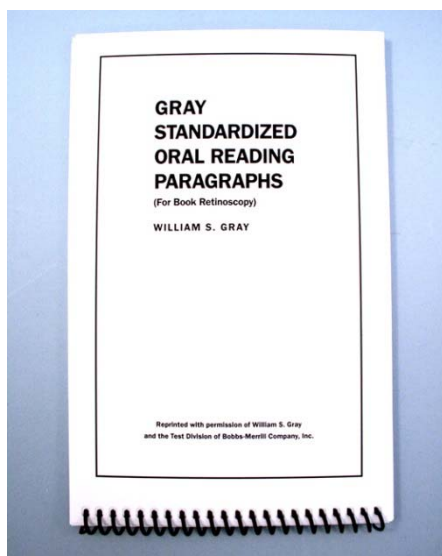
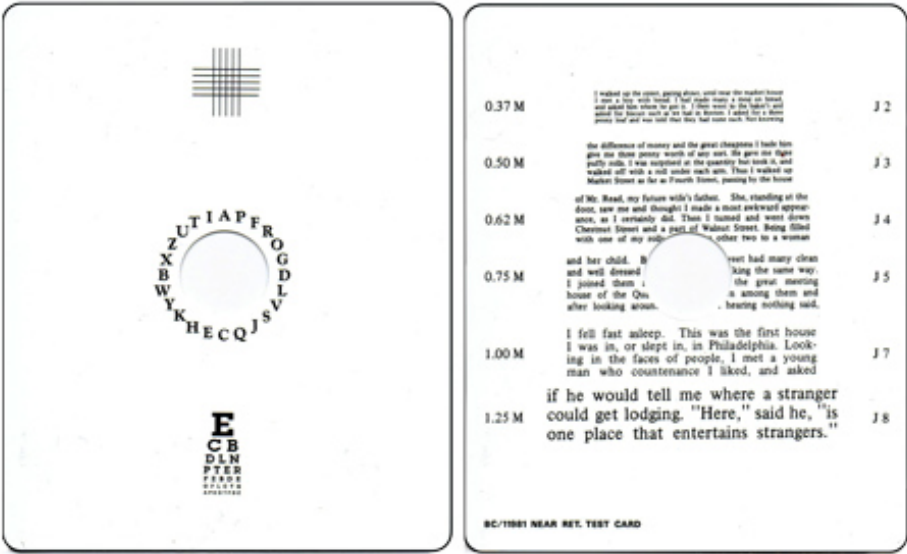


Figure 2: MEM Cards that attach to the retinoscope



Figure 3: MEM hole cards



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F. Management of Abnormal Egocentric Localization

Brenda Heinke Montecalvo, O.D.

Many tests and treatment regimens used by the neuro-optometric rehabilitation optometrist are dependent on the function and efficiency of the visual system as it affects the input and output of information to and from the brain and motor systems.²⁻⁶ Prescribing optical lenses, filters, prisms and optometric vision therapy can have an immediate and positive effect on the patient's visual performance. Secondary benefits can be realized by the patient's interdisciplinary treatment team.⁷

The neural vision process of egocentric localization is pervasive throughout the brain.⁸⁻⁹ (ref areas in brain involved with ego). These processes include but are not limited to the magnocellular pathway (MCP) and the tecto-pulvinar pathway (TPP).¹⁰ The MPC is involved with spatial orientation and the ability to navigate through space. Thus, stimulating the oculomotor systems can have a positive effect on the patient's ability to accurately localize self and objects in space.^{2,4-5,10-12}

In addition to the MCP, the TPP coordinates the visual motor system with head and body movements. This is important to maintain accurate fixation and orientation. So again, working with the visual motor system in OVT can greatly benefit the patient's ability to make accurate spatial judgments.²⁻⁶

Neuroscience has demonstrated the concept of brain neuroplasticity for over ten years. Neuroplasticity helps to explain how improvements are realized with OVT for patients with brain injury.¹³ Neuroplasticity is a process by which neurons can increase their connections with other neurons through sensory stimulation, learning and experience.⁴⁻⁵ Effectiveness of sensory and motor stimulation has been demonstrated and replicated in a wide variety of studies.¹⁴ Regular activity and systemic activities with an enriched environment stimulates the growth of new nerve connections, mainly in the hippocampus and throughout life.¹⁴⁻¹⁶ Neuroanatomical and neurophysiological changes are constantly occurring in the brain. Sometimes it is the creation of new synapses. Sometimes it is an increased amount of neurotransmitter stored in the presynaptic button. Sometimes it is a remodeling (either strengthening or weakening) of existing synapses. This is what makes all new learning possible.¹⁰

Clinical case reports suggest that these procedures may have some value to gain accurate egocentric localization. The following are a few of the treatment regimens:^{2-6,17-9,25-6}

- Bi-nasal Occlusion (BNO)
- Micro Yoked Prism
- Macro Yoked Prism
- Optometric Vision Therapy (BIERM Vol1B pg. 17-32)
 - Localization activities
 - Fixation and pursuit activities
 - Saccadic activities
 - Accommodative posture
 - Convergence posture

Bi-nasal Occlusion

BNO is designed to decrease visual confusion by eliminating the more complicated visual information, the overlapped visual field.¹⁷⁻²² (see diagram below) BNO also increases attention to the peripheral visual field which in turn appears to improve central localization estimation.¹⁷⁻²² Clinical case reports suggest that BNO may have some value to improve a multitude of visual skills.¹⁹⁻²³ This may be due to better orientation and organization allowing for egocentric judgment to be aligned properly. This style of BNO is very different to those used for strabismus.¹⁷ BNO

for an egocentric localization dysfunction are equal in width and more narrow. Typically the BNO are approximately 2-3 mm. nasal to the edge of the limbus. (see image)¹⁷⁻¹⁸

Bi-nasal Occlusion Procedure

A wedge shaped apparatus is placed over the nasal area of the patient's two eyes. It occludes the area that is approximately 2 mm. nasal to the edge of the limbus. The localization of egocenter is measured with the occlusion in place. The occlusion is gradually increased if there is no shift toward the accurate center. If there is a positive response toward the center then the occlusion is decreased until there is no longer an improvement. The goal is to identify the smallest amount of occlusion needed to get a shift toward accurate egocenter. The occlusion is placed permanently on the patient's glasses with either scotch tape or clear nail polish. The effect of the bi-nasal is re-evaluated at one month. If the egocentric localization dysfunction is improved, the BNO is reduced or removed.¹⁷⁻²²

Figure 1: Line placement for BNO



Figure 2: BNO Wedge



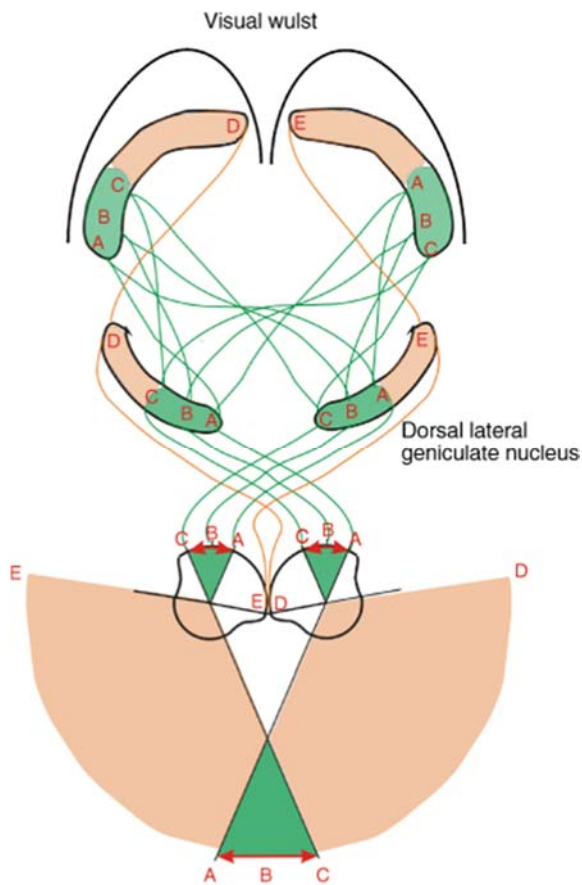
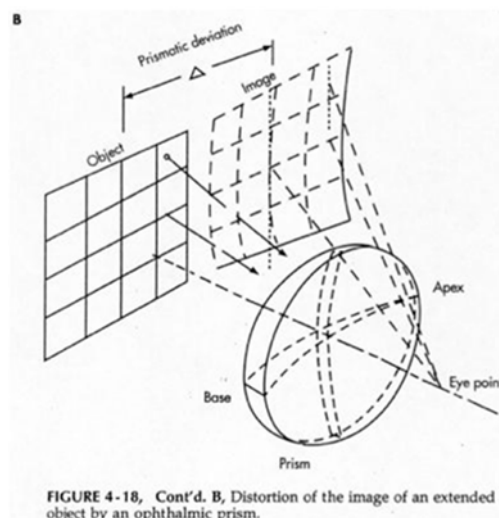


Diagram 1 (ref: Google image)

Micro Prisms

Forty years ago, Kraskin and Kaplan began using yoked prisms by adding them to patients' prescription glasses to reduce spatial mismatches and visual stress.²⁴⁻²⁵ Both prisms are of equal dioptric value for each eye and oriented in the same direction. Yoked prism can be placed either base-up, base-down, base-left, or base-right. The effect of wearing yoked prisms is to deflect peripheral light rays, shifting space in a manner that dramatically alters the patient's view of the external world.²⁴ Perceptual changes brought about by yoked prisms, which include a perception of increased curvature, displacement of objects, and a tilting of the meridian planes, require patients to "recalibrate" their visual systems, using skills that previously were suppressed.²⁴ Spatial changes of a curved prism can be seen on Figure 3.

Figure 3: Prism spatial changes



Egocentric Shift Yoked Prism

	Expected Response	Paradoxical
Lateral right	Base Left	Base Right
Lateral left	Base Right	Base Left
Anterior	Base Down	Base Up
Posterior	Base Up	Base Down

Table 1: Direction to place yoked prism depending on the egocentric shift.

The brain can reorganize visual processes in adaptation to new input whether the input is normalized by facilitative prism lenses, or distorted by disruptive lenses.²⁸ A yoked prism creates an increase in stimulation in certain areas of the visual process.²⁸⁻³¹

Micro Yoked Prism Procedure

After determining an egocentric localization dysfunction¹ a curved micro yoked prism lens of 2.00 PD is placed with the base in one of four positions. See Table 1 for which direction to initially use. Paradoxical response in the opposite direction expected can occur.²⁻⁵

After placing the yoked prism on the patient, the point of egocentric localization is reassessed.¹ If there is no return to the visual midline a larger prism is tried, moving up in 0.50 PD steps up to 5.00 PD. The smallest amount found to create a shift toward center is the amount prescribed full time.²⁻⁵ After prescribing the prism, recheck the effectiveness on a regular basis to determine if it is still warranted.

Macro Yoked Prism

Streff and Apell used large macro yoked prisms to create a distorted illusion of the outer world, forcing patients to become aware of their environment in a way that lead them to reorganize their manner of thinking, moving, and feeling. They emphasized, however, that OVT was a necessary adjunct to the use of prism lenses, if patients were to

secure meaning and understanding from the changes the lenses created.^{24-5,34} Yoked prism modify sensory input. The change stimulates the processes involved in the plasticity of sensorimotor correspondence by activating brain functions related to multisensory integration and space representation. Exposure to yoked prisms alters the coordinate transformations used by the nervous system to represent extra-personal space.²⁸⁻³⁰

Temporary Macro Prism Procedure

This technique involves temporarily placing large amounts of yoked prism (12-20pd) over the habitual prescription while the patient is asked to perform a multi-sensory task such as balancing on a walk rail. The patient makes five-10 passes on the walk rail with the yoked prism in one of the four directions (Base Up, Base Down, Base Right, Base Left). He repeats the process with each set of prisms experiencing the activity with all four directions.

Permanent Macro Prism Procedure

The permanent macro prism procedure involves using very large amounts of yoked prisms greater than 5.00 pd incorporated into the patient's prescription. Determining the amount of the prism is similar to the assessment procedure for micro prisms discussed previously. Additionally, an attempt is made to observe shifts in posture during sitting and mobility. Shifts in posture observed can be right, left, anterior or posterior. It has been noted that as much as 40 pd may be prescribed for permanent full time wear. Shifts in posture observed can be right, left, anterior or posterior.

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G. Non-organic Ophthalmic Manifestations

Chrystyna Rakoczy O.D.

Introduction

At times, a patient with TBI (confirmed or not) may present with ophthalmic symptoms that are out of the ordinary. Visual complaints without evidence of pathology account for about 5-12% seen in eye care.¹ The patient may have true disease, may be consciously feigning disease (maliciously or not), or may be unaware that their “real” symptoms have no clinical basis. Differentiating between organic vs non-organic ophthalmic symptoms is challenging as some patients can be very convincing. However, the visual system respects anatomical rules that are not typically comprehended by a patient. Understanding of ocular anatomy, neuroanatomy, neurophysiology and familiarity with non-organic ophthalmic manifestations (NOOM) of somatic symptom and related disorders (SSRD), and malingering will allow the primary care optometrist to use better judgment in clinical decision making.¹ Older terms for these manifestations such as hysterical amblyopia, neurotic, psychosomatic, psychogenic, and supratentorial are still in use in some text books. The newer terms: non-organic ophthalmic manifestations (NOOM), non-organic visual loss (NOVL), functional loss, visual conversion reaction are seen in current manuscripts and journals and are therefore used in this article.

SSRD, and Malingering

The *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5)², the [American Psychiatric Association](#)'s classification and diagnostic tool was released in 2013. It did not change drastically from DSM-4 but there was re-classification of several disorders including SSRD.

NOOM can present in malingering and in SSRD. The SSRD often have associated physical health issues, but the psychological response manifestation is disproportionate or incongruent with those findings. For example: the SSRD category “psychological factors affecting a general medical condition” requires there to be a diagnosed medical condition, but psychiatric factors are found to be influencing the physical manifestation, maintenance, and recovery of the established diagnosis. According to DSM-5 there are 5 specific SSRD:²

1. Somatic Symptom Disorder (replaces DSM-4 Somatization Disorder)
These patients will have at least one somatic symptom resulting in significant disruption of everyday life. Their symptoms are excessively time consuming, out of proportion to the degree of seriousness, accompanied by a high level of anxiety and may be associated with predominant pain.
2. Conversion Disorder
Patients present with prominent unexplained/incompatible neurological symptoms specified as weakness, paralysis, sensory loss, tremor or seizures.
3. Psychological Factors Affecting a Medical Condition
Psychological factors affect a documented medical condition in an adverse way such as delayed recovery. These factors may also interfere with treatment for the medical condition (for example: contribute to poor treatment adherence), exacerbate a medical condition and/or create a unique health risk. (examples: smoking and COPD, anxiety and asthma, chronic occupational stress and hypertension)
4. Factitious Disorder
The core feature of factitious disorder is the voluntary production of physical or psychological signs or symptoms without specific motivation. There are two types of factitious disorder: (1) factitious disorder imposed on self and (2) factitious disorder imposed on another. Factitious disorder imposed-on-self may include: falsification of physical or psychological signs or symptoms, injury, or disease identified as deceptive behavior, presentation to others as ill, impaired, or injured, deception that is evident in the absence of obvious external rewards, or deceptive behavior that is not better explained by another mental disorder. Factitious disorder imposed on another include the same characteristics but focus on a child, parent, sibling or other person.

5. Anxiety Illness Disorder

This disorder characterized by excessive worrying with mild or absent symptoms. Somatic symptoms may be of mild intensity. Patients are characterized as “Care-seeking type” or “Care-avoidant type”².

Of note: hypochondriasis, pain disorder, and body dysmorphic disorder have been removed from the SSRD category.

As in DSM-4, in DSM-5 malingering is not considered a mental illness. Malingering receives a V code as one of the other conditions that may be a focus of clinical attention. DSM-5 describes malingering as “the intentional production of false or grossly exaggerated physical or psychological symptoms, motivated by external incentives such as avoiding military duty, avoiding work, obtaining financial compensation, evading criminal prosecution, or obtaining drugs.”² Though malingering is deliberate behavior for a known external purpose and not considered a form of mental illness or psychopathology, it can occur in the context of true mental illnesses.

Malingering should be strongly suspected if any combination of the following is noted:³⁻⁵

1. Medico-legal context of presentation (e.g., the person is referred by an attorney for examination).
2. Marked discrepancy between the person’s claimed stress or disability and the objective findings.
3. Lack of cooperation during the diagnostic evaluation and in complying with the prescribed treatment.
4. The presence of antisocial personality disorder.

The incidence of malingering was found to be higher (44.8%) in patients with injury claims or compensation.² It is associated with socioeconomic burdens related to loss of productivity in industry resulting in absenteeism, depletion of insurance benefits, private and governmental social security, and disability and worker's compensation resources, and depletion of the medical system of resources.⁶

Not all are driven by greed. Malingering could be an escape from physical or emotional abuse.⁷ Blindness may not be the inability to see but may be a desire not to see.⁸ They, may still have authentic disease, as intentional exaggeration of symptoms can be a desperate attempt for attention for a problem the patient actually has.⁷ The complaint should be considered true until proven otherwise, and proof is time consuming.

There are two types of malingerers: positive malingerer or negative malingerer.⁴⁻⁵

1. Positive malingers can show qualities of:
 - Simulation: feigning of a non-existent disease.
 - Exaggeration: the pretense that a certain condition is worse than it actually is.
 - False attribution: assignment to a disease or injury of an origin other than the real one.
2. Negative malingerers show:
 - Dissimulation: the pretense that a disease does not exist or that its effects are less than they actually are: a form of reverse malingering and is found in candidates for insurance or entry into service. Many athletes are negative malingers because they want to continue playing despite a concussion.

The malingerer will have difficulty maintaining consistency with false or exaggerated claims for extended periods. They usually lack knowledge of nuances of the feigned disorder. Rapid fire questioning increases likelihood of contradictory or inconsistent responses.

Clues to diagnosis of non-organic ophthalmic manifestations

There are several indicators that hint at characteristics SSRD and malingering. Vague, bizarre, inconsistent description of symptoms precipitated by stress and/or seem to worsen in the presence of others; non-anatomic distribution of abnormalities; wearing sunglasses into the exam room without sensitivity to light; no objective evidence of symptom related disease; inconsistency on repeated examination; persistence of symptoms despite medical intervention; history of multiple visits or surgeries. Signs of psychiatric illness or unstable personality and denial of psychological etiology also contribute to high suspicion of non-organic nature.

NOOM can mimic any pathology of the visual or oculomotor systems. Sudden total or transient loss of vision is most common⁶ followed by visual field defects. Color blindness, double vision, ptosis, convergence spasm, unilateral gaze paresis, nystagmus among other manifestations are also seen. The approach to differentiation

includes: first, determination of monocular vs. binocular symptoms allowing localization of potential lesions; next, determination if the loss is central (acuity loss) vs. peripheral (field loss).¹

Non-Organic Vision Loss (NOVL)

NOVL is sudden onset total blindness in one eye, partial blindness in one eye, total blindness in both eyes, and partial blindness in both eyes. Patients can complain of variable loss of vision without refractive or organic cause.⁹ Vision loss may be accompanied by abnormal color vision, and/or field loss. Thirty-six to 80% report vision loss with or without visual field loss.¹⁰⁻¹¹ Some present with sunglasses even though they are not sensitive to light.⁶ NOVL accompanied by SSRD is more common in younger patients and females.^{10, 12-16} In contrast, NOVL expressed by malingeringers is more common in adults than children and more common in males than females. Though patients with SSRD and malingeringers both can exhibit non-organic ophthalmic manifestations, it is important to always rule out organic disease that may coexist.

If the NOVL is transient, the practitioner should exclude organic causes first. Then correct optical error as accommodative spasm can cause fluctuating vision. Accommodative spasm is accompanied by pain. Fading vision with prolonged viewing without periocular pain is always non-organic.¹⁸

A patient who has no indication of non-organic loss, no RAPD and yet has unexplained acuity loss needs ERG, mfERG, pattern reversal and flash evoked VEP. Be mindful of malingeringers' actions: they tend to look away or defocus during these tests.

Appendix G contains a list of tests that can be performed to document NOVL.

Visual Field Defects

Isolated field dysfunction is seen in 38-89% of patients with NOOM.¹⁰⁻¹¹ Non-organic field defect manifestations include constricted fields and hemianopic defects. Many constricted fields are due to procedural artifact, poor refraction or due to tiredness of the patient. Tiredness often produces "clover leaf" fields (Figure1). Kinetic spiral fields (Figure2) are seen in SSRD. The polka-dot pattern seen on a static HVF is a static manifestation of the spiral field.

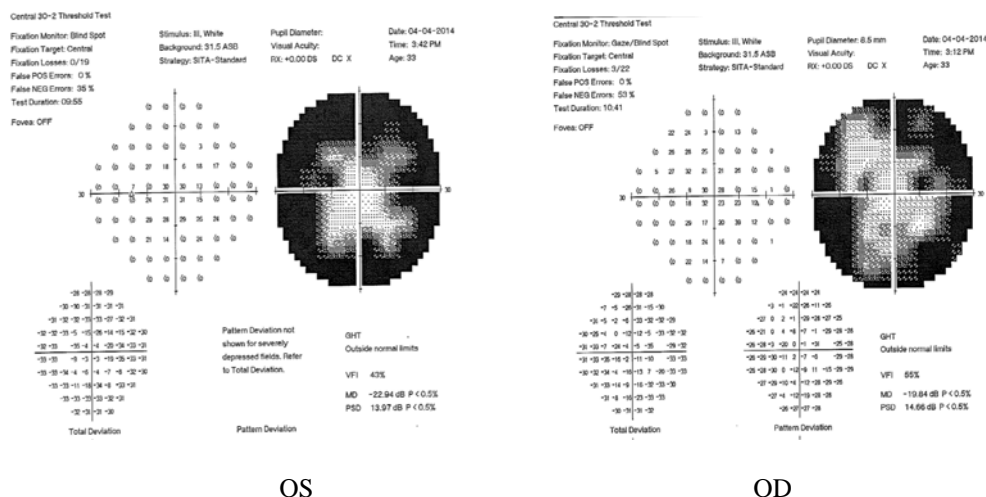


Figure 1. Cloverleaf visual fields secondary to fatigue. Patient performed well initially on each eye but tired by the time testing moved out off center. Note that the patient also performed better on the right eye which was tested first. Technician remarked that patient was falling asleep.

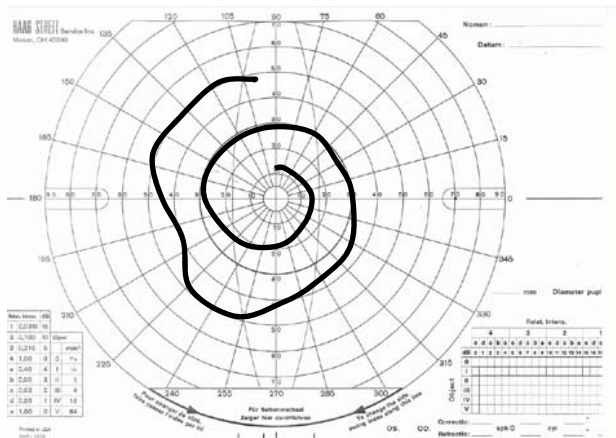
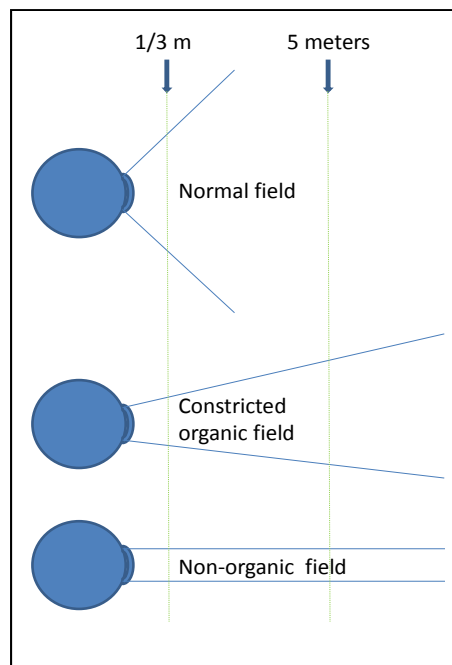


Figure 2. Kinetic spiral fields of SSRD. Static tests do not exhibit spiral.

Testing for constricted fields should be performed at two distances (figure 3): 1/3 meter and at 5 meters. If non-organic, the size of field remains the same at all distances. Fields will have sharp margins. Different test objects will give the same isopters. These fields are typically circular in shape and do not show the normal widening to the temporal side.

Figure 3. Dual field testing at 1/3m and at 5m reveals a non-organic field if it has not expanded at 5m.



In manifestations of bi-temporal or bi-nasal field defects, test for post-/pre-fixational blindness.¹⁸ With bi-temporal field defects, rule out chiasmal lesion. As a patient with true bi-temporal field cut focuses on a near target, all objects beyond the target will fall in the blind fields. As the patient with true bi-nasal field cut focuses on a distance target, all objects in front of the target will fall in the blind fields. (Figure 4)

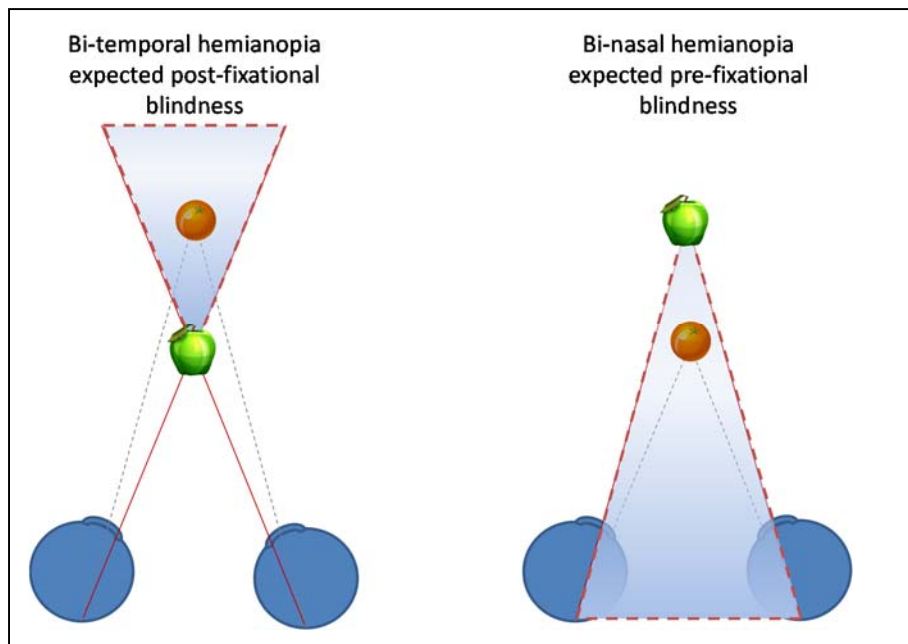


Figure 4. Post- and pre-fixational blindness

To rule out nonorganic monocular hemianopias and scotomas, test monocularly and binocularly (Figure 5). A field defect present only in one eye when tested monocularly and still present when tested binocularly is nonorganic. Also if organic, the defect should shrink on binocular field testing. Nonorganic bi-temporal and bi-nasal field defects disappear under binocular testing. A list of other visual field tests to NOOM are listed in Appendix G of this volume.

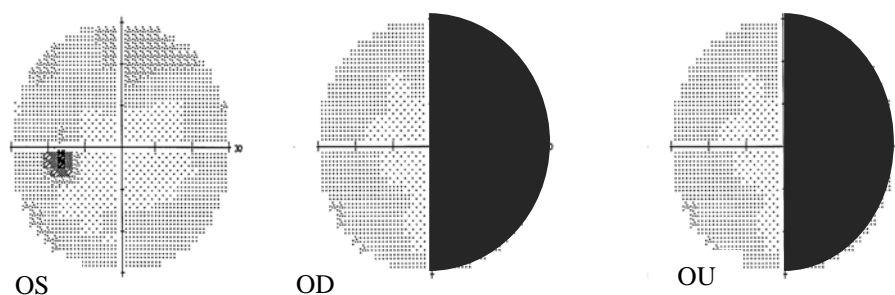


Figure 5. Monocular hemianopic field defect persists on binocular testing. Note no blind spot on OU.¹

Other nonorganic ophthalmic manifestations

Monocular diplopia

True monocular diplopia is indicative of uncorrected refractive error, ocular surface, retinal or lenticular irregularity.^{17,19} Diplopia that can be blinked away can be due to lethargy, drugs¹⁹ or ocular surface irregularity. Distances between images are often inconsistent. Note that an INO can produce “triple” images: one from the paretic eye and the other two from the abducting, jerking eye.^{9,19}

Convergence impairment

Along with up-gaze, convergence declines with age. Most common cause for convergence impairment (not to be confused with convergence insufficiency) is lack of interest and lack of effort.¹⁹ It can be associated with accommodative insufficiency.

Spasm of the near reflex

Spasm of the near reflex can be mistaken for bilateral abducens palsy, divergence insufficiency or horizontal gaze paresis if not tested properly. Bilateral abducens palsy, though, will be associated with other neurological signs. Check ductions and oculocephalic ranges under monocular conditions. Full abduction and release of miosis should be noted. Voluntary convergence will be intermittent because it is very difficult to sustain. Look for concomitant miosis as part of the near triad. If you cover one eye the pupils will dilate. Look for increased accommodative amplitude resulting in excessive pseudomyopia (8 to 10 diopters). Amplitude of convergence can be unequal: one eye more converged than the other and will be associated with unilateral or bilateral abduction deficits on version testing.

Organic conditions mimicking spasm of the near reflex are: CN VI paresis, horizontal gaze paresis, pretectal esotropia (pseudo-abducens palsy), intrinsic lesions of the mesencephalon, extrinsic lesions compressing the dorsal mesencephalon. The patient will need imaging if diagnosis is not confirmed. Management consists of reassurance. Cycloplegics with a bifocal spectacle rx, and/or binasal occlusion have also been used.⁹

Horizontal or vertical gaze palsy

Gaze palsy is a very rare presentation for SSRD, and malingering because it is difficult to sustain. On passive observation look for eye movement readily extending into the impaired field of gaze. Check for intact oculocephalic movements and positive OKN.^{9,19} One can also check for pursuit and saccadic eye movements during chair rotation.

Downward deviation in nonorganic coma

Nonorganic coma presents with eyes focused downward. If the head is moved the eyes will saccade to the floor. Patients who are in an organic-based coma will either have no eye movements at all or will have a positive oculocephalic response.⁹

Night blindness

A simple red-blue test can be used to confirm difficulty seeing at night. A blue and a red disc are viewed in equal intensity of illumination. Diminish the illumination gradually. To the normal person, the red becomes black sooner than the blue; to the night blind without retinal lesions, the reverse occurs. This test is based on the fact that Purkinje's phenomenon is reversed in night blindness. A malingerer either gives the normal sequence or more probably says that they both disappear simultaneously.⁶

Ptosis

Voluntary ptosis (pseudoptosis) can be achieved with practice.¹⁷ The diagnostic clue is presence of ipsilateral eyebrow depression with pseudoptosis as opposed to brow elevation with true ptosis.^{17,19} Do rule out myasthenia and progressive ophthalmoplegia.¹⁷ Blepharospasm is rarely nonorganic but has been seen in children with emotional trauma.

Bilateral lid retraction is often seen in patients with anxiety. It will be variable and intermittent and therefore distinguishable from lid retraction of dysthyroid orbitopathy.⁹

Pupil abnormalities

Unequal pupils can be due to self-administration of a mydriatic.¹⁹ If the pupil remains fixed and dilated to both light and near, administer 1/8% pilocarpine to both eyes. If no constriction is noted, use 0.5%. A pharmacological pupil will not react as the pilocarpine is too weak to counteract it. A normal pupil or neurologically dilated pupil (tonic on CN III) will constrict in 30 minutes.

Those with anxiety disorder or schizophrenia can present with poorly responding dilated pupils. In patients with panic disorder, during an attack, pupils will dilate and will be poorly responsive secondary to autonomic disturbance of sympathetic hyper-function. The patient will also exhibit profuse sweating, an increased heart rate, and trembling.⁹ Patients on psychotropic medications may also exhibit pupillary side effects as well. (BIERM Vol1B pg 44)

Sensitivity to light, patterns, colors or moving objects

Exclude ocular causes for photophobia such as albinism, dilated pupils (common after head trauma), dry eye, keratitis, uveitis, and cone dystrophy. Other organic causes of sensitivity to light are: meningeal inflammation, basal cranial blood vessel inflammation, and migraine.

Painful inappropriate sensitivity to ordinary light, sensitivity to patterns, colors or moving objects has been associated with anxiety disorders and phobias. These patients will tend to avoid fluorescent light, computer monitors and headlights on cars. They will also tend to stay indoors, wearing dark sunglasses.¹⁸

Nonorganic nystagmus and saccadic oscillations

Voluntary nystagmus is willfully initiated and can be produced in 5 to 8% of the population as a familial trait. Typically it is binocular, horizontal presenting as rapid alternating saccades oscillating at 3 to 42 HZ⁹ with fluttering eyelids and a strained facial expression. These patients will complain of oscillopsia and blurred vision. Voluntary saccadic disturbances can be produced but cannot be sustained. More so, they will only occur when the doctor is looking.¹⁹ They will present as rare large amplitude conjugate saccades without inter-saccadic interval. They can be multidirectional, curvilinear and of large amplitude. The voluntary saccades are similar to ocular flutter or opsoclonus but without associated neurological disease. Typically, organic saccadic oscillations are from disease of the brainstem and cerebellum, therefore true disease should be ruled out.⁹

Nonorganic visual illusions and hallucinations

Visual illusions and hallucinations are more common with organic disease than nonorganic. Retinal and optic nerve conditions should be ruled out, especially if manifestations are monocular. Diagnosis of nonorganic hallucinations and illusions is by exclusion. Other causes include: substance abuse, toxic medications, encephalopathy, migraines transient ischemic attacks, and seizures. Some typical nonorganic presentations have been described. Formed images that are delusional or paranoid and often associated with auditory hallucinations will present as nonorganic transient hallucinations. These are common in schizophrenia: twinkling lights around viewed objects will present as non-organic persistent hallucinations; altered shapes or sizes of images will present as nonorganic persistent illusions. Note: Persistent illusions in one hemifield are probably from posterior cerebral artery occlusion.

Nonorganic lacrimal disturbances

Lacrimation can be nonorganic and associated with blepharospasm. Haemolacria, or bloody tears, can be indicative of a tumor in the lacrimal apparatus but more commonly, bloody tears come from blood of self-induced nosebleeds intentionally deposited in the conjunctiva.⁹

NOOM in SSRD vs. malingering: Approach and management

Visual conversion reaction is the use of the eye/eyes as a target organ for expression of nonspecific conflicts influenced by biologic, intra-psychic and environmental factors and is associated with psychiatric disorders.¹² SSRD

can also give positive results to tests for malingering⁸ but some differentiation can be noted: NOVL secondary to SSRD is usually bilateral whereas malingers feign blindness in one eye⁸; patients with a SSRD enjoy the exam while malingers resent testing^{6,8}; those with SSRD are highly suggestible but malingers “try too hard” to convince the physician of symptoms²⁶; patients with true bilateral blindness will face the person they are speaking to while malingers look elsewhere⁹; patients with a SSRD will have tubular fields, however malingers present any other shape.⁸

Malingers fake disorder for a gain or relief from unpleasant circumstances. This is antisocial behavior. Hostility and rough attitude toward the patient will bring out a similar response from the patient. Do not tell the patient they are a malingers. This term is accusatory of moral character and not a diagnosis. If you suspect malingering, your chart should read: “symptom has no organic basis.” Tell the patient in a non-confrontational way that the exam failed to explain their disturbance.

Patients diagnosed with SSRD are usually amenable to suggestive therapy. Gain the confidence of the patient. Changing plano lenses back and forth, or adding plus and minus lenses of equal power will make the patient read lower and lower on the chart but in a hesitating manner.

Those patients with factitious disorder are aware they are faking symptoms but do not know why. The primary difference between malingering and factitious disorder is motivation.⁷ Munchhausen syndrome is an extreme variation of factitious disorder where the patient seeks multiple caregivers to solicit potentially life-threatening interventions. Hostility and rough attitude toward these patients as well will bring out a similar response from the patient. Tell the patient in a non-confrontational way that the exam fails to explain their disturbance and arrange for neuro-ophthalmologic, neurologic or psychiatric care.¹⁸

Patients with somatic symptom disorder should be repeatedly reassured that there is no pathology and that the eyes and brain are both fine but that the brain may be playing tricks on the eyes. Barris showed 78% improvement of nonorganic visual impairment in 4 to 1,121 days.¹¹ Consider arrangement for neuro-ophthalmologic, neurologic or psychiatric care.

Conversion disorder is a maladaptive attempt to avoid anxiety of socially unacceptable impulses thereby gaining sympathy or avoiding obligations.¹⁸ These patients typically present with immobilizing blindness with clear and constant symptoms. Conversion disorder typically affects young, depressed women. Repeatedly reassure the patient that there is no pathology and that the eyes and brain are both fine but that the brain may be playing tricks on the eyes.¹¹ Consider arrangement for neuro-ophthalmologic, neurologic or psychiatric care.

Conclusions

In cases of suspected NOOM, most importantly, rule out organic disease. The ocular diseases to be considered in your differential diagnosis are: cortical visual loss, optic neuropathies, retinal dystrophies and degenerations, and amblyopia. If evidence of NOOM is not certain, then additional testing such as MRI with contrast, ERGs, VEPs and other more sophisticated modalities such as nuclear medicine imaging studies would need to be accessed.^{1,27}

Neoplasms involving the central nervous system may cause visual loss with psychiatric features, therefore, be sure to differentiate NOOM from true disease, especially in cases of doubt. One should also not be too quick to dismiss true organic symptoms as functional/nonorganic in patients with known psychiatric disease. Some psychiatric medications can cause pigmentary retinopathy presenting with early symptoms of brown vision and difficulty with night vision. Ocular and vision side effects of psychotropic medications taken by patients with SSRD are not uncommon. (BIERM Vol1B pg. 44)

Nevertheless, management of NOOM can be characterized by faults. Ordering costly testing when indications of NOOM is extensive can serve to reinforce a patient’s belief that their condition is real. In addition, a wary presentation of conclusions on part of the clinician to the patient and poor chart notation also fortify misimpression

of nonorganic disease.¹⁸ Remember to be empathetic and encouraging. Acknowledge that a thorough exam has been performed and that the eyes and visual system are healthy.

The optometrists recognition of nonorganic ophthalmic manifestation occurrence has implications for the patient's future (legal, financial and medical).⁷ Disclosure of the nonorganic nature of visual manifestations takes discretion. Proper documentation is vital. Common practice has been not to make the distinction between nonorganic manifestation of malingering and those of SSRD in patients' records. "Nonorganic visual loss" is an accepted term for both situations. "Functional disease: Objective examination may not explain the cause of symptoms" or "Functional disease: Symptoms do not correlate with clinical findings" are also accepted statements. Pure "Nonorganic" or "Functional Vision Loss" are not diagnoses of exclusion. Demonstration of normal visual function should be documented. Always support your conclusions with medically sound assessments.

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Section V: Sample Case Studies

A. Case 1. Mild myopia with accommodative insufficiency and infacility

Chung To, O.D.

History:

P.A., a 22-year-old male athletic trainer, sustained blunt head trauma as a result of a twenty-pound dumbbell hitting his head about 8 months prior to examination. He reported less than 5 minutes loss of consciousness with an altered state of consciousness lasting more than 24 hours. He was evaluated at the local urgent care clinic and was released the following day after neuroimaging studies including CT/MRI scans were unremarkable. Since that time he has noted blurred vision when looking near -to-far and difficulty concentrating after prolonged reading.

The patient was examined 8 months after the head injury. At that time, he was not wearing any corrective prescription.

Significant Clinical Findings:

VA (distance, uncorrected):	OD, OS: 20/30
VA (near, uncorrected):	OD, OS: 20/20
Near point of convergence (Accomm. Target)	3 cm break, 4 cm recovery
Cover test all positions of gaze (dist., uncorrected):	Orthophoria
Cover test (near, uncorrected)	Orthophoria
Subjective Refraction:	OD: -0.50-0.50x180 20/20 OS: -0.50-0.50X180 20/20
Distance lateral phoria:	Orthophoria
Base-in vergence (distance)	x/7/4
Base-out vergence (distance)	x/20/10
Near lateral phoria:	Orthophoria
-1.00 gradient:	3 esophoria
Gradient AC/A ratio:	3:1
Base- in vergence (near)	12/24/16
Base- out vergence (near)	6/17/10
Vergence facility:	15 cpm
NRA/PRA:	+1.50/-1.00
Accommodative amplitude (push- up):	OD, OS: 5 D
Monocular accommodative facility (MAF):	OD, OS: 0 cpm, fails plus and minus
Binocular accommodative facility (BAF):	0 cpm, fails plus and minus
Fused crossed cyl finding:	+1.50
Stereopsis:	250 seconds random dot , 25 seconds Wirt
SLE/DFE:	Unremarkable. Pupils: PERRL -RAPD

Case Analysis:

The distance and near phoria are both normal in this case. There is a small amount of refractive error present. The patient had difficulty with all tests that probed accommodative abilities including a lower than average accommodative amplitude for the patient's age and inability to clear plus and minus lens on monocular and binocular accommodative facility. Additionally, PRA and NRA were reduced and the fused crossed cyl finding revealed higher plus. All other findings, including NPC and AC/A ratio, were essentially within the expected range. These findings supported the diagnosis of accommodative insufficiency and accommodative infacility.

Diagnoses:

Disorders of accommodation

Myopia

Astigmatism

Brain Injury nec.

Management:

Prescription for the small amount of refractive error was given because the uncorrected ametropia can cause symptoms of accommodative fatigue, especially in patients with low degrees of astigmatism. A +1.00 ADD was also prescribed based on the fused cross-cyl result. Since the patient had complaints at distance and near, separate single vision distance and near glasses were recommended. An OVT program was also initiated to facilitate normal accommodative function and decrease dependency on reading glasses.

OVT for Accommodative Insufficiency and Accommodative Infacility

Phase I: Goal is to improve ability to stimulate accommodation and normalize the amplitude of accommodation. Emphasize magnitude rather than speed of accommodative response. Focus on minus lenses initially then progress to addition of plus lenses at end of phase I.

- Near-Far Focus (Hart chart) saccades
- Loose Lens Accommodative Rock
- Brock String Activities (gross convergence with focus on feeling, concept of looking close, converging and accommodating, bug-on-a string activities)
- Lifesaver cards (focus on convergence initially)

Phase II: Emphasize speed of accommodative response. Introduce use of plus and minus lenses stimulating and relaxing accommodation. Introduce binocular accommodative facility procedures.

- Binocular Near-Far Focus (Hart chart) saccades
- Binocular Loose lens accommodative rock
- Continue brock string activities (extend length and speed of jump ductions)
- Lifesaver cards (convergence and divergence)

Phase III: Integration of accommodation and binocular therapy

- Binocular accommodative facility
- Lifesaver cards jump facility, with addition of +/-2.00 flip lenses
- Random dot stereograms with loose prism jumps/facility
- Incorporate movement in different positions of gaze with procedures listed above

Outcome:

P.A required 14 in-office visits to complete the OVT program. At re-evaluation, he reported significant improvement of all symptoms. While wearing the near glasses during the program, he could read for as long as necessary without eyestrain and blur. After completion of the program, he noted improvements in concentration and ability to complete near work activities without difficulty and with less dependency on his near glasses.

Comparisons of examination results before and after vision therapy are summarized below.

Examination results before and after vision therapy:

Test	Before OVT	After OVT
Cover test (distance/near)	Orthophoria	Orthophoria
Near point of convergence	3 cm break, 4 cm recovery	3 cm break, 4 cm recovery
Base-in vergence (near)	12/24/16	12/24/16
Base-out vergence (near)	6/17/10	10/25/12
NRA/PRA:	+1.50/-1.00	+2.50/-3.00
Accommodative amplitude (push- up):	OD, OS: 5 D	OD, OS: 10 D

Monocular accommodative facility (MAF):	OD, OS: 0 cpm, fails + and -	OD, OS: 15 cpm
Binocular accommodative facility (BAF):	0 cpm, fails plus and minus	15 cpm, no difficulty
Fused crossed cyl finding:	+1.50	+0.50

B. Case 2. Emmetropia with convergence insufficiency, pursuit dysfunction, saccadic dysfunction

Chung To, O.D.

History:

J.L., a 30-year-old male English teacher, has a history of mild concussion secondary to a fall accident 2 years prior to examination. He lost consciousness briefly for no more than 2 minutes during the incident and suffered an altered state of mental status for 5 to 10 minutes. He denies any posttraumatic amnesia. Currently, he is enrolled at a university for his masters in communications but reports difficulty completing his homework assignments due to complaints of headaches, eyestrain, skipping and repeating lines when reading, and intermittent binocular double vision after 10 to 15 minutes of any near visual activities. At the time of the initial optometric examination, he was not wearing any corrective prescription.

Significant Clinical Findings:

VA (distance, near, uncorrected):	OD, OS, OU: 20/20
Near point of convergence	
Accomm. Target:	12 cm break, 10 cm recovery
Penlight:	20 cm break, 15 cm recovery
Cover test all positions of gaze (dist., uncorrected):	2 exophoria
Cover test (near, uncorrected):	10 exophoria
Subjective:	OD, OS: Plano 20/20
Distance lateral phoria:	2 exophoria
Base-in vergence (distance):	x/7/4
Base-out vergence (distance):	x/19/11
Vertical associated phoria (distance):	No vertical deviation
Near lateral phoria:	10 exophoria
-1.00 gradient:	8 exophoria
Gradient AC/A ratio:	2:1
Base-in vergence (near):	14/20/14
Base-out vergence (near):	6/8/4
Vertical associated phoria (near):	No vertical deviation
Vergence facility:	2 cpm, (slow with BO)
NRA/PRA:	+1.75/-2.50
Accommodative amplitude (push- up):	OD, OS: 9 D
Monocular accommodative facility (MAF):	OD, OS: 14 cpm
Binocular accommodative facility (BAF):	2 cpm (slow with plus)
Fused crossed cyl finding:	+0.50
Stereopsis:	50 seconds Wirt, 250 seconds random dot
Direct observation of fixation:	Unsteady, frequent loss of fixation
NSUCO saccades:	Head movement 3, ability 4, accuracy 2
NSUCO pursuits:	Head movement 3, ability 4, accuracy 3
DEM:	Ratio score: below 15 th percentile

SLE/DFE:

Error score: below 15th percentile

Unremarkable. Pupils: PERRL -RAPD

Case Analysis:

There is a high degree of exophoria at near relative to distance. The patient had difficulties with all tests that probed the positive fusional vergence including direct measurements (base-out at near, vergence facility) and indirect findings (NRA, binocular accommodative facility). The AC/A ratio was also low. Additionally, direct observation of fixation, saccades and pursuits revealed poor control of eye movement skills. DEM testing further exemplified these observations. All other findings, including accommodative functions, were essentially within the expected range. Analysis of the data confirms a diagnosis of convergence insufficiency with a secondary ocular motor dysfunction that is consistent with the patient's complaints at near.

Diagnoses:

Exophoria

Convergence insufficiency or palsy

Deficiencies of saccadic eye movements

Deficiencies of smooth pursuit movements

Brain Injury nec

Management:

Spectacle correction and vertical prisms were not indicated in this case given no refractive error and no vertical deviation was present. Added lenses would provide minimum desirable effect and may even worsen the symptom due to the low AC/A ratio. Horizontal prisms were considered but deferred due to the patient's motivation with vision therapy alone to improve skills without the use of spectacle eye wear. An OVT program was prescribed to normalize the vergence system and improve the ocular motor skills.

OVT for convergence insufficiency with mild ocular motor dysfunction

Phase I: Goal is to initially develop steadier fixation and more accurate gross saccades and fine pursuits then progress to equalization of the abilities between the two eyes. Once voluntary convergence is developed, normalize the positive fusional vergence amplitudes along with the accommodative amplitude. During phase I, emphasize range of motion and ocular motor control with main focus on convergence abilities. Progress to binocular activities at end of phase I.

- Fixation and Tracking Activities
- Post-It saccades
- Monocular Near-Far Focus (Hart Chart), add saccadic activities
- Brock String Activities (gross convergence with focus on feeling concept of looking close, converging and accommodating, bug-on-a string activities)
- Barrel Card

Phase II: Develop more accurate fine saccades and large excursion pursuits using binocular activities. Normalize both negative fusional vergence and positive fusional vergence amplitude and facility. Phase II should have a stronger emphasis on increasing speed and accuracy of response.

- Binocular Sequential fixation
- Binocular Spoon pursuits
- Binocular Near-Far Focus (Hart Chart), add saccadic activities
- Lifesaver cards (convergence and divergence)
- Random dot stereograms with loose prism jumps

Phase III: Integration of accurate saccades and pursuits with changes in convergence, divergence and accommodation.

- Lifesaver cards jump facility
- Random dot stereograms with loose prism jumps/facility
- Binocular accommodative facility
- Incorporate movement (rotations, lateral movements, saccades) in different positions of gaze with procedures listed above

Outcome:

J.L required 20 in-office visits to complete the OVT program. Over the course of therapy, he noted gradual improvements in his ability to maintain clear and comfortable single vision for longer periods of time at near. He also noted a decreased frequency and severity of his headaches while completing his reading assignments. At the end of the program, he reported significant improvements in his grades with resolution of all visual symptoms at near. Comparisons of examination results before and after vision therapy are summarized below.

Examination results before and after vision therapy:

Test	Before OVT	After OVT
Cover test (distance):	2 exophoria	Orthophoria
Cover test (near):	10 exophoria	3 exophoria
Near point of convergence:		
Accomm. Target:	12 cm break, 10 cm recovery	3 cm break, 4 cm recovery
Penlight:	20 cm break, 15 cm recovery	3 cm break, 4 cm recovery
Base-in vergence (near):	14/20/14	16/24/16
Base-out vergence (near):	6/8/4	18/28/24
Vergence facility:	2 cpm, (slow with BO)	16 cpm
NRA/PRA:	+1.75/-2.50	+2.75/-2.75
Binocular accommodative facility (BAF):	2 cpm (slow with plus)	12 pm
Stereopsis:	50 seconds on Wirt	20 seconds on Wirt
Direct observation of fixation:	Unsteady, frequent fixation loss	Steady, no fixation loss
NSUCO saccades:	Head movement 3, ability 4, accuracy 2	Head movement 5, ability 5, accuracy 5
NSUCO pursuits:	Head movement 3, ability 4, accuracy 2	Head movement 5, ability 5, accuracy 5
DEM:	Ratio score: below 15 th % Error score: below 15 th %	Ratio score: 90 th % Error score: 99 th %

C. Case 3. Latent hyperopia with residual divergence insufficiency

Chung To, O.D.

History:

S.M., a 22-year-old female college student, sustained a concussion from a bicycle versus car accident 5 months prior to examination. She reported being in a coma for 24 hours and developed post-traumatic amnesia lasting more than 7 days. Initial complaints included intermittent double vision that appeared to be worse when watching TV and blurred vision when looking far to near that resulted in moderate to severe headaches. She admitted to having these symptoms prior to the car accident but to a lesser degree and with less frequency, and therefore has never sought the attention of an eye care professional. The patient was examined 5 months after the head injury. At that time, she was not wearing any corrective prescription.

Significant Clinical Findings:

VA (distance, near, uncorrected):	OD, OS: 20/20
Near point of convergence	
Accomm. Target:	4 cm break, 6 cm recovery
Penlight:	4 cm break, 6 cm recovery
Cover test all positions of gaze (dist. uncorrected):	8 esophoria
Cover test (near, uncorrected)	2 esophoria
Subjective:	OD: +0.50 20/20
	OS: +0.50 20/20
Cycloplegic Refraction:	OD: +1.50 20/20
	OS: +1.50 20/20
Distance lateral phoria:	6 esophoria
Base-in vergence (distance)	x/2/0
Base-out vergence (distance)	6/20/16
Vertical associated phoria (distance)	No vertical deviation
Near lateral phoria:	Orthophoria
-1.00 gradient:	2 esophoria
Gradient AC/A ratio:	2:1
Base-in vergence (near)	10/17/12
Base-out vergence (near)	14/24/14
Vertical associated phoria (near)	No vertical deviation
Vergence facility:	12 cpm
NRA/PRA:	+2.50/-2.50
Accommodative amplitude (push- up):	OD: 12 D, OS: 12 D
Monocular accommodative facility (MAF):	OD, OS: 14 cpm
Binocular accommodative facility (BAF):	10 cpm
Fused crossed cyl finding:	+0.50 OD, OS
Stereopsis:	250 seconds random dot, 20 seconds Wirt
SLE/DFE:	Unremarkable. Pupils: PERRL -RAPD

Case Analysis:

This case is a classic example of divergence insufficiency given the significant degree of esophoria that is greater in the distance relative to near along with a low AC/A ratio and low base-in vergence amplitude distance finding. The history suggests that this is not an acute problem given that she had these complaints even prior to the accident but the symptoms are likely exacerbated following her brain injury. Cycloplegic refraction revealed a small degree of latent hyperopia, which may contribute to the higher degree of esophoria at distance. All other findings were within normal limits.

Diagnosis:

Hypermetropia
Esophoria
Anomalies of divergence
854.00 Brain Injury nec

Management:

The maximum plus of the full cycloplegic refraction was prescribed given that it decreased the esophoric posture by a small degree at both distance and near despite the low AC/A ratio. In addition, base-out prism was incorporated into her glasses. The amount of prism needed at distance was determined based on Percival's criterion to allow the patient to operate in the middle third of the vergence range. The calculated prism amount (following the formula of

1/3 the greater lateral limit minus 2/3 the lesser lateral limit) was calculated to be 2 base-out. A trial frame of the plus prescription along with the horizontal prism was demonstrated to the patient and she noted immediate subjective improvements. The final prescription was:

OD: +1.50 with 1 BO

OS: +1.50 with 1 BO

Single vision glasses were prescribed for full-time use at distance and near. An OVT program was also initiated to increase negative fusional vergence amplitude at distance and improve the vergence facility to permit rapid changes in vergence and accommodative demand.

OVT for divergence insufficiency

Phase I: Develop feeling of divergence by increasing range of motion and ocular motor control. Normalize negative fusional vergence amplitude starting with near initially. Extend out to intermediate distance at end of phase I.

Sensory motor fusion is most important: Introduce space training as soon as the patient is able to do so.

- Eye rotation
- Four corner saccades
- Monocular Near-Far Focus (Hart Chart)
- Brock String Activities (gross divergence with focus on feeling concept of looking far, diverging and relax of accommodation, bug-on-a string activities)
- Lifesaver cards (divergence)
- Random dot stereograms with loose prism (divergence)

Phase II: Normalize positive fusional vergence amplitudes and incorporate negative and positive fusional vergence facility, starting with near then extend to intermediate and far distance at end of phase II. Focus on dynamic fusion and speed of recovery.

- Post-it saccades
- Binocular Near-Far Focus (Hart Chart)
- Brock String Activities (extending length of string, progress to jump vergence demands)
- Lifesaver cards (divergence and convergence)
- Random dot stereograms with loose prism (divergence and convergence)

Phase III: Extend length to intermediate and far distance with emphasis on negative fusional vergence amplitudes and facility. Incorporate voluntary control of vergence demand with changes in accommodative target.

- Binocular accommodative facility (adjust + and - for working distance at intermediate and far)
- Lifesaver cards jump facility, can also add plus and minus lens
- Random dot stereograms with loose prism jumps/facility
- Incorporate movement (rotations, lateral movements, saccades) in different positions of gaze

Outcome:

S.M required 25 in-office visits to complete the OVT program. Initially, with the use of the glasses alone, she reported some relief in the severity and frequency of her symptoms. After the OVT program, she felt that she had more control of her focusing abilities, which completely alleviated her symptoms. She was told to continue to wear the glasses in the same manner and return for follow up 6 months after completion of the OVT program.

Comparisons of examination results before and after vision therapy are summarized below.

Examination results before and after vision therapy:

Test	Before OVT	After OVT
Cover test (distance)	8 esophoria	4 esophoria
Cover test (near)	2 esophoria	2 exophoria
Near point of convergence		
Accomm. Target:	4 cm break, 6 cm recovery	3 cm break, 4 cm recovery

Penlight:	4 cm break, 6 cm recovery	3 cm break, 4 cm recovery
Base-in vergence (distance)	x/2/0	x/8/4
Base-out vergence (distance)	6/20/16	6/20/16
Base-in vergence (near)	10/17/12	12/24/12
Base-out vergence (near)	14/24/14	16/26/22

D. Case 4. Decompensating CNIV and vestibulopathy

Michael Peterson, O.D.

History:

A 61-year-old male presented to the Brain Injury Vision Assessment and Rehabilitation clinic with complaints of progressively worsening dizziness and imbalance. He reported having these symptoms since 2008, but in the last several months they had worsened. His history is significant for multiple head injuries throughout his life, but most recently he had a concussion in 2008 from a fall. He complained about veering to the left and bumping into objects when walking. He was noticing diplopia intermittently and reported that the diplopia was binocular, with the images diagonal and appearing the same at both distance and near. In the last few months, he had also noticed himself closing an eye to see more clearly. Reading material was much more difficult to focus on and he would lose his place after reading a single line, giving him a headache and causing excessive tearing OU. All of this would occur within 3 to 4 minutes of beginning to read. He could no longer ride his motorcycle or play softball like he once could. When playing softball he was having trouble seeing the ball when batting and was unable to run the bases.

Significant Clinical Findings:

Current Spectacles:	OD: +1.50 OS: +2.00-0.25x115 ADD: +2.50
VA: (distance, corrected)	OD, OS: 20/20
VA: (near, corrected)	OD, OS: 20/25
Extraocular motility:	OD: full to 9 positions of gaze OS: right gaze, IO overaction
Pursuits:	able to complete 2 rotations, 4 to 10 refixations
Saccades:	constant slight undershooting
Observation:	right head tilt
Cover test in all positions of gaze (distance):	3 left hyper
Cover test (near):	6 exophoria, 3 left hyper
Stereopsis:	70 secs. Wirt
Maddox Rod:	Primary gaze: left hyper Right gaze: >left hyper Left head tilt: >left hyper
Excyclotorsion (double Maddox rod):	3 degrees
Vertical vergence amplitudes:	OD: 1 BD OS: 6 BD
Base-in vergence (distance):	x/4/2
Base out vergence (distance):	x/10/6
Base-in vergence (near):	4/6/2
Base-out vergence (near):	8/12/8
SLE/DFE:	significant for dry eyes/unremarkable. Pupils: PERRL -RAPD

Case Analysis:

The patient's symptoms seem to have been related to his eyes. The symptoms began after the concussion in 2008. Maddox Rod testing conforms to congenital 4th nerve palsy, which began to be compromised by head trauma and continued to be compromised as he got older. With a longstanding 4th nerve palsy, patients will demonstrate larger than normal vertical vergence amplitudes (normal is 4 to 5, congenital may be up to 25). The other pertinent findings are the right head tilt, the Parks 3-step test and the 3 degrees of excyclotorsion. Very commonly, patients with 4th nerve problems will complain of vestibular-related issues, such as dizziness, imbalance and difficulty walking.

Diagnosis:

Hypermetropia
Astigmatism
Diplopia
Hypertropia
Fourth or trochlear nerve palsy

Management:

Through a trial period using Fresnel prism it was found that 3 BD OS neutralized the left hyper. Spectacles were designed with 1.5 BU OD and 1.5 BD OS and after wearing them for 2 weeks, the patient returned for follow up and the following findings were revealed:

Cover test (distance):	orthophoria
Cover test (near):	4 exophoria
Vertical vergence amplitudes:	OD, OS: 4 BD
Base-in vergence (distance):	x/9/6
Base out vergence (distance):	x/18/12
Stereopsis:	20 secs Wirt
Base-in vergence (near):	8/16/10
Base-out vergence (near):	10/22/16

Correcting vertical imbalances may provide a tremendous difference to a patient's visual comfort and daily activities. With the glasses the patient was able to read as long as he wanted, was able to ride his motorcycle again and resumed his stature as one of the better players on his softball team.

E. Case 5. Skew deviation

Michael Peterson, O.D., Chrystyna Rakoczy, O.D.

History:

43-year-old male seen 3 years post cycling accident. He had been helmeted, cycling at high speed, stopped suddenly, flipped over his handlebars, hit the left side and back of his head. EMT evaluation noted altered mental status, a GCS of 3T and blood draining from his left ear. Emergent CT showed intracranial hemorrhages and bilateral skull fractures. His LOC lasted 2 weeks. Neurology diagnosed TBI-related frontal network syndrome and cerebellar syndrome. Vestibular diagnosed global left vestibulopathy involving the otolith and semicircular canals. Since emerging consciousness, symptoms of dizziness, vertigo with movement, poor balance, occasional vertical diplopia, sensitivity to light and brow ache with reading persisted. Observation noted a left head tilt and unsteady gait supported by cane. Reviews of medications, personal and family histories were otherwise noncontributory.

Significant Clinical Findings:

Current RX DVO:	OD: +0.50 -0.50 x 090	OS: +0.75 -0.50 x 085
Current RX NVO:	OD: +1.50 -0.50 x 090	OS: +1.75 -0.50 x 085
VA: (distance, near, corrected)	OD, OS: 20/20	

Dynamic Acuity:	20/60 with Oscillopsia but no nystagmus
Global Stereo:	200 sec random dot, 60 sec Wirt
Distance Cover Test:	orthophoria
Distance Cover/uncover:	1pd left hyper
Vertical vergence:	2/1BD OD and 4/1BD OS
Parks Biellchowsky with Maddox:	left hyper, slightly greater on left gaze, and left tilt
Double Maddox for torsion:	OD (hypo eye) 5 degrees of excyclotorsion
Visuoscropy:	excyclotorsion of OD
Versions:	no over or under action noted
Pursuits and saccades:	mild cog wheeling and undershoot that did not extinguish
Retinoscopy/refraction:	without change
SLE/DFE:	Unremarkable. Pupils: PERRL -RAPD

Case Analysis:

Skew deviation per excyclotorsion of hypotropic eye; rule out myasthenia and thyroid disease as other causes of vertical deviation.

Diagnosis:

- Hypermetropia
- Astigmatism
- Presbyopia
- Hypertropia
- Cyclotropia
- Skew deviation
- Deficiencies of saccadic eye movements
- Deficiencies of smooth pursuit movements
- Torticollis, NOS

Management:

A 1pd BD OS Fresnel was added to both current glasses for a trial of two weeks. Blood work was ordered. On return, results of blood work were normal. He stated that with the prism he felt confident in his gait and that his vertigo and occasional diplopia had not recurred. Binocular acuity was 20/20, vertical vergences and amplitudes were balanced (3/2BDOD and 3/2BD OS) with prism in glasses, and head tilt had resolved. Rx for glasses with the prism was given and 4-week follow up scheduled. On return, the patient reported he could focus more quickly, read for longer periods of time and that he did not need his cane anymore. One year follow up was recommended, or sooner if symptoms resurface.

F. Case 6. Decompensating vertical phoria and convergence insufficiency

Michael Peterson, O.D.

History:

A 48-year-old male presented to the Brain Injury Vision Assessment and Rehabilitation clinic with complaints of blurred vision, occasional diplopia, sensitivity to light, headaches, dizziness and difficulty walking. He reported he could only read for 10 minutes before his eyes started to blur and tear, which made it very difficult to function in his occupation, which required him to spend his day reading paperwork and using the computer. His history is significant for multiple blunt head traumas, as a result of blast waves from explosive devices while he was deployed. His current ocular medication was Xalatan for glaucoma.

Significant Clinical Findings:

Current Spectacles:	OD: -0.25-1.00 x 005 OS: -0.25-0.25 x 165 ADD: +2.00
VA:(distance, corrected)	OD: 20/25 OS: 20/20
VA: (near, corrected)	OD: 20/30 OS: 20/30
Extraocular motility:	OD, OS: full to 9 positions of gaze
Pursuits:	good fixation, accurate
Saccades:	no under/over shooting
Observation:	no head tilt
Cover test (distance):	10 exophoria, 1 left hyper
Cover test (near):	12 exophoria, 1 left hyper
Maddox Rod	Primary gaze: left hyper
Excyclotorsion (double Maddox rod):	0 degrees
Vertical vergence amplitudes:	OD: 2 BD OS: 4 BD
Base-in vergence (distance):	x/8/6
Base out vergence (distance):	x/12/10
Near Point of Convergence:	1 st attempt: 8"/10" 5 th attempt:10"/12"
Base-in vergence (near):	4/10/8
Base-out vergence (near):	2/6/4
Vergence Facility (3BI/12BO):	0.5 (failed BO)
SLE/DFE:	Significant for controlled glaucoma. Pupils: PERRL -RAPD

Case Analysis:

This case demonstrates a situation where a patient reports symptoms that are typically associated with a convergence insufficiency (CI). However, the convergence insufficiency was greatly exaggerated by the presence of a vertical misalignment. In these instances, the first issue that needs to be addressed is management of the vertical component and then re-evaluation of the distance and near horizontal findings. This was done by prescribing glasses with vertical prism. Once the patient had the glasses, 2 weeks of general wear was allowed for the patient to adapt.

Diagnosis:

Myopia
Astigmatism
Presbyopia
Diplopia
Vertical heterophoria
Convergence insufficiency or palsy
Brain Injury nec

Management:

Spectacle Rx (distance):	OD: -0.25-0.25 x 180 0.5BU OS: -0.50-0.50 x 020 0.5BD
Spectacle Rx (near):	OD: +1.50-0.25 x 180 0.5BU OS: +1.25-0.50 x 020 0.5BD

Visit #2 (1 month later)

Visual acuity (with correction):	OD, OS: 20/20
Cover test (distance):	6 exophoria
Cover test (near):	10 exophoria

Vertical vergence amplitudes:	OD, OS: 2BD
Base-in vergence(near):	6/10/8
Base-out vergence (near):	30/45/35

Management:

Patient adapted very well to the prism, and no longer demonstrated CI symptoms.

Visit #3 (1 year later)

Patient reported difficulty with night vision and eye fatigue when using computer after 25 minutes.

Best corrected visual acuity:	OD, OS: 20/20
Cover test (near):	6 exophoria, questionable left hyper
Vertical vergence amplitudes:	OD: 2BD OS: 3BD
Base-in vergence (near):	6/8/6
Base-out vergence (near):	18/25/20
In office: addition of 0.5 BD OS to current RX (total of 1.5 BD OS):	
Vertical vergence amplitudes re-measured:	OD: 3BD OS: 3BD
Base-in vergence (near):	8/10/6
Base-out vergence (distance):	35/40/30

Management:

Prescribe distance spectacles with new prescription and with 0.75 BU OD and 0.75 BD OS. Also new prism used in new spectacles for the reading and for the computer. This case demonstrates a situation where symptoms are typical of a convergence insufficiency(CI). The CI was greatly exaggerated by the presence of a vertical misalignment. In such instances, it is very important to rule out a vertical problem, as it can make treatment for a CI, such as vision rehabilitation techniques or reading glasses with base-in prism, nearly impossible. This case also shows that vertical phorias may decompensate with time, causing the symptoms to reappear, therefore these patients need to be monitored for changes. Patient also to return to his primary eye care clinician for continued glaucoma management.

G. Case 7: Divergence insufficiency, pseudo-convergence insufficiency, accommodative insufficiency

Chung To, O.D.

History:

A.K., an 18-year-old honors college student, sustained a mild head concussion during a game of tackle football 12 months prior to examination. He reported loss of consciousness for 3 to 4 minutes with no altered state of consciousness. He did not seek immediate medical attention until a week after he complained of headaches to his primary care physician. Reviews of his medical report including CT of the head were unremarkable. Since the date of injury, he reported complaints of intermittent binocular double vision at distance and near that appeared to be worse during the end of the day, intermittent blurred vision, and headaches associated with nausea. He also admits that these complaints are interfering with his school work and has noted a decline in his grades.

The patient was examined 13 months after the mild head concussion. At that time, he was not wearing any corrective prescription.

Significant Clinical Findings:

VA (distance, uncorrected):	OD: 20/20
	OS: 20/20
VA (near, uncorrected):	OD: 20/20- (squinting)
	OS: 20/20- (squinting)
Near point of convergence	
Accommodative Target	14 cm break, 16 cm recovery
Penlight	14 cm break, 16 cm recovery
Cover test (distance, uncorrected)	6 esophoria
Cover test (near, uncorrected)	10 exophoria
Subjective:	OD: +1.00 20/20
	OS: +1.00 20/20
Distance lateral phoria:	4 esophoria
Base-in vergence (distance)	x/2/-2
Base-out vergence (distance)	x/16/14
Near lateral phoria:	10 exophoria
-1.00 gradient:	8 exophoria
Gradient AC/A ratio:	2:1
Base-in vergence (near)	12/24/16
Base-out vergence (near)	2/10/8
Vergence facility:	8 cpm (slow with base-out)
Negative relative accommodation (NRA):	+2.00
Positive relative accommodation (PRA):	-1.00
Accommodative amplitude (push-up):	OD: 4 D, OS: 4 D
Monocular accommodative facility (MAF):	OD: 2 cpm, slow with -2.00
	OS: 2 cpm, slow with -2.00
Binocular accommodative facility (BAF):	5 cpm, slow with minus -2.00, normal with +2.00
Fused cross cyl finding:	+1.50

Pupils were normal; all external and internal health tests were negative, the deviation was comitant, and color-vision testing revealed normal function.

Diagnosis/Case Analysis:

There is a significant degree of esophoria at distance relative to the high magnitude of exophoria at near along with low-distance base-in vergence amplitude. Analysis of the near data revealed difficulties with tests that probed the positive fusional vergence when measured directly, including a receded near point of convergence, low base-out ranges, and difficulties with vergence facility on base-out. However, the indirect findings are either normal (NRA, BAF with +2.00) or high (Fused cross cyl). The AC/A ratio was also low. Additionally, all tests that probed the patient's ability to stimulate accommodation, including amplitude of accommodation, PRA, monocular and binocular accommodative facility with minus lens were abnormal.

Given the longstanding nature of the patient's complaints along with esophoria at distance that corresponds to the low base-in vergence ranges and a low AC/A ratio, the most likely diagnosis is divergence insufficiency. Furthermore, the abnormal near findings may have suggested an initial diagnosis of convergence insufficiency, however, when coupled with accommodative insufficiency, the more likely diagnosis is pseudo-convergence insufficiency. Repeating the near cover test and the near point of convergence through a +1.50 plus lens over the manifest refraction reveals a decrease in the exophoria and moderate improvements in the near point of convergence. The initial high exophoria was likely due to the difficulty with stimulation of accommodation resulting

in under-accommodation and a greater degree of exophoria. The patient's positive response to plus lens at near confirms the diagnosis of pseudo-convergence insufficiency.

Management:

Given the entanglement of this case with abnormal findings at distance and near, two prescriptions are necessary to relieve the patient's immediate symptoms. For distance, despite the low AC/A ratio, the hyperopic refractive error was fully corrected because the plus lens reduced the esophoric deviation by a small degree. In addition, base-out prism was incorporated into his glasses. The amount of prism needed at distance was determined based on the 1:1 Rule (base-in recovery should be at least as great as the amount of the esophoria). The calculated prism amount (the difference between base-in recovery and the esophoric posture divided by 2) was calculated to be 3 base-out. A trial frame of the plus prescription along with the horizontal prism was demonstrated to the patient and he noted moderate improvements in comfort and clarity. The final prescription for single vision distance was:

OD: +1.00 with 1.5 BO

OS: +1.00 with 1.5 BO

For near, a prescription of +2.50 OU was prescribed for the accommodative insufficiency based on the fused cross cyl and balance between the NRA/PRA.

An optometric vision therapy (OVT) program was also initiated to facilitate the fusional ranges at distance/near and the stimulation of normal accommodative demands.

Phase I: Develop feeling of divergence by increasing range of motion and ocular motor control. Stimulate accommodation and normalize the amplitude of accommodation. Sensory motor fusion is most important in this case, therefore, introduce space training as soon as the patient is able to do so.

- Eye rotation
- Loose Lens Accommodative Rock
- Monocular Near-Far Focus (Hart Chart) saccades
- Brock String Activities (gross divergence with focus on feeling concept of looking near to far, convergence/diverging, and stimulation/relaxation of accommodation, bug-on-a string activities)
- Lifesaver cards (start with divergence initially)
- Random dot stereograms with loose prism (start with divergence)

Phase II: Normalize positive fusional vergence amplitudes and incorporate negative and positive fusional vergence facility starting with near first then extending to intermediate and far distance at end of phase II. Incorporate accommodative demands into fusional vergence techniques with focus on speed of accommodative response. Introduce binocular accommodative facility procedures.

- Post-it saccades
- Binocular Near-Far Focus (Hart Chart)
- Binocular loose lens accommodative rock
- Brock String Activities (extending length of string, progress to jump vergence demands)
- Lifesaver cards (divergence and convergence)
- Random dot stereograms with loose prism (divergence and convergence)

Phase III: Extend length to intermediate and far distance with emphasis on negative fusional vergence amplitudes and facility. Incorporate voluntary control of convergence and divergence demand with changes in accommodative target.

- Binocular accommodative facility (adjust plus and minus lens accordingly for working distance at near/intermediate/far distance)

- Lifesaver cards jump facility, incorporate plus and minus lens
- Random dot stereograms with loose prism jumps/facility, incorporate plus and minus lens
- Incorporate movement (rotations, lateral movements, saccades) in different positions of gaze with procedures listed above

Outcome:

A.K required 26 in-office visits to complete the OVT program. At the reevaluation, he reported significant improvements of all symptoms. He still required the distance glasses for comfort but feels less dependent on the near glasses for reading. He no longer complained of double vision and his headaches have improved dramatically. Additionally, he has managed to improve his grades in all of his course work. The patient was told to continue to wear the distance prescription with no indication for changes in the prism amount. He can wear the near glasses as needed. Comparisons of examination results before and after vision therapy are summarized below.

Examination results before and after vision therapy:

Test	Before Vision Therapy	After Vision Therapy
Cover test (distance)	6 esophoria	1 esophoria (with prism)
Cover test (near)	10 exophoria	4 exophoria
Base-in vergence (distance)	x/2/-2	x/7/4 (with prism)
Near point of convergence	14 cm break, 16 cm recovery	3 cm break, 4 cm recovery
Base-in vergence (near)	12/24/16	14/24/18
Base-out vergence (near)	2/10/8	14/26/24
Negative relative accommodation (NRA):	+2.00	+2.50
Positive relative accommodation (PRA):	-1.00	-3.00
Accommodative amplitude (push-up):	OD: 4 D, OS: 4 D	OD: 12 D, OS: 12 D
Monocular accommodative facility (MAF):	OD: 2 cpm, slow with -2.00 OS: 2 cpm, slow with -2.00	OD: 16 cpm, equal OS: 16 cpm, equal
Binocular accommodative facility (BAF):	5 cpm, slow with -2.00	15 cpm, no difficulty
Fused cross cyl finding:	+1.50	+0.50

H. Advanced case 1. Convergence insufficiency with unstable binocularity distance and near, accommodative spasm, ocular motor and fixation deficits (dorsal stream processing deficits)

Allen Cohen, O.D.

History:

A 33-year-old female (MG) theatre director had an 18-foot theatre set fall on the right side of her face. Loss of consciousness lasted for 15 minutes. When she woke up her vision was lost. She sustained a second loss of consciousness after running into the bathroom bleeding. Jaw and five teeth were broken/lost. Facial reconstructive surgery was required. Systemic health was unremarkable. After her incidents she noted: intermittent blur while reading, loss of focus and attention, eye strain/pain around OD, loss of concentration, an inability to sustain reading for long periods of time, disequilibrium. See the included Post Trauma Vision Survey.

Significant Clinical Findings:

VA (distance, near, best corrected): OD, OS, OU: 20/20-2

Refractive Analysis:

1. High myopia with increase plus manifested on over-refraction of contact lenses
2. Accommodative spasms noted OU
3. MEM over SCL: OD: +1.00 OS: +1.25

Eye Health Evaluation:

Confrontation Visual fields: FTFC

SLE/DFE: Unremarkable. Pupils: PERRL -RAPD

Summary of Sensory Motor Exam:

Dorsal stream processing deficits

Fixation: Unsteady, cannot hold longer than 6 to 8 seconds with several intrusion jumps; discomfort and blur

DCT: large, increasing exophoria with slow sensory motor recovery, blurred vision and pain noted in OD

NCT: large, intermittent exophoria-tropia, slow sensory motor recovery, ocular pain OD, and dizziness

CNP: difficult reach, fragile grasp noted ranging 10/6 inches; intermittent diplopia; difficulty maintaining fusion at 8 inches

Pursuits: Quality: grade 3 with significant strain and dizziness

Saccades: Quality: grade 3+, undershoots with corrects and significant strain and dizziness

KVS: under convergence DV/NV with alternating suppression

Cheirosopic trace: exo posture with suppression of OD

Fixation disparity: unstable exo shift between 2 to 3 BI

Stereopsis: 250 shapes and 25 seconds Wirt circles

Diagnoses:

1. Convergence insufficiency (with unstable binocularity distance and near)
2. Accommodative spasm
3. Ocular motor and fixation deficits

Management:

Goals of Therapy

1. Read with more comfort
2. Increase speed of reading
3. Feel more balanced
4. Process multi-stimuli without symptoms
5. Focus and retain visual information while reading

Therapy:

1. Currently in Phase 1: MG has only just begun her therapy, completing only 7 sessions to date.
2. Phase 1 of therapy has been designed to primarily work on stabilizing fixation, stressing monocular pursuit and saccades in addition to accommodative facility.
3. Currently working with Wayne fixator, NVR programs, incorporating balance, stabilizing fixation using a metronome. She has begun some binocular work with saccades and pursuit exercises, which utilize variable yoked prisms.
4. Re-assessment has not yet been performed; however MG has been diligent in her home and office therapy and has shown progress in overall stability of movements and posture when performing multisensory exercises.
5. Phase 2 goals: binocular accommodative techniques, BAF, build binocularity and fusion facility with emphasis on: convergence, increase speed of reading, and increase jump ductions and fusion ranges.
6. Phase 3 goals: stress stability and maintaining binocular accommodation and vergence ranges, enforcing multisensory processing exercises to reinforce automatic response of eye movements and sustainability.

Post-trauma Vision Survey

Emergent Visual Conditions	Degree of Presence
Flashes of light	1
Floaters in field of view	1
Restricted field of vision	2
“Curtain” billowing into field of view	0
Urgent Visual Conditions	
Inability to close eyes	1
Difficulty moving or turning eyes	2 OD > OS
Pain with eye movement	3
Pain in or around eyes	2 OD
Wandering eye	3
Double vision	3
OVT Conditions	
Blurred vision, distance	2
Blurred vision, near viewing	3
Slow to shift focus, near to far	3
Difficulty taking notes	2
Pulling or tugging sensation around eyes	3
Face or head turn	2
Head tilt	2
Covering, closing one eye	2
Disorientation	3
Bothered by movement in spatial world	2.5
Bothered by noises in environment	2
Light sensitivity	2
Unable to sustain near work/reading for adequate periods	3
Loss of place while reading	3
Eyes get tired while reading	3
Headaches	3
Decreased attention span	3
Reduced concentration ability	3
Difficulty remembering what has been read	3
Loss of balance	3
Poor eye-hand coordination	3
Poor handwriting	1.5
Poor posture	2.5
Dizziness	3
Poor coordination	3

I. Advanced case 2. Convergence insufficiency, divergence insufficiency, ocular motor and fixation deficits, (dorsal stream processing deficits)

Allen Cohen

History:

M.A. is a 51-year-old female artist who fell into an uncovered shaft on a New York City sidewalk, falling 8 feet, and sustained loss of consciousness. She was diagnosed with a “vestibular migraine.” Systemic health was unremarkable. She complained of: diplopia at near, difficulty “seeing the big picture,” short-term memory loss, nausea, disequilibrium, extreme sensitivity to rapid movements and hand motion, primarily when close to her face. Refer to attached PTVS for more detailed symptoms.

Significant Clinical Findings:

VA (distance, near, best corrected): OD, OS, OU: 20/20

Refractive analysis: Compound hyperopic astigmatism and presbyopia; separate reading and distance Rx prescribed; CL preferred

Eye health evaluation:

Confrontation fields: full with extreme discomfort when occluding one eye

SLE/DFE: unremarkable. Pupils: PERRL-APD

Summary of sensory motor examination:

Dorsal stream processing deficits

EOMs: comitant and full with extreme discomfort

CNP: 12/13 inches with extreme discomfort and poor reach grasp release

Cover test at distance and near: ortho, extreme sensitivity to occlusion and moving paddle

DLP: 6eso

NLP: ortho

Dist. BI: x/8/0 *****

Dist. BO: x/22/18

Near BI: x/18/10

Near BO: x/20/14

Keystone visual skills: high exo at near

Cheirosopic trace: eso posture noted ranging from 4 to 15 diopters

Diagnoses:

1. Convergence insufficiency
2. Divergence insufficiency
3. Ocular motor and fixation deficits

Management:

Goals of therapy:

1. Ability to multitask without confusion
2. Sustainable visual memory
3. Reduce dizziness/nausea induced by visual stimuli
4. Stabilize fusion control/divergence
5. Integrate binocularity with balance and eye movement
6. Read longer and more accurately
7. Pass driver's evaluation

Current Phase of Therapy and Progress

1. Initially we recommended 25 to 30 sessions of in office therapy
2. MA has now completed more than 70 therapy sessions and has initiated Phase 3 of therapy
3. Most recent re-evaluation performed 11/29/2012:
 - a. CNP: 2/3 inches, good peripheral awareness and diplopia appreciated, good reach grasp release
 - b. KVS: unstable eso posture at distance was noted, however near vision is ortho
 - c. Tolerates motion and occlusion well
 - d. Pursuits and saccades 3+ with minor discomfort
 - e. DBI through CL: 12/17/2 **
 - f. DBO through CL: 12/17/14
 - g. NBI c +2.00 over CL: -/17/12
 - h. NBO c +2.00 over CL: -/26/15**
4. Primary goals now: being able to pass a driver's evaluation, stabilize fusion control with focus on divergence and divergence recovery, integrating binocularity with balance, and increasing longevity of reading

Examples of current therapy techniques:

1. High-level vergence using stereopsis; Vectograms, VTS3, NVR with multisensory feedback and balance board
2. Promoting accommodative convergence sustainability; base-in reading cards
3. Visualization and perceptual; Nike flasher glasses, and perceptual computer programs

Post-trauma Vision Survey

Emergent Visual Conditions	Degree of Presence
Flashes of light	0
Floater in field of view	0
Restricted field of vision	0
"Curtain" billowing into field of view	0
Urgent Visual Conditions	
Inability to close eyes	0
Difficulty moving or turning eyes	0 but very dizzy
Pain with eye movement	0
Pain in or around eyes	0
Wandering eye	3
Double vision	3
OVT Conditions	
Blurred vision, distance	3 When tired at end of day
Blurred vision, near viewing	3
Slow to shift focus, near-to-far-to-near	2
Difficulty taking notes	2
Pulling or tugging sensation around eyes	1
Face or head turn	3
Head tilt	3
Covering, closing one eye	0

Disorientation	3
Bothered by movement in spatial world	3
Bothered by noises in environment	3
Light sensitivity	3
Unable to sustain near work/reading for adequate periods	3
Loss of place while reading	2
Eyes get tired while reading	2/3
Headaches	3
Decreased attention span	3
Reduced concentration ability	3
Difficulty remembering what has been read	3
Loss of balance	3
Poor eye-hand coordination	1
Poor handwriting	3
Poor posture	3
Dizziness	3
Poor coordination	3

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Section VI: Practice Management

A. Coding and billing

AOAExcel™ has developed a document on insurance, vision therapy and neuro-optometric rehabilitation written by Harvey Richman, O.D., Jason Clopton, O.D., and Richard Soden, O.D. The AOAExcel™ website has the most current (2014) information on coding for brain injury cases. Please refer to aoa.org/coding.

The website has information on the following topics:

- Reimbursement of optometric vision therapy
- Procedure and testing codes
- How to document sensorimotor examination
- Follow-up examination procedure codes
- Therapy codes
- How to meet the coding requirements
- Who can submit 97000 codes
- Diagnosis coding rules
- Clinical standards used to evaluate claims
- Insurance tips

In addition, there are several sample letters that can be sent to insurance companies regarding coverage and claims. They include:

- Predetermination of coverage
- Requests for additional information
- Denied claim
- Additional sessions
- Difference between sensorimotor examination and eye examination
- Patient's responsibility with insurance coverage
- Alternative Insurance Coverage Form

Overview of coding procedures follows and includes:

- General ophthalmologic services
- Special ophthalmologic services
- Otorhinolaryngologic vestibular function testing
- Central nervous system testing
- Health and behavior assessment
- Evaluation and management codes for diagnosis
- Prolonged services
- Case-management services
- Therapeutic procedures and diagnostic tests
- Physical medicine and rehabilitation

There are also statements of AOA policy regarding optometric vision therapy which include:

- Vision Therapy Information for Health Care and Other Allied Professionals: A Joint Organizational Policy Statement of the American Academy of Optometry and the American Optometric Association
- "The Efficacy of Optometric Vision Therapy." Report by the American Optometric Association.

Most of what is offered on the AOAExcel™ website can be applied to care of patients with brain injury associated with visual dysfunction assessment and rehabilitation. Additional information on medical records and coding can be found on: aoa.org/coding.

B. Brain Injury Websites/Support Groups:

Information about TBI that is appropriate for patients, caregivers and doctors can be found on many websites. Below are hyperlinks to sites that are run by reputable entities on a national level. Excluded are sites run by law firms. Because there are so many state and university medical centers sites, these sites are also excluded to avoid reiteration. There are many websites with vast information. Those listed are updated continuously and provide the most comprehensive data. All have been accessed as of December 2013.

TBI

Brain Injury Association of America	biausa.org/
Brain Injury Association of America State Affiliates	biausa.org/state-affiliates.htm
Brain Injury Guide: Lists support groups by state	braininjuryguide.org/braininjurysupportgroups.html
Brain Injury Guide: Survival guide run by patient with TBI who has peripheral field loss. Lots of great tips.	braininjuryguide.org/aboutbraininjurywebsite.html
Brain Injury Support Group	facebook.com/pages/Brain-Injury-Support-Group/163713670318087
Brainline.org: nongovernment brain injury resources by state	brainline.org/resources/index.php
Brainline military	brainlinemilitary.org/
Brain Trauma Foundation	braintrauma.org/
Catalogue of Federal Domestic Assistance	cfda.gov/index?s=program&mode=form&tab=core&id=dcd4a093aa1fe06ad6ac06b4ae026466
Center for Disease Control and Prevention	cdc.gov/traumaticbraininjury/ cdc.gov/injury/index.html cdc.gov/traumaticbraininjury/get_the_facts.html cdc.gov/concussion/headsup/youth.html cdc.gov/TraumaticBrainInjury/severe.html cdc.gov/concussion/sports/index.html
Center of Excellence for Medical Multimedia, Office of the Air Force Surgeon General	traumaticbraininjuryatoz.org/
Defense and Veterans Brain Injury Center	dvbic.dcoe.mil/about-dvbic

Family Caregiver Alliance	caregiver.org/traumatic-brain-injury
Head injury: map of brain with functions	headinjury.com/brainmap.htm
Health and Human Services	hhs.gov/asl/testify/2012/03/t20120319a.html
Library of Congress	loc.gov/index.html
Mayo Clinic	mayoclinic.org/diseases-conditions/traumatic-brain-injury/basics/definition/con-20029302
Military.com	military.com/benefits/veterans-health-care/tbi-resources.html
National Conference of State Legislatures	ncsl.org/research/health/traumatic-brain-injury-legislation.aspx
National Highway Traffic Safety Administration	nhtsa.gov/
National Institute of Neurological Disorders and Stroke	ninds.nih.gov/disorders/tbi/tbi.htm
National Resource Center for Traumatic Brain Injury	tbinrc.com/
North American Brain Injury Society	nabis.org/
United States Brain Injury Alliance	usbia.org/
U.S. Department of Defense	defense.gov/home/features/2012/0312_tbi/
U.S. Department of Veteran Affairs	polytrauma.va.gov/understanding-tbi/
U.S. National Library of Medicine, National Institute of Health	nlm.nih.gov/medlineplus/traumaticbraininjury.html

Vision:

American Academy of Optometry	aaopt.org/
American Optometric Association/ VRS	aoa.org/
College of Optometrists in Vision Development	covd.org/
Defense Center of Excellence	dcoe.health.mil/MediaCenter/News/details/13-03-26/DVBIC_Releases_Clinical_Guidance_for_Vision_Problems_After_Traumatic_Brain_Injury.aspx
Ohio State University Medical Center synopsis of visual dysfunction	patienteducation.osumc.edu/Documents/visual-perceptual.pdf

Optometric Extension Program Foundation	oe pf.org/
Optometrist's network	braininjuries.org/
Neuro-Optometric Rehabilitation Association	nora.cc/
Strabismus support group	eyesapart.com
Vision Center of Excellence	vce.health.mil/about

Other:

American Speech-Language-Hearing Association	asha.org/public/speech/disorders/TBI/
Aphasia Hope Foundation	aphasiahope.org/
National Aphasia Association	aphasia.org/
National Ataxia Foundation	ataxia.org/

Educational (for the OD):

Brain anatomy: Anatomy Zone	part 1: youtube.com/watch?v=D1zkVBHPh5c part 2: youtube.com/watch?v=8hC6NGQReL4
Brain anatomy: Cranial nerves	youtube.com/watch?v=vFp_qNifHzw&list=PLmGQgRI4QyEDCSPyYurmj_zatY5BWz_r
Brain anatomy: Midbrain	youtube.com/watch?v=lgQuznVG1F8
Brain anatomy: Medulla	youtube.com/watch?v=Jg9qTzchy6E
Brain anatomy: Pons	youtube.com/watch?v=vi8OKSb0XTM
Brain anatomy: Stem	part 1: youtube.com/watch?v=XPM_bxrwi4c part 2: youtube.com/watch?v=f8aaePulJfA part 3: youtube.com/watch?v=LJXMi5mnDEE
Brain anatomy: Imaging	youtube.com/watch?v=R8Mghs6SDjE

Section VII: Appendices

Appendix A: Basic Optometric Vision Therapy Instructions

1. EYE ROTATION (with eyes closed)

PURPOSE: To get a sense of eye direction, position in space and aim

MATERIALS: none

PROCEDURE: Have patient seated with eyes closed. Place your finger on the patient's center forehead and ask patient to "look" at it with eyes closed. Hold position for 5 seconds. Move your finger to four corners of the face, ears and chin and ask patient to "look" in those directions. Hold at each position. Move clockwise then counterclockwise. This can then be repeated with the patient using their finger at arm's length, visualizing where it is in space. The finger/arm should be moved clockwise and then counterclockwise while following with their eyes closed.

DURATION AND REPETITION: start with one minute of exercise and 30 seconds rest. Build to three minutes, twice daily. Repeat daily until movements are smooth. Repeat again with both eyes.

CHALLENGE: to increase difficulty:

- Have patient stand on solid surface while performing skill
- Have patient stand on thick foam surface to incorporate balance while performing skill

ENDPOINT: smooth movement and patient comfort with task

NOTES:

- Be aware of patients balance challenges. Patient may lose balance when doing this skill standing. Be ready to steady them

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2. FIXATION TRAINING

PURPOSE: To steady fixation in all positions of gaze

MATERIALS:

- occluder/patch
- tongue depressor with small target drawn or pasted on
- small flashlight
- full face hand held mirror

PROCEDURE: Have patient seated in front of you with one eye occluded. Hold target at arm's length from patient. Ask patient to look at your target without moving their head or body. Move target into all positions of gaze. Hold target for 10 seconds in each position. Observe fixation. Encourage patient to keep head and body still.

DURATION AND REPETITION: three minutes each eye, twice daily. Repeat daily until movements are smooth.

CHALLENGE: to increase difficulty:

- Change distance of target from patient (closer is more difficult)
- Have patient stand on solid surface while performing skill
- Have patient stand on thick foam surface to incorporate balance while performing skill

NOTES:

- TBI patients are often sensitive to light. In those cases use the tongue depressor as the target.
- Severe TBI patients may be more receptive to seeing their own image in a mirror. Use a full face hand held mirror for fixation.
- Target could also be a brightly colored ball.

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3. FIXATION AND TRACKING

PURPOSE: To steady fixation in all positions of gaze.

MATERIALS: Tongue depressor with small target drawn or pasted on, small flashlight, occluder/patch, full face hand held mirror.

PROCEDURE: Have patient seated in front of you with one eye occluded. Hold target at arm's length from patient. Ask patient to look at your target with without moving head or body. Slowly move target up and down, side to side, diagonally and in a circle. Observe motility. Encourage patient to keep head and body still.

DURATION AND REPETITION: Three minutes each eye, twice daily. Repeat daily until movements are smooth. Repeat again with both eyes.

CHALLENGE: To increase difficulty:

- Move target closer to patient.
- Have patient stand on solid surface while performing task.
- Have patient stand on thick foam surface to incorporate balance, while performing.

ENDPOINT: Fixation on target with smooth, intrusion free monocular and binocular pursuits.

NOTES:

- TBI patients are often sensitive to light. In those cases use the tongue depressor as the target.
- Severe TBI patients may be more receptive to seeing their own image in a mirror. Use a full face hand held mirror for fixation.
- Target could also be a brightly colored ball.
- If skill is too difficult and patient has mobility of arms, patient can put his finger on the target and follow with eyes and finger.

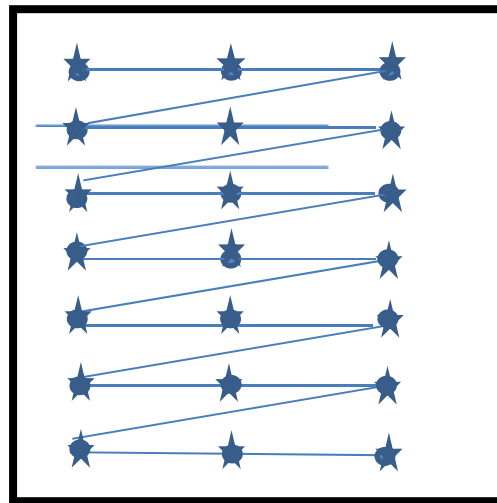
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4. SEQUENTIAL FIXATION

PURPOSE: To help with more accurate fixations one after another in rhythmic sequence. This exercise helps to transfer fixation skills developed in previous exercises to real life experience.

MATERIALS:

- Occluder/patch
 - Metronome
 - Sequence fixator (easy to make, instructions are below)
- Materials: Red, blue or black felt tipped pen, 8x10 piece of clear Plexiglas (hardware store)
Mark Plexiglas using marker as follows:



PROCEDURE: Have patient look at the first fixation target (first blue star) on the upper left hand corner. Ask patient to be aware of as much of the surrounding field of view as possible. They will move eyes to the rhythm of the metronome from one fixation target to the next along each line. Start at a slow speed (largo for those who play an instrument) and maintain fixation on the target until prompted to move by the metronome. Once the far right target is reached make a long sweep to the far left target on the second line. Continue across that line and back to the third line just like the eyes would be moved in reading. Strive for accuracy first then speed. Do not look back at targets already passed over. Maintain a rhythmic shift from target to target. Be sure to see each fixation target clearly and to be aware of your side vision. This skill can be done monocularly and then binocularly.

DURATION AND REPETITION: Three minutes each eye, twice daily. Repeat daily until movements are smooth.

CHALLENGE: To increase difficulty:

- Change distance of target from patient (closer is more difficult).
- Increase speed on metronome.
- Have patient stand on solid surface while performing skill.
- Have patient stand on thick foam surface to incorporate balance while performing skill.

NOTES: Targets may need to be adjusted for size and/or color depending on the patient's attention.

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5. SPOON PURSUITS

PURPOSE: To develop fixation ability and peripheral awareness.

MATERIALS: Spoon with reflective back surface

PROCEDURE: Stand erect with good posture and balance. Cover one eye with your hand on the same side as your eye. Thrust out the other hand holding a spoon with the convex side facing your eyes, elbow straight. With your opened eye, fixate on the image of your face in the spoon. Move the spoon slowly in the following directions: horizontal left and right; vertical up and down; oblique up and down. Follow spoon with your eye while your arm moves the route smoothly and easily and to the point when you cannot see the image of your eye on the surface of the spoon. Repeat six times in each direction; clockwise, counterclockwise, up, down, left, right and diagonally. Move only your arm and your eyeball, making sure your head is not moving. Repeat for other eye. As this activity is continued, increase your awareness of the other objects in the room around you without taking your eye off your thumbnail.

DURATION AND REPETITION: Start with one minute of exercise and 30 seconds rest. Build to three minutes, twice daily. Repeat daily until movements are smooth. Repeat again with both eyes. Repeat in clockwise and counter clockwise directions.

CHALLENGE: To increase difficulty:

- Have patient stand on solid surface while performing skill.
- Have patient stand on thick foam surface to incorporate balance while performing skill.

ENDPOINT: Smooth movement and patient comfort with task.

NOTES:

- Ability to follow the image on the convex surface of the spoon easily, smoothly with no strain, without body or head movement.
- Try to feel the eyes moving.
- Perform this activity with each eye and when successful with both eyes. Remember to wear your appropriate glasses as recommended.

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6. FOUR CORNER SACCADICS

PURPOSE: This technique will help develop proper eye movement skills.

MATERIALS:

- Occluder/patch
- Small flashlight/laser light

PROCEDURE: With your right eye (your left eye is patched), face a wall standing approximately 5-10 feet away. Look to the upper left corner. When your helper says "shift," move your eye to the upper right hand corner of the room. Try to move from the left corner to the right corner without moving your head (only move your eyes). On command, shift your eye to the lower right corner and then the lower left corner. After each fixation (at each corner) accurately aim a flashlight at each corner of the wall. If you cannot perform this activity without moving your head or body, place a book or sponge on your head. If you move your head, the sponge or book should fall off. Try to perform this activity without allowing the book or sponge to fall off. Repeat this procedure 10 cycles with two repetitions clockwise and counter-clockwise. Next, shift the patch to your right eye and repeat the above procedure with your left eye. When you can successfully perform this procedure with each eye, repeat the above with both eyes open. Try to be aware of objects in the room when shifting from corner to corner. Perform the activity according to the instructions provided, wearing your appropriate glasses.

*The goal is to visualize the corner with your peripheral vision and then move your eye and accurately fixate the corner followed by a visually guided movement of the laser light to accurately flash the corner.

DURATION AND REPETITION: Three minutes each eye, twice daily. Repeat daily until movements are smooth.

CHALLENGE: To increase difficulty:

- Change distance of target from patient (closer is more difficult).
- Have patient stand on solid surface while performing skill.
- Have patient stand on thick foam surface to incorporate balance while performing skill.

NOTES: Emphasize accuracy before speed.

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7. POST-IT SACCADICS

PURPOSE: To develop smooth and accurate eye fixations while increasing peripheral awareness (side vision).

MATERIALS:

- 15 Post-It sheets with numerals 1-15 drawn in the center of each. The numerals should be about two inches in height. Place these cards randomly on an uncluttered wall.
- Flashlight or laser light
- Eye patch or occluder

PROCEDURE: The patient stands about six feet away from the wall, directly in front of the Post-It sheets. The observer should be able to see the type of eye movements made by the patient. The eyes should fixate on each number in sequence as the observer calls off a number. Encourage the patient to be aware of all the numbers out of the corner of his or her eyes (his or her side vision) even though they are fixating directly on a particular number. Move closer to the wall as fixation improves, but do not go closer than 4 feet. Try to eliminate any head or body movements or jerky eye movements. With improvement, the number pattern can be varied by adding additional cards with more numbers. After you are proficient in this task, use a flashlight to light each Post-It. The goal is to find the number with accurate eye movements and then accurately illuminate each card with a visually guided movement.

DURATION AND REPETITION: Three minutes each eye, twice daily. Repeat daily until movements are smooth.

CHALLENGE: To increase difficulty:

- Repeat binocularly.
- Change distance of target from patient (closer is more difficult).
- Have patient stand on solid surface while performing skill.
- Have patient stand on thick foam surface to incorporate balance while performing skill.
- Perform while navigating hallway with Post-Its on two walls.

NOTES: Emphasize accuracy before speed.

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8. HART CHART SACCADICS

PURPOSE: This procedure is designed to improve visual fixation skills which are most important in reading.

MATERIALS:

- Occluder/patch
- Distance Hart chart (Appendix B, BIERM Vol 1B pg. 112)
- Metronome or other means of keeping rhythm.
- Small flashlight/laser light

PROCEDURE: Start monocularly first. Call off the first letter on the first row, then the last letter of the first row. Next, call off the first letter on the second row and then the last. Continue until the entire sheet is completed. Then, call off the second letter on the first row and then the next to the last letter on the second row. Continue this procedure for the entire sheet. When finding the letters attempt to visualize where the next letter is by expanding your peripheral awareness and then move your eyes to the next letter.

DURATION AND REPETITION: Three minutes each eye, twice daily. Repeat daily until movements are smooth.

CHALLENGE: To increase difficulty:

- Repeat binocularly.
- Randomly call off letters (i.e., third row column 4, fifth row column 18, etc..)
- Perform above with a metronome waiting for the appropriate beats before finding the next letter. Start slow and increase speed to increase difficulty.
- Repeat above but now using a laser light. Flash the fixated letter after you move your eye and fixate it. It is important that you first visualize where the letter is, then move your eye and fixate the letter and then visually guide your hand to accurately flash the letter.
- Change distance of target from patient (closer is more difficult).
- Have patient stand on solid surface while performing skill.
- Have patient stand on thick foam surface to incorporate balance while performing skill.

NOTES: Emphasize accuracy before speed.

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9. NEAR-FAR FOCUS (Hart Chart): Phase 1 and 2

PURPOSE: To develop the ability to quickly and easily change focus from distance to near and near to distance; build accommodative amplitude and accommodative facility.

MATERIALS:

- Large print Hart Chart on a wall (Appendix B, BIERM Vol 1B pg. 112)
- Smaller print Hart Chart (Appendix B, BIERM Vol 1B pg. 113)
- Occluder/patch
- Selection of low minus lenses

BASIC PROCEDURE: Place distance hart chart on a wall approximately 10 feet away at eye level for the seated patient. Cover/patch one eye. Ask the patient to hold the small print chart at 40cm (16inches), read the first row of letters on the top line. The patient should then move the near chart closer until the letters cannot be kept clear and then move it away by 2.5 cm. Shift to the distance chart to read the first line. Return at near for the next line until all are read. Switch eyes.

DURATION AND REPETITION: Three minutes, twice daily. Repeat daily until endpoint is met

CHALLENGE/MODIFICATION: To increase difficulty:

- Move near chart 1-2 inches close each time you read at near until chart is 4-6 inches from nose.
- Use low minus lenses at near to stimulate accommodation.

ENDPOINT:

- Ability to clear near chart effortlessly at distance for age appropriate amplitude.
- Shift between distant and near targets noting the feeling of focusing at near and release of focusing at distance.
- Phase 2: Work on speed. Endpoint is clarity with 10 cpm of far to near fixation.

NOTES: If patient is having difficulty:

- Ask the patient to move the card slightly away from the nose as a starting point.

YOUTUBE VIDEO LINK:

[youtube.com/watch?v=fX8mqtdzgs](https://www.youtube.com/watch?v=fX8mqtdzgs)

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10. LOOSE LENS ACCOMMODATIVE ROCK: Phase 1 and 2

PURPOSE: To develop the ability to quickly and easily change focus; build accommodative amplitude and accommodative facility.

MATERIALS:

- Smaller print Hart Chart (Appendix B, BIERM Vol 1B pg. 113)
- +/- flippers: +/- 0.50 to +/- 3.00 in 0.50 increments (loose lenses from a trial lens set and an empty adaptable flipper work even better because you can put in non-matching lens powers; i.e. +0.50 on one side and -1.50 on the other)
- Occluder/patch

BASIC PROCEDURE: Cover/patch one eye. Ask the patient to look through the +0.50 flippers and read the first row of letters of the top line small print chart held at 40cm (16inches). Have the patient take their time to achieve clarity. Once letters are clear, flip to the -0.50 lens and read the next line, again taking time to achieve clarity. The patient should continue alternating between the + and – lenses reading one line at a time. Clear vision for 10 repetitions regardless of time.

DURATION AND REPETITION: Three minutes, twice daily. Repeat daily until endpoint is met.

CHALLENGE/MODIFICATION: To increase difficulty:

- Increase by 0.50 once clarity is achieved.

ENDPOINT:

- To clear +1.50/-3.00 at 10 cycles in one minute.
- Ability to appreciate effort needed to focus.
- Phase 2: endpoint +2.00/-6.00, 10 cycles in one minute.

NOTES: If patient is having difficulty:

- Ask the patient to move the card slightly away from the nose as a starting point.

YOUTUBE VIDEO LINK: none

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11. BROCK STRING

PURPOSE: To develop sense of convergence and divergence.

MATERIALS:

- One meter Brock string with three colored beads: green, then yellow and lastly red.
- -2.00D flipper

BASIC PROCEDURE: Have patient hold the end of the string with the green bead at the bridge of their nose. The other end can be tied to a stationary object. Set the green bead at 30cm, yellow at 50cm and the red at the end. (Be consistent with the sequence of beads, i.e. always use the same colored bead at the nose.)

The patient should first look at the green bead (red) and describe what they see (they should perceive a “V” of strings emanating from the green bead with two yellow beads and two red beads along the strings in the distance). Have them close one eye and describe the view and then close the other eye. Next, ask them to fixate on the yellow bead and then the red, describing what is perceived with each. Explain the meaning of the “V” and “X” patterns, and the ability to see double along with the feeling of convergence and divergence. Use language the patient will understand. Once fusion is attained at near, mid and far beads, hold fixation at the near bead for 5 seconds. Repeat for mid and far beads. Switch back and forth. After three repetitions move the near bead closer by 5 cm. Repeat steps until near bead is 2.5cm from the nose.

DURATION AND REPETITION: Three minutes, twice daily. Repeat daily until endpoint is met.

CHALLENGE/MODIFICATION: To increase difficulty:

- Slowly move the near bead closer to patient’s nose.
- Fuse far bead and slowly increase convergence along the string until the near bead is fused.
- Have patient stand on solid surface while performing the skill.
- Have patient stand on thick foam surface to incorporate balance while performing the skill.
- Have the patient perform this skill while walking.

ENDPOINT:

- The ability to appreciate physiologic diplopia, the feeling of convergence versus divergence.
- Phase 1: Converge to a bead at 2.5cm from the nose.
- Phase 2: Voluntarily converge to a bead 2.5cm from the nose.

NOTES: If patient is having difficulty:

- Ask the patient touch the beads with his fingers for kinesthetic sense.
- Use minus lenses (-2.00D) to stimulate accommodative convergence.
- While you are focusing on a specific bead be aware of your peripheral vision.
- While shifting your eye between beads, try to be aware of how your eyes feel.

YOUTUBE VIDEOLINKS:

youtube.com/watch?v=EGlCVTdNqfw

youtube.com/watch?v=71o20wyPsR0

ADDITIONAL TECHNIQUES:

- A longer string can be used to train divergence at distance. Beads would be placed further out.

- Fasten one end of the string to any convenient object at or slightly below eye level. Hold the other end of the string between your thumb and forefinger, just below the bridge of your nose. Look at the far end of the string. You should see one bead and two strings emerging from the sides of your face and meeting at the far bead forming a "V." This is the normal response. Slowly walk up pulling the string and fixate on the bead. Take small steps and feel your eyes aimed at the bead keeping the bead clear and single with two strings crossing at the bead. Your goal is to be able to slowly walk up to 2-3 inches from the bead, seeing one bead and two strings aimed at the bead. If at any time the bead doubles or if the strings cross in front or behind the bead, stop and aim your eyes until you refuse. If this is not possible, slowly walk backwards until you fuse the bead and then start walking towards the bead again.

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12. BARREL CARD

PURPOSE: To develop sense of convergence and divergence and to achieve a normal near point of convergence.

MATERIALS:

- Barrel card
- -2.00D flipper

BASIC PROCEDURE: Patient should be seated with a distraction free field of view in front of them. Hold the card with your thumb and index finger at the lower edge of the card. Place the card edgewise directly in front of the patient's nose with the largest barrel toward the nose and the smallest furthest away. Make sure the card is not tilted by asking the patient to alternately wink each eye to determine if the same amount of card space is visible on each side. Ask patient to fixate on the barrel furthest away until it is single and seen clearly. The closest and middle barrels should appear doubled. Ask the patient to shift fixation to the middle barrel until it is single and clear. The closest and furthest barrels should appear doubled. Finally, ask patient to fixate the nearest barrel. The other two should be doubled. Hold fixation for 5 seconds at each barrel. The patient should be able to shift between barrels 10 times.

DURATION AND REPETITION: Three minutes, twice daily. Repeat daily until endpoint is met.

CHALLENGE/MODIFICATION: To increase difficulty:

- Have patient stand on solid surface while performing the skill.
- Have patient stand on thick foam surface to incorporate balance while performing the skill.
- Have the patient perform this skill while walking.

ENDPOINT:

- Ability to appreciate physiologic diplopia, the feeling of convergence versus divergence.
- Shift between barrel effortlessly maintaining fixation for 10 seconds with each barrel and physiologic diplopia of non-focused barrels.

NOTES: If patient is having difficulty:

- Ask the patient to move the card slightly away from the nose as a starting point.
- Using minus lenses (-2.00) to stimulate accommodative convergence.
- Cut the card in half length-wise to decrease septum effect.

YOUTUBE VIDEO LINK:

[youtube.com/watch?v=HtzEHSie-90](https://www.youtube.com/watch?v=HtzEHSie-90)

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13. LIFE SAVER CARDS (convergence): Phase 1, 2 and 3

PURPOSE: To increase the ability to converge without effort.

MATERIALS:

- Opaque life saver cards
- Sharpened pencil
- Flip prism 4BI/8BO

BASIC PROCEDURE: Hold life saver card at 16" from nose; closer life savers at bottom of card. Hold pencil point in front of the card, just below and between the two lowest circles. While staring at the pencil point, slowly bring it closer to yourself. Note: Two circles become four circles. As you push the pencil point in and continue to stare at it, the two middle circles will come together to form one mixed red and green circle under the pencil point. Clear the third (middle) circle by slowly moving the pencil point in and out. The third circle should look as if it is floating towards you. All of the letters in "Clear these letters" should be present. Hold for 5 seconds and then remove the pencil but keep the middle circle single and clear. Hold for another 5 seconds then relax.

If you see two red and one green circle, the left eye is being suppressed; if two green and one red the right eye is being suppressed. "Clear these letters" will have missing letters if suppression occurs. The middle circle also should not appear to be half-red and half-green, but a mixture of the two colors. If any of these conditions occur, blink your eyes a few times and/or slowly move the card side to side to regain the correct appearance of the middle circle.

DURATION AND REPETITION: Three minutes, twice daily. Repeat daily until endpoint is met.

CHALLENGE/MODIFICATION: To increase difficulty:

- Once fusion is attained, trombone the pencil from the arm's length to nose and maintain fusion.
- Once fusion is attained, slowly move your head side to side, up and down and then in a small circle while maintaining fusion.
- Phase 2: Repeat the procedure with the upper sets of lifesavers.
 - Repeat without the aid of a pointer, starting with the bottom circles.
 - Focus on a distant target then look at the card held at 40cm to fuse the top lifesavers. Repeat.
- Phase 3: Jump Ductions with flipper prisms 4BI/8BO.
 - Repeat the procedure starting with lower set of lifesavers.
 - Repeat without the aid of a pointer, starting with the bottom circles.

ENDPOINT:

- Ability to appreciate fusion, the feeling of convergence versus divergence.
- Shift between near target and top lifesavers effortlessly while maintaining fusion and clarity of both targets.

NOTES: If patient is having difficulty:

- Ask the patient to move the card slightly away from the nose as a starting point.

YOUTUBE VIDEO LINK:

[youtube.com/watch?v=wcVX684r3xQ](https://www.youtube.com/watch?v=wcVX684r3xQ)

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14. LIFE SAVER CARDS (divergence) Phase 1, 2 and 3

PURPOSE: To increase the ability to diverge without effort.

MATERIALS:

- Transparent life saver cards
- Sharpened pencil
- Flip prism 4BI/8BO

BASIC PROCEDURE: Hold life saver card at 16" from nose, more spread apart life savers at top of card. The background should be distraction free such as blank wall. Hold the pencil point behind the card just below and between the two lower circles. While staring at the pencil point, slowly move the pencil point away from yourself. Note: two circles become four circles. As you push the pencil point out and continue to stare at it, the two middle circles will come together to form one mixed red and green circle in front of the pencil point. Clear the third (middle) circle by moving the pencil point in and out. The third circle should look as if it is floating away from you. All of the letters in "Clear these letters" should be present. Hold for 5 seconds and then remove the pencil but keep the circle single and clear. Hold for another 5 seconds then relax.

If you see two red and one green circle, the left eye is being suppressed; if two green and one red the right eye is being suppressed. "Clear these letters" will have missing letters if suppression occurs. The middle circle also should not appear and ½ red and ½ green, but a mixture of the two colors. If any of these conditions occur, blink your eyes a few times and/or slowly move the card side to side to regain the correct appearance of the middle circle.

DURATION AND REPETITION: Three minutes, twice daily. Repeat daily until endpoint is met.

CHALLENGE/MODIFICATION: To increase difficulty:

- Once fusion is attained, trombone the card from the arm's length to nose and maintain fusion.
- Once fusion is attained, slowly move head side to side, up and down and then in a small circle while maintaining fusion.
- Phase 2: Repeat the procedure with the upper sets of lifesavers.
 - Repeat without the aid of a pointer, starting with the bottom circles.
 - Focus on a distant target then look at the card held at 40cm to fuse the top lifesavers. Repeat.
- Phase 3: Jump Ductions with flipper prisms 4BI/8BO.
 - Repeat the procedure starting with lower set of lifesavers.
 - Repeat without the aid of a pointer, starting with the bottom circles.

ENDPOINT:

- Ability to appreciate fusion, the feeling of divergence versus convergence.
- Shift between distant target and top lifesavers effortlessly maintaining fusion and clarity of both targets.

NOTES: If patient is having difficulty:

- Ask the patient to move the card slightly closer to the nose as a starting point.
- Use a more distant target such as a point on a wall for initial fusion.

YOUTUBE VIDEO LINK:

youtube.com/watch?v=Ui3KTZOdzbo

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15. BINOCULAR ACCOMMODATIVE FACILITY

PURPOSE: To increase the speed of accommodation under binocular conditions.

MATERIALS:

- Flippers: +/- 1.00, +/-1.50, +/-2.00
- Age appropriate reading material 20/30 to 20/80
- Polaroid reader
- Polarized glasses

BASIC PROCEDURE: Place Polaroid reader on reading material held at 40cm. Patient wears polarized glasses over their habitual/reading glasses. Start with +/-1.50 flippers. Ask the patient to look through the +flippers and read the first row of letters of the top line small print chart. If the patient can't clear the print, cut back to +/-1.00. If the letters are cleared, flip the lenses to the minus side and ask patients to read the next line. Reading material should always be visible through all stripes. Ask patient if they notice a difference in the effort put out for plus and minus lenses and if they notice any other changes (smaller/larger print, closer/further print, easier to see all print with plus or minus through polarization).

The patient should continue alternating between the + and – lenses reading one line at a time, maintaining clear vision for 3 minutes.

DURATION AND REPETITION: Three minutes, twice daily. Repeat daily until endpoint is met.

CHALLENGE/MODIFICATION: To increase difficulty:

- Increase by 0.50 once clarity is achieved.

ENDPOINT:

- Single, clear vision of 20/30 print through +/-2.00 at 13 cpm without suppression. (age corrected).
- Ability to appreciate voluntary stimulation and relaxation of the accommodative system.

NOTES: If patient is having difficulty:

- Ask the patient to move the card slightly away from the nose as a starting point.

YOUTUBE VIDEO LINK: none

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16. RANDOM DOT STEREOGRAMS (convergence and divergence)

PURPOSE: To increase the ability to converge and diverge without effort.

MATERIALS:

- Stereograms (from Google/Images)
- Prism bar
- Flip prism 4BI/8BO or loose prisms: 6^Δ, 8^Δ, 10^Δ, 12^Δ, 15^Δ, 20^Δ, 25^Δ

BASIC PROCEDURE: <http://www.youtube.com/watch?v=kgrUfUI0Y9g> (nice how to)

Demonstrate physiologic diplopia using two fingers: hold one finger about 5 inches in front of the nose and the other finger about another 10 inches in front. Have patient note the multiple images as they focus on each finger and to also note the sense of convergence and divergence. Explain that allowing the eyes to relax and look beyond is what is needed to see the stereograms; as in looking through a window to see what is behind it. Another exercise is: look at a window screen and then focus beyond the screen to see what is behind it.

When viewing a stereogram on a computer:

1. Sit directly in front of the stereogram on the computer screen.
2. Relax the eyes to look beyond the computer screen. Try not to blink.
3. The 3D image should begin to come into view (some are more difficult than others and may require more relaxation). The longer you look beyond the screen, the clearer the 3D image.
4. If you are having difficulty, come closer to the screen. Once you see the image, slowly move away from the screen.

DURATION AND REPETITION: Three minutes, twice daily. Repeat daily until endpoint is met.

CHALLENGE/MODIFICATION: To increase difficulty:

- Maintain 3D view while slowly moving head side to side and up and down.
- Maintain 3D view while incrementally adding BI prism to further train divergence or by adding BO prism to train convergence. Use prism bars to increase prism. Some images may display more detail with the addition of prism.
- Maintain 3D view while introducing BI/BO prisms for jump ductions.

ENDPOINT:

- Ability to appreciate fusion/3D, the feeling of convergence versus divergence with use of prism
- Increase of fusional ranges to expected.
- Shift focus between computer screen and image effortlessly while maintaining fusion and clarity.

NOTES: If patient is having difficulty:

- Move closer to the computer screen
- Retrain physiologic diplopia.

WEBSITES:

See appendix F. Google/Images: “easy stereograms”

Stereograms for beginners, How to view stereograms, Moving stereograms, Cool stereograms, How 3D stereograms work, and many others. Any of these images will lead to websites hosting stereograms that can be used for therapy.

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Appendix B: Basic Distance-Near Charts

	1	2	3	4	5	6	7	8	9	10
1	C	F	J	P	K	D	N	E	H	E
2	L	B	A	T	O	E	K	L	R	X
3	D	O	H	W	F	M	B	K	A	Y
4	I	X	F	R	T	O	S	M	V	C
5	D	M	V	R	S	X	B	E	T	O
6	N	P	O	E	A	N	C	B	K	F
7	E	V	W	D	B	K	E	P	M	A
8	A	L	P	S	M	A	R	D	L	G
9	P	N	U	A	X	S	O	Z	P	B
10	X	O	S	N	C	T	U	K	U	W

Near Chart

	1	2	3	4	5	6	7	8	9	10
1	C	F	J	P	K	D	N	E	H	E
2	L	B	A	T	O	E	K	L	R	X
3	D	O	H	W	F	M	B	K	A	Y
4	I	X	F	R	T	O	S	M	V	C
5	D	M	V	R	S	X	B	E	T	O
6	N	P	O	E	A	N	C	B	K	F
7	E	V	W	D	B	K	E	P	M	A
8	A	L	P	S	M	A	R	D	L	G
9	P	N	U	A	X	S	O	Z	P	B
10	X	O	S	N	C	T	U	K	U	W

Appendix C: Basic Out-of-office Activities for Patients Needing Neuro-Optometric Rehabilitation

Brenda H. Montecalvo, O.D.

There are many simple out of office activities that can be employed with patients that may not be ready for or cannot continue formal Neuro-Optometric rehabilitative Therapy (NORT) for one reason or another. The following are examples of initial out of office basic activities. These activities which address fixation and other simple visual motor skills are not formal visual therapy but are easy skills that patients can do by themselves or with a care giver. Once the patient progresses to a higher level and is able to participate in in-office NORT, binocularity can be addressed with guided skills.

Activities:

PEN/CAP(aka; pointer/straw)

Purpose: Accurate judgment of objects fixated. Helps with fixation, peripheral awareness, localization, orientation

Materials: Pen with a cap, occluder (wooden spoon)

Procedure:

Part 1 - Monocular: Patient begins with holding cap between index and thumb with hand in lap. Patient covers one eye. Observer holds pen at 10 inches on visual axis. Instruct patient to look at tip of pen and not at cap while performing the task. Have patient attempt to place cap on pen. Record if cap is judged in front, behind, right or left of pen. Work with each eye for about 1 minute. Repeat with other eye.

Part 2 - Binocular: Same procedure with both eyes open.

EYE STRETCH

Purpose: To improve eye mobility. Helps with fixation, pursuits, saccades, motor planning, visualization.

Materials: None or may need targets placed at all 12 o'clock positions on ceiling, walls and floor. Target for tracking.

Procedure:

Part 1 - With both eyes open, patient is to cover one eye and fixate the 12 o'clock position on the ceiling above. The patient moves eye slowly to the one o'clock position then continues as he rotates the eye clockwise three times then counter clockwise three times while stretching the eye as far as possible. Do Eye Stretch two times per day.

Part 2 - To work pursuits (tracking), have observer hold a target and rotate it in extreme secondary position. Do one minute for each eye.

Part 3 - Imagine a small lady bug on the ceiling. Watch it crawl from 12 o'clock around to all of the clock positions. Repeat three times clockwise, three times counterclockwise with each eye.

Games/workbooks:

SOLITAIRE

Purpose: Hand eye coordination, looking to the far left and far right.

Materials: Deck of cards, use ones for visual impairment if easier to see.

Procedure: Patient plays solitaire with cards. Do for 10 min./day Do not use the computer. If patient consistently ignores cards in direction of visual field defect, place a bright strip of paper at the edge of the cards to that side.

CONCENTRATION

Purpose: Memory, matching, figure ground.

Materials: Large print deck of cards.

Procedure: Begin with only two pairs of cards. See if matching is possible with memory. If using two pairs is easy increase to four pairs. Increase to entire deck as possible. Do for 10 minutes per day. If memory is extremely difficult work matching first with cards face up, this helps matching and figure ground skills.

SUDOKU

Purpose: Saccades, visual memory, planning, concentration.

Materials: A variety of large Sudoku puzzles from very easy to mildly difficult, some of the easy ones need to have some of the numbers filled in if easy is still too hard.

Procedure: Patient works on completing the puzzle for 10 minutes at a time. Coaching patient to plan and figure out how to choose the correct number is important until they understand the process.

JIGSAW PUZZLE

Purpose: Improve hand/eye coordination, figure/ground, closure, visual memory.

Materials: Jigsaw puzzles from 10 – 250 piece with good contrast, timer.

Procedure: Begin with 10 piece puzzle. Time how long it takes patient to complete. Repeat with same puzzle to see if time can be shortened. Once there is little seek and find being used to complete puzzle move to the next larger piece puzzle and repeat procedure.

BALLOON TAP

Purpose: Improve hand/eye coordination, pursuits and motor planning.

Materials: String, bag of balloons, metronome.

Procedure: Tie one end of string to a fully inflated balloon and attach the other end to a hook or fixture in ceiling. Have patient tap balloon with alternate hands if possible. To increase difficulty use balloons with less inflation and tap to the beat of a metronome.

BALLOON VOLLEYBALL

Purpose: Improve hand/eye coordination, pursuits and motor planning.

Materials: Bag of balloons.

Procedure: Have the observer sit facing the seated patient approximately three feet between them. Tap fully inflated balloon back and forth. Keep score. To increase difficulty, move further apart and use a balloon that is less inflated.

PING PONG

Purpose: Improve hand/eye coordination, pursuits and motor planning.

Materials: Ping pong net, yellow ping pong balls, light weight paddles.

Purpose: Use either a ping pong table or a dinner table. Place net on table to play ping pong.

BALL DRIBBLE

Purpose: Improve hand/eye coordination, timing and motor planning.

Materials: Rubber ball well inflated, metronome.

Procedure: In a seated position or standing position if possible, position the patient to dribble the ball. To increase difficulty dribble to the beat of a metronome.

WORD SEARCH

Purpose: Improve figure/ground, planning and saccades.

Materials: Large bold print simple word search puzzles

Procedure: Have patient search for the hidden words. If too difficult, bold print words within the puzzle. Work puzzle for 10 minutes at a time.

CROSSWORD PUZZLE

Purpose: Improve cognition and saccades.

Materials: Large bold print simple Crossword puzzles.

Procedure: Work easiest crossword puzzle available. If too difficult, fill in some of the letters of each word. Work puzzle for 10 minutes

Ergonomic suggestions:

VISOR

Purpose: Decrease eyestrain from photosensitivity.

Materials: Visor or hat with a brim.

Procedure: A brimmed hat or golf visor should be used for photosensitivity (inside and outside) and situations when there is excessive visual stimulation. A prescription may be required from the optometrist if it is needed at work or school.

PRIMARY READING GAZE

Purpose: To improve ease of reading. Helps improve cognitive function.

Materials: Reading material the size of best reading acuity.

Procedure: Reading acuity is measured in primary gaze at patient's working distance. Lenses are prescribed for the distance of best near reading acuity and comfort. Patient is instructed to place reading straight ahead and to use a specific size based on reading performance. Read for 10 minutes three times per day.

RADIO OR BOOKS ON TAPE

Purpose: Cognitive stimulation, memory, visualization, closure.

Materials: Radio, taped books.

Procedure: Have the patient listen to the radio or tape for 15 minutes. When finished ask what was heard and what do characters look like. Encourage vivid visual description. For taped programs stop the story and ask what they think might happen next.

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Appendix D: References for OVT

Chrystyna Rakoczy, O.D.

Books:

Scheiman M, Wick B. *Clinical Management of Binocular Vision: Heterotropic, Accommodative and Eye Movement Disorders*. 4th ed. Walters Kluwer

Chapter 21 – Binocular and Accommodative Problems Associated with Acquired Brain Injury. Includes great case studies.

ISBN-13: 978-1451175257 ISBN-10: 1451175256

Griffith JR, Grisham JD. *Binocular Anomalies: Diagnosis and Vision Therapy*. 4th ed. Butterworth Heinemann

Chapter 20 – Suggested sequencing of Techniques

ISBN-13: 978-0750673693 ISBN-10: 0750673699 Edition: 4th

Press LJ. *Applied Concepts in Vision Therapy: with Accompanying Disc*

ISBN-13: 978-0815167297 ISBN-10: 0815167296 Edition: Har/Dskt

Suter PS, Harvey LH. *Vision Rehabilitation: Multidisciplinary Care of the Patient Following Brain Injury*. 2011
CRC Press

ISBN-13: 978-1439836552 ISBN-10: 1439836558 Edition: 1st

Suchoff IB, Ciuffreda KJ, Kapoor N. *Visual and Vestibular Consequences of Acquired Brain Injury*. OEP
Foundation 2001

ISBN- 0-94359904203 Edition: 1st

Zoltan B. *Vision, Perception, and Cognition: A Manual for the Evaluation and Treatment of the Adult with Acquired Brain Injury* (for OTs)

ISBN-13: 978-1556427381 ISBN-10: 1556427387 Edition: 4th

Scheiman M. *Understanding and Managing Vision Deficits: A Guide for Occupational Therapists*

ISBN-13: 978-1556429378 ISBN-10: 1556429371 Edition: Third Edition

Swartwout JB. *Opt Vision Therapy Manual - Procedures and Forms for In-Office & Out-of-Office Training Programs*

oeopf.org/product/opt-vision-therapy-manual-procedures-and-forms-office-out-office-training-programs

Richman JE, Cron MT. *Guide to Vision Therapy*. Bernell

bernell.com/product/BCV/214

Caloroso ER, Rouse MW. *Clinical Management of Strabismus*. OEP Foundation

oeopf.org/products/category/books

You tube videos for OVT:

Brock string:

youtube.com/watch?v=EGICVTdNqfw

Life saver cards: Dominick Maino

BI: [youtube.com/watch?v=wcVX684r3xQ](https://www.youtube.com/watch?v=wcVX684r3xQ)
BO [youtube.com/watch?v=Ui3KTZOdzbo](https://www.youtube.com/watch?v=Ui3KTZOdzbo)
[youtube.com/watch?v=Ui3KTZOdzbo&list=PL17FD7E74328BD0B3](https://www.youtube.com/watch?v=Ui3KTZOdzbo&list=PL17FD7E74328BD0B3)

Hart chart: Dominick Maino
[youtube.com/watch?v=fX8mqtgdzgs](https://www.youtube.com/watch?v=fX8mqtgdzgs)

Barrel card: Dominick Maino
[youtube.com/watch?v=HtzEHSie-90&list=PL17FD7E74328BD0B3](https://www.youtube.com/watch?v=HtzEHSie-90&list=PL17FD7E74328BD0B3)

Bunt Ball: aka Marsden ball:
Dominick Maino
[youtube.com/watch?v=RTy3o8DwON8&list=PL17FD7E74328BD0B3](https://www.youtube.com/watch?v=RTy3o8DwON8&list=PL17FD7E74328BD0B3)
Julie Steinhauer
[youtube.com/watch?v=2rszMv01psc](https://www.youtube.com/watch?v=2rszMv01psc)
[youtube.com/watch?v=mO8ZkV2bTGs](https://www.youtube.com/watch?v=mO8ZkV2bTGs)

Wayne saccadic fixator: Julie Steinhauer
[youtube.com/watch?v=K3UfrB_VNSw](https://www.youtube.com/watch?v=K3UfrB_VNSw)

Balance board: Julie Steinhauer
[youtube.com/watch?v=4WwZn1BwpIM](https://www.youtube.com/watch?v=4WwZn1BwpIM)

Split Vectograms: Dominick Maino
[youtube.com/watch?v=Tzieb5qDvJA](https://www.youtube.com/watch?v=Tzieb5qDvJA)

Neuro Vision Rehabilitator (NVR)
nrvvision.com/

Neuro Vision Technologies: (NVT)
[youtube.com/watch?v=CFSvIwOaa54](https://www.youtube.com/watch?v=CFSvIwOaa54)

Dynavision
Madonna Rehabilitation Center
[youtube.com/watch?v=GCogrh7sIxs](https://www.youtube.com/watch?v=GCogrh7sIxs)
[youtube.com/watch?v=L3IP85_pDVc](https://www.youtube.com/watch?v=L3IP85_pDVc)

Madonna Rehabilitation Center: vision rehab Lyca CNIII
[youtube.com/watch?v=yA0dvznc8FM](https://www.youtube.com/watch?v=yA0dvznc8FM)

Lynn Hellerstein: Vision rehab 20 yrs. post TBI
part I: [youtube.com/watch?v=ZvekLUXROaQ](https://www.youtube.com/watch?v=ZvekLUXROaQ)
part II: [youtube.com/watch?v=IpGVSR62raA](https://www.youtube.com/watch?v=IpGVSR62raA)

Stereograms:

How to view stereograms

[youtube.com/watch?v=kgrUfUI0Y9g](https://www.youtube.com/watch?v=kgrUfUI0Y9g)

Google/Images: easy stereograms: Stereograms for beginners, How to view stereograms, Moving stereograms, Cool stereograms, How 3D stereograms work, and many others.

aolej.com/stereo/training.html; stereo training.

easystereogrambuilder.com

3dstereograms.com/

brainbashers.com/stereo.asp

easystereogrambuilder.com/stereograms.aspx

eyetricks.com/3stereo.htm

magiceye.com/3dfun/stwkdisp.shtml

netaxs.com/~mhmyers/rds-ex.html

vision3d.com/sghidden.html

Game websites:

Eyecanlearn.com

eyetricks.com

facebook.com/pages/Mondo-Stereogrammi/173717029330964

hidden-3d.com

learningresources.com

mindwareonline.com

nowscape.com

stereogramsworld.wordpress.com

Therapro.com

visiontherapysolution.net

vision3d.com

Workbooks:

Reversing Reversals: Fun Activities that Build Sequencing, Visual Discrimination and Tracking Ability Paperback– January 1, 2008 by Dr. Erica Warren \$15.99

amazon.com/Reversing-Reversals-Activities-Sequencing-Discrimination/dp/0982221134/ref=sr_1_1?ie=UTF8&qid=1413991274&sr=8-1&keywords=reversing+reversals

Developing Ocular Motor and Visual Perceptual Skills: An Activity Workbook Paperback– February 1, 2005

by Kenneth Lane OD FCOVD \$50.07

amazon.com/Developing-Ocular-Visual-Perceptual-Skills/dp/1556425953/ref=sr_1_1?ie=UTF8&qid=1413991304&sr=8-1&keywords=developing+ocular+motor

Vincett Perceptual Training Workbooks

Visual Tracing

Saccadic Fixations, Level I

Saccadic Fixations, Level II

GEO Board

Visual Memory, Level I & II (Numbers & Letters)

Visual Memory, Level III (Symbols)

Visual Memory, Level IV & V (Arrows & Tic-Tac-Toe)

oepf.org/product/set-7-vincett-perceptual-training-workbooks-0

Various workbooks

bernell.com/category/1253

Ann Arbor Word Tracking Workbook

bernell.com/product/AT8706/214

Crossword puzzle book cancel with r/g glasses

bernell.com/product/HDCW1/214

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Appendix E: TBI APPs

Candice Elam, O.D.

Apps for the OD

mTBI Pocket Guide

- Comprehensive, quick-reference guide includes clinical practice recommendations for assessing and treating service members and veterans who have sustained a mild TBI.
- Designed by Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury.
- Device: Android, iOS
- Price: Free

Brain Injury Resource Directory

- Locate brain injury resources by city, state or ZIPcode.
- Narrow search results to civilian, military or both.
- Device: Android, iOS
- Price: Free

CNS Mobile

- Information about TBI, research, treatment and rehabilitation services at Centre for Neuro Skills.
- Device: Android, iOS
- Price: Free

EyeHandbook

- Diagnostic and treatment reference tool for eye care providers.
- Device: Android, iOS
- Price: Free

EyeChartHD

- Snellen and tumbling E charts.
- Also includes Ishihara plates and Amsler grid.
- Device: iOS
- Price: Free, full version \$0.99

OptoDrum

- Adjustable stripe pattern, width and speed.
- Device: iOS
- Price: \$4.99

OKN Strips

- Adjustable stripe speed, width and color (red, black).
- Also includes red desaturation test and Amsler grid.
- Device: iOS
- Price: \$2.99

General Apps for the Brain Injured Patient

ICE (In Case of Emergency)

- Stores doctors name, current medications, medical conditions and allergies, insurance information.
- Device: Android, iOS
- Price: Free version or \$1.99 for full functionality iOS, Free for Android

Pill Time

- Settings for multiple medications, usage times and dosages per day.
- Device: iOS
- Price: \$0.99

Med Minder

- Pill and medicine scheduler, medication reminder.
- Device: Android
- Price: Free

Locate Me Now

- Finds your current location/address.
- Device: iOS
- Price: Free

Where Am I?

- View and share your location.
- Device: Android
- Price: Free

Wallet Advanced

- Manage website logins, passwords, PIN numbers, credit cards and more.
- Master password protected, data encryption, self-destruct, and auto-lock protection.
- Device: iOS
- Price: \$2.99

Pocket

- Safely store sensitive data such as bank account details and passwords.
- Device: Android
- Price: Free

Today Screen

- One-stop view of upcoming agenda, appointments, tasks due and weather forecast.
- Device: iOS
- Price: Free version, \$2.99 for full version

Touch Calendar

- See your whole calendar at a glance.
- Device: Android
- Price: Free, full version \$3.95

Corkulous

- Collect, organize and share ideas; notes, labels, photos, contacts and tasks.
- Device: iOS
- Price: Free version, \$4.99 full version

Evernote

- Stay organized - take notes, capture photos, create to-do lists, record voice reminders.
- Device: Android
- Price: Free

Breathe2Relax

- Stress management, diaphragmatic breathing.
- Device: Android, iOS
- Price: Free

PTSD Coach

- Education about PTSD, information about professional care, self-assessment, opportunities to find support, and tools such as relaxation skills, positive self-talk and anger management.
- Created by Veterans Affairs' National Center for PTSD and the Department of Defense's National Center for Telehealth and Technology.
- Device: Android, iOS
- Price: Free

Quick Talk AAC

- Allows non-verbal individuals to communicate.
- Device: Android, iOS
- Price: Android \$24.99, iOS \$24.99

SmallTalk Aphasia

- Provides a vocabulary of pictures and videos that talk in a natural human voice.
- Device: iOS
- Price: Free

TapToTalk

- Tap a picture to speak.
- Different sets of augmentative and alternative communication (AAC) albums are available.
- Can create individualized albums with TapToTalk Designer.
- Device: Android
- Price: Free application; Designer \$149.95

T2 Mood Tracker

- Designed for service members and veterans to self-monitor, track and reference emotional experiences associated with deployment-related behavior health issues like PTSD, brain injury, depression and anxiety.
- Device: Android, iOS
- Price: Free

Apps for Visually Impaired Patients

Dragon Dictation, Dragon Remote Microphone

- Turns speech into text
- Device: Android, iOS
- Price: Free

iBooks with Voiceover

- Content of downloaded books and magazines is read aloud
- Device: iOS
- Price: Free

Audible

- Listen to books on mobile device.
- Device: Android, iOS
- Price: Free

Learning Ally Audio

- Over 75,000 audiobooks and audio textbooks.
- Membership and proof of learning disability, physical disability or visual impairment required to use app.
- Device: Android, iOS
- Price: Free; may be quarterly charge for membership.

Apps for Rehabilitation of Patients

Flashcards Deluxe

- Create flashcards on your computer or within the app.
- Can browse and download flashcards from Quizlet.com and FlashcardExchange.com.
- Device: Android, iOS
- Price: Free versions, \$3.99 full version.

iMazing

- Skill-based maze game
- Device: iOS
- Price: Free

Lumosity

- Brain exercises targeting memory, attention, speed, flexibility, and problem solving.
- Option to design personalized training with TBI- and/or PTSD-specific content.
- Device: iOS, Web
- Price: Free; Paid subscription for advanced features.

Matrix Game

- Helps develop visual perception skills such as visual discrimination.
- Develops attention, concentration, spatial orientation and principles of classification and categorization.
- Device: iOS
- Price: Free; Paid versions for advanced levels and more functionality.

n-Back

- Improves working memory through active memorizing and recalling of information.
- Device: iOS
- Price: Free

Naming TherAppy

- Word-finding app for people with aphasia to practice naming and description skills.
- Device: iOS
- Price: \$24.99

Spaced Retrieval TherAppy

- Facilitates recalling an answer over expanding intervals of time to help cement information in memory.
- Device: iOS
- Price: \$3.99

Kinetic Visual Acuity

- Improve kinetic visual acuity.
- Device: iOS
- Price: Free version, \$1.99 iPhone, \$2.99 iPad.

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Appendix F: Vision and Ocular Side Effects of Medications Used in the Treatment of TBI-related Sequelae

Matthew Rhodes, O.D.

Defect	Medication (generic name only)
Defects of Vision	
Decreased Acuity	carbamazepine, gabapentin, ibuprofen, indomethacin, haloperidol, prazosin, sodium valproate, SSRI's, topiramate, trazodone, tricyclics antidepressants, quetiapine
Diplopia	benzodiazepines, gabapentin, ibuprofen, sodium valproate, topiramate, trazodone, quetiapine
Photosensitivity	carbamazepine, haloperidol, ibuprofen, SSRI's, trazodone
Myopia	haloperidol, topiramate
Abnormal Visual Sensations	ibuprofen, topiramate, trazodone
Color Vision Abnormalities	acetaminophen, benzodiazepines, carbamazepine, ibuprofen, indomethacin
Oscillopsia	carbamazepine
Visual Hallucinations	acetaminophen, baclofen, carbamazepine, gabapentin, ibuprofen, haloperidol, methylphenidate, prazosin, sodium valproate, quetiapine
Visual Field Defects	indomethacin, topiramate

Defects of the Eye and Adnexa	
Conjunctival Hyperemia	topiramate
Eyelid Erythema	benzodiazepines, ibuprofen, prazosin
Non-specific Conjunctivitis	acetaminophen, benzodiazepines, gabapentin, ibuprofen, prazosin
Non-specific Ocular Irritation	indomethacin, topiramate, trazodone
Allergic Conjunctivitis	benzodiazepines, haloperidol
Blepharospasm	benzodiazepines (lorazepam), haloperidol
Cataract Formation	haloperidol, phenothiazines
Corneal Deposits	ibuprofen, phenothiazines
Dry Eye	ibuprofen, quetiapine
Angle Closure Glaucoma	topiramate, tricyclics

Defects of the Pupils	
Decreased Light Reaction	acetaminophen (toxic states)
Miosis	chlorpromazine, donepezil, modafinil, thioridazine
Mydriasis	acetaminophen (toxic states), haloperidol, methylphenidate, SSRI's, topiramate, tricyclic antidepressants
Anisocoria	SSRI's

Defects of Accommodation	
Decreased Accommodation	benzodiazepines, carbamazepine, haloperidol, phenothiazines (chlorpromazine), tricyclic antidepressants
Accommodative Spasm	topiramate

Defects of Fixation and Ocular Alignment	
Nystagmus	benzodiazepines, carbamazepine, gabapentin, sodium valproate
Strabismus	benzodiazepines (lorazepam)
Altered Convergence	carbamazepine
Abnormal Eye Movements	anti-epileptics, benzodiazepines, carbamazepine, haloperidol, lithium, SSRI's, topiramate

Neuro-ophthalmological Defects	
Abnormal ERG, EOG, VEP, or Critical Flicker Frequency	benzodiazepines (lorazepam), ibuprofen, indomethacin
Exophthalmos	lithium (secondary to associated thyroid dysfunction)
Optic Neuritis	prazosin
Ptosis	phenothiazines (thioridazine), quetiapine

* The noted association with the above listed medication[s] has either been well established or is considered highly probable.

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Appendix G: Tests for Non-Organic Vision Loss and Non-Organic Visual Field Loss

Chrystyna Rakoczy, O.D.

Tests for total blindness in one eye

Make sure both eyes are open ALL of the time! Test should confuse the patient about the eye being tested.

<i>Duane's test</i> ^{8,9}	While the patient is reading aloud rapidly, place a high prism base down before the allegedly blind eye. If the eye is blind, there will be no effect on reading. If there is vision in the eye, the patient will stumble reading.
<i>Pinhole test</i> ⁶	Place a trial frame with a pinhole in front of the good eye on the patient. The "blind" eye is left uncovered. Tell the patient to use the pinhole to read. While the patient is reading, tilt the frame slightly so as to move the pinhole off the visual axis. If the patient continues to read, he is doing so with the "blind" eye.
<i>Plus 10 reading test</i> ^{1,3,9}	Place a plus 10 D lens in front of the good eye with reading material at four inches. Gradually move the card away while the patient is engrossed in his reading. If he continues to read he is doing so with the "blind" eye.
<i>Vertical bar test</i> ⁶	Hold a ruler five inches from the nose in between the eyes while the patient reads at near. Overlaps of visual fields allow a binocular person to read across the bar without interruption. A truly monocular person will pause to shift fixation across the bar. If the patient reads without interruption, functional blindness is proved.
<i>Physiological diplopia</i> ⁶	Have the patient look at a distant object through two short slightly converging tubes held close to the eyes. As the distance target is fixated, place your finger immediately in front of the tubes. Ask how many fingers the patient sees. The presence of diplopia indicates both eyes are used.
<i>Fogging test</i> ^{6,9}	Slip in convex or concave lenses of increasing strength in front of the good eye while the patient is reading. If the patient continues to read, malingering is proved.
<i>Stereoscopic test</i> ^{1,6,9,19}	Stereo acuity is directly proportional to Snellen acuity. Forty seconds of arc stereo acuity is compatible with no worse than 20/20 Snellen acuity both eyes.
<i>Objective prism test</i> ⁹	Ask the patient to fixate a distant target. Place a high prism base out in front of the bad eye. A seeing eye will normally move inward involuntarily. A blind eye will not make any movement.
<i>Lytton test</i> ^{6,9}	With best correction, place a +1.00 Dcyl. together with -1.00 Dcyl. axis aligned in front of the good eye. As the patient reads, change the axis of one cyl thereby blurring the image.
<i>Binocular filed test</i> ¹	Plot a binocular field. If the "blind eye" is truly non-seeing, the physiologic blind spot of the seeing eye will be plotted.

One eye is occluded in the following tests.

<i>Signature test</i> ^{6,20}	Occlude the good eye. Ask the patient to sign their name. The patient with blindness can sign his or her name without difficulty, whereas malingerers claiming to be blind will produce a bizarre signature. This test is false-positive in patients with corporal agnosia with blindness.
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<i>Mirror Test</i> ^{3,6,9,17,21}	Occlude the good eye. Move a large mirror in front of the patient to elicit nystagmoid movement. Following an image in the mirror is unavoidable and a normal response to tilting of mirror in front of patients face. The development of nystagmus or a nystagmoid movement of the eyes indicates that the patient can see moving images in the mirror and thus is not blind.
<i>Graefe's test</i> ^{6,18}	Occlude the suspected eye. Elicit uni-ocular diplopia in the good eye by bisecting the pupil with the base of a strong prism. Quickly uncovered the suspected eye and simultaneously slip the prism over the whole pupil of the other: if diplopia is confessed, malingering is proved.
<i>Optokinetic nystagmus test</i> ^{6,22}	In a patient claiming unilateral blindness, first rotate the drum while the patient is looking straight ahead with both eyes open. Once nystagmus is elicited, continue to rotate the drum and suddenly cover the good eye with the palm of your hand and observe the "blind" eye for continued nystagmus. If present, it favors the diagnosis of malingering. Positive OKN indicates at least 20/200 acuity.

Tests for partial blindness in one eye

<i>Coaxing/Reverse acuity check</i> ^{1,9}	Cover the better eye. For patients who claim acuity loss of 20/40 to HM, present a Snellen chart starting at the 20/20 line. Ask the patient to concentrate. Tell the patient the letter size will be doubled and present the next line. Continue until full line is read usually producing better acuities. "I know these are small letters that are hard to see, but take a guess!"
<i>Preferential looking</i> ²²	Patient is told they are getting a color test. Cover the better eye. Use adapted Teller cards with circular color target between them. The patient will be noted to show a fixation preference for the grating pattern if acuity is good enough to see the stripes.

For the following tests, the patient should be made to believe they are using the good eye at time of testing.

<i>Fogging test</i> ^{6,9}	A strong convex or concave lens is slipped in front of the better eye while the patient is reading. If the patient continues to read, malingering is proved and true acuity of the bad eye can be attained.
<i>Lytton test</i> ⁹	With best correction, place a +1.00 D cyl. together with -1.00 D cyl. axis aligned in front of the better eye. As the patient reads, change the axis of one cyl thereby blurring the image.
<i>Cycloplegic test</i> ^{3,9}	One drop of cycloplegic is used in the better eye and normal saline in the worse eye. The patient is asked to read. Since the better eye cannot read because of paralyzed accommodation, ability to read gives a proof of malingering and true acuity of the worse eye can be attained.
<i>Potential acuity meter</i> ²⁴	Malingers claim they have poor vision typically under normal conditions. Testing with a PAM is artificial to them and they will reveal their true acuity. Test worse eye first.

Tests for total blindness in both eyes

Attitude: A blind person walks carefully to avoid obstacles.¹ The malingerer bumps purposefully into obstacles to prove he is blind and will avoid eye-to-eye contact.⁶ A blind patient will not direct their eyes towards their hands during manual tasks.²⁶

<i>Pupillary reflex</i> ^{6,9,19}	Pupils with retinal, optic nerve, optic tract or chiasmal lesions do not react to light stimulation. Presence of both direct and consensual reflex indicates an unimpaired lower visual pathway. Pupillary reflex cannot rule out: <ul style="list-style-type: none"> • Cortical and subcortical blindness. • In SSRD, extreme mydriasis or miosis, which can occur due to spasm. • Use of mydriatic eye drops.
<i>Menace reflex/visual threat</i> ^{1,19}	A sudden surprise movement of the examiner's hand toward the face of the patient often causes the patient to blink. Be careful not to cause air movement as this will cause a blink as well. Even if the patient has learned to suppress blinking, he/she will have an increase in the pulse rate.
<i>Objective prism test</i> ⁹	Ask the patient to fixate a distant target. Place a high prism base out in front of the bad eye. A seeing eye will normally move inward involuntarily. A blind eye will not make any movement.
<i>Optokinetic nystagmus test</i> ^{1,6,9}	If nystagmus due to OKN horizontal spin is present, assume 20/200 or better acuity.
<i>Signature test</i> ⁶	Patients with blindness can sign their name without difficulty, whereas patients with malingering who claim to be blind may produce an extremely bizarre signature. This test is false-positive in patients with corporeal agnosia with blindness.
<i>Mirror Test</i> ^{1,6,9,17}	The normal response to tilting of a mirror in front of patients face enacts reflex following of eyes. If malingering the patient will look away each time mirror is placed in front of them. The development of nystagmus or a nystagmoid movement of the eyes indicates that the patient can see moving images in the mirror and thus is not blind.
<i>Schmidt-Rimpler test</i> ⁶	The patient is asked to look at his hand which is placed in front of his eye. One with alleged blindness will not look in that direction. One with blindness knows by proprioception where their hand is. In corporeal agnosia (neglect) the person with blindness may not be able to perform the test.
<i>Finger-finger test</i> ⁶	The patient is asked to touch the index finger of his horizontally outstretched hand while keeping both eyes open. The patient with alleged blindness has a negative test result. The patient with blindness is able to perform the test with help of proprioception, unless he has associated corporeal agnosia.

Tests for partial blindness in both eyes

<i>Stereoscopic test</i> ^{3,6}	Stereo acuity is directly proportional to Snellen acuity. Forty seconds of arc stereo acuity is compatible with no worse than 20/20 Snellen acuity both eyes.
<i>Potential acuity meter</i> ²⁴	Malingers claim they have poor vision typically under normal conditions. Testing with a PAM is artificial to them and they will reveal their true acuity. Test worse eye first.

<i>Acuity at two distances</i> ¹	Normal acuity is halved at half the distance (20/200 at 20 feet and 20/100 at 10 feet). Functional patients will claim the same acuity at 20 feet and at 10 feet. (20/200 at 20 feet and 20/200 at 10 feet).
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