Visual Dysfunction Following a Neurological Event

AN ARTICLE FROM NORA IN COOPERATION WITH IARP CASE MANAGEMENT SECTION

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Introduction

Following a neurological event such as a traumatic brain injury, cerebrovascular event, multiple sclerosis, etc., the medical needs of the person are of primary importance initially, for purposes of survival. As medical treatment proceeds and the survival needs of the person are met, the team of rehabilitation professionals will be established in an attempt to improve upon function performance in order to sustain quality of life. The rehabilitation team may be composed of a physician, physical therapist, occupational therapist, speech therapist, recreational therapist, vocational specialist, case manager, the psychologist, social worker, and nurse, to name several. It is often during this time that additional medical and rehabilitative needs are identified through diagnosis or observation by members of the rehabilitation team. The case manager is an integral member of the rehabilitation team. It is imperative that the case manager understand the implications of a vision dysfunction and the potential ramifications affecting the outcome of rehabilitation if the visual problem is not diagnosed or treated appropriately. If the case manager can detect a visual dysfunction, then their recommended rehabilitation program will be facilitated if the visual problem can be corrected. However, visual problems resulting from the acquired brain injury are often overlooked during treatment of the injury. Frequently the problems are hidden and neglected which, in turn, can impair rehabilitation progress. Very few health care rehabilitation professionals are aware of visual problems resulting from brain injury. This can create a gap in rehabilitation resulting in incomplete treatment. It is the intent of this presentation to give the case manager tools to identify and define visual problems caused by neurological events. In addition, emphasis will be placed on what results can be expected from neuro-optometric rehabilitation as part of the overall rehabilitation team.

Visual problems are not usually identified in early stages of medical treatment unless trauma, disease, or some overt symptom is reported by the person. If there is trauma or disease, an ophthalmologist will usually be called into the hospital in order to develop a treatment protocol. During the rehabilitation process, observations of motor dysfunction by the team or symptoms by the patient may be directed more toward function and performance. This may cause the team member to recommend the vision examination. In most cases, the person will be referred to an ophthalmologist or optometrist to have a thorough eye examination, the results of which are rarely directed toward the reason for referral. The examining doctor will usually determine the state of health of the eyes and possible refractive needs (whether the person needs glasses to see clearly at distance). Upon returning to the rehabilitation program, the person will continue to demonstrate the same performance or express the same symptoms prior to referral.

Vision problems are among the most common dysfunctions to occur following a neurological event. In most cases, they are secondary to the neurological event but they can become a primary interference to performance and directly affect outcome of rehabilitation. Gianutsos and Matheson (1986) have emphasized that visual problems can not only occur following brain injury but interfere with information processing. Hellerstein, Freed, and Maples (1995) have documented commonality of vision problems following traumatic brain injury affecting accommodation, binocularity, oculomotor function, and visual field.

Two visual syndromes have been documented in the literature and are common following a neurological event. Post Trauma Vision Syndrome (Padula and Argyris-1994) and Visual Midline Shift Syndromes (Padula and Shapiro-1992) are two conditions that frequently occur following a neurological event and often are undiagnosed from routine eye examinations.

Vision problems can often be misinterpreted as related to psychological issues, perceptual problems, vestibular dysfunction, and / or other neurological problems that may or may not be treatable. The symptoms can vary but frequently fall into categories affecting: 1) balance and space or 2) near vision function (Padula-1988). Following the neurological event, the person will often have binocular function difficulties in the form of strabismus (eye misalignment), convergence and accommodative (focusing) dysfunctions, photophobia (glare sensitivity), and difficulty with binocular function. These types of problems make compensation difficult leading in many cases to double vision (diplopia), headaches, eye strain, blurred vision, and asthenopia (experiencing pain or discomfort particularly around the head, neck, and shoulder area).

Vision as a Process

Seventy percent of all the sensory nerves in the entire body come from the two eyes. A portion of these nerves are directed to the mid brain and the majority extend themselves to the occipital cortex for purposes of seeing. Vision is a misunderstood and often, taken for granted process. Fortunately, we do not have to think about the process of using vision as we use vision in our daily activities. The very dynamics of visual processing are often masked behind our intense attention and concentration to the task at hand. For example, the task of writing involves vision but we do not think about where we are looking at when we move the pen on the page. Nor do we think of how we see print as we read. Do we see each individual letters on the page or do we see more globally and embrace whole words and phrases?

There are two separate visual processing systems (Trevarthen, 1968). The first system has been called the focal process. Information is sent primarily to the occipital cortex for the purpose of seeing detail. This is the portion of the system which enables us to attend to concentrate. If all we had was the focal process, the world would break apart into a mosaic of fragments. We would see only the lines, shadows and shapes on a persons face and although we would see clearly, we would not be able to recognize the relationship of all these details. Approximately 20 percent of fibers from both eyes are delivered to the midbrain. Here, the visual process matches up information with kinesthetic, proprioceptive, tactile and vestibular. This portion of the brain has been called the sensory-motor feedback loop. It serves to organize spatial information about position and orientation. The visual process is very much involved. Information received particularly from the peripheral vision is matched up with these other sensory-motor processes for the purpose of developing concepts of midline, body posture and orientation. Once this is accomplished, a feed -forward phenomena occurs. Information is relayed from midbrain up to the occipital cortex where it pre- programs the higher seeing area to know how to look at visual information first spatially before focalizing on detail. This is called the ambient visual process. In this manner, the occipital cortex will organize information first spatially before it looks at the detail. In other words, it is as if we know where to look before we know what we are looking at.

In order to shift the position of the eyes from one point another, we must spatially orient to the next destination before shifting the eyes to look to detail. The ambient process is critical for anticipating change. Without this process, it becomes isolated on detail and has difficulty shifting visual regard as well as attention. The ambient visual process is also important for establishing a concept of visual midline that matches up with kinesthetic, proprioceptive, and vestibular input. A variation in sensory-motor function will interfere with position concept of the visual midline. As we will note in a few moments, if the visual midline shifts it will reinforce postural imbalances.
The ambient process is not a conscious process as the focal system is. We cannot think in the ambient processing system. Instead, we orient this portion of the visual system to motor information. The ambient

visual process helps to work with sensory-motor information. Without the ambient visual process, not only would we become fragmented in vision, but we will have difficulty in organizing posture and movement.

Post Trauma Vision Syndrome (PTVS)

Following a brain injury, CVA, multiple sclerosis, cerebral palsy, autism, to name several, interference with function can often occur with ambient visual processing. When this occurs, information is received by the occipital cortex without spatial pre-programming. The person will often experience a very focalized nature of their vision. The visual world in this type of altered state can often cause the person to experience a number of symptoms (see Figure 1) such as: diplopia, seeing words and print move, difficulty shifting gaze, difficulty in adapting to environments where there is movement in the periphery such as in shopping malls, etc. The ambient process is responsible for stability in the visual spatial world. In enables us to move our eyes from one point to the other without seeing the world shift and jump. The ambient process also enables us to move within the busy moving environment and maintain orientation spatially. Without this process, any movement will appear as detail and not only can become quite disturbing. It will directly interfere with our ability to maintain our spatial orientation. Persons with ambient visual processing dysfunction will often describe having significant difficulty in a busy supermarket. They may find that movement in their peripheral vision is overwhelming and have to remove themselves from this busy environment. In severe circumstances it can even lead to panic attacks.

Research (Padula, Argyris, Ray 1994) has been conducted to evaluate brain wave responses as measured on visual evoked potentials (VEP) for traumatic brain injury persons. The study documents that the amplitude of the wave forms produced in the visual process are depressed for many individuals. When a low amount of base in prism was used in conjunction with binasal occlusion (two vertical bars placed on glasses located on the nasal side of each lens), the amplitude of the VEP increased immediately. This indicates that the prism and binasal occlusion acted to re-establish spatial organization in the ambient process thereby influencing the waveform generated in the occipital cortex. The experimental group in this study all showed increased amplitudes with this treatment. The control group, composed of persons who were not brain injured, demonstrated decreased amplitudes with the same treatment regimen. This indicates that the binasal occlusion and base and prism interfere with ambient visual processing for individuals that were not brain injured. The study also found common characteristics of the visual system following a brain injury such as: exotropia (misalignment of the eyes turned outward), convergence insufficiency, accommodative dysfunction, oculomotor dysfunction, (see Figure 1).

It has been found that by rebalancing the ambient visual process through use of lenses, prisms, and binasal occlusion, the ambient visual process can be rebalanced and the relationship to sensory-motor functioning and higher focal processing of the visual system can be re-established. When persons are treated with base in prism and binasal occlusion, in many cases, the symptoms will diminish almost immediately. In some severe cases of post trauma vision syndrome, persons will interpret the movement that they are experiencing in their peripheral vision as hallucinations. Upon appropriate treatment as mentioned, the hallucinations will be eliminated or reduced considerably.

Persons who suffer from post trauma vision syndrome will often have clear vision and their eyes will be healthy. If they are referred for a routine eye examination and if the examiner is not familiar with this syndrome, the report will often be that there's nothing wrong with the persons eyes and that the symptoms appear to be more psychological in nature. Many persons will spend years suffering from this condition unless it is diagnosed and treated. Needless to say, this can be the cause of additional inappropriate referral treatment at high costs to families, and third party reimbursement systems. Often, treatment will not only reduce symptoms, but it will also directly affect attention, concentration, and cognitive processing. The

optometrist will prescribe the appropriate lenses, prisms, and/or binasal occlusion that with treatment end the ambient/focal vision dysfunction causing post trauma vision syndrome.

Visual Midline Shift Syndrome(VMSS)

Following a neurological event such as a TBI or CVA, a person may be left with a hemiplegia or hemiparesis. The loss of neurological and motoric function has been thought to be the sole cause for inability to weight-bear on be affected side. Also, in cases of visual field loss such as with homonymous hemianopsia, it has been served that individuals will begin to lean away from the side of visual field loss even if they do not have a hemiparesis.

Studies (Padula, Argyris 1996) have demonstrated that the visual processes is involved with organizing concepts of midline related to posture. Through the ambient visual process information is matched with kinesthetic, proprioceptive, and vestibular information which is then organized through higher visual perceptual processing as a concept of visual midline. This may be observed by passing an object in front of a persons face and asking them to report when the object appears to be directly in front of their nose. In the case of a visual field loss such as a homonymous hemianopsia, the person will report the target in front of their nose when it is directed to the side away from the visual field loss. An interesting observation occurs when working with patients with hemiparesis or hemiplegia. The person will also project the concept of midline in the majority of cases away from the neurologically affected side. The shift in concept of visual midline away from the side of the hemiparesis and / or homonymous hemianopsia appears to be in survival mechanism. By doing this, the midline shift will enable the person to weight- bear on the side that is more functional. This, however, interferes with aspects of rehabilitation where the physical therapist will attempt to develop the ability to weight- bear on the affected side. In a sense, the shifting concept of visual midline away from the affected side essentially reinforces the neglect of hemiparesis and / or hemianopsia. Visual midline shift can also occur with other types of neurological conditions such as multiple sclerosis, cerebral palsy, Freidrich's Ataxia, autism etc.

The shifting concept of the visual midline alters the perceptions of space causing compression and expansion in opposite fields. It is this compression and expansion of space that shifts the concept of visual midline. The midline can shift laterally and/or in the anterior/ posterior axis. The visual midline will shift usually away from affected side. This has been termed Visual Midline Shift Syndrome (see Figure 2).

Through a neuro-optometric rehabilitation examination, the optometrist will prescribe prisms that can be used to counter the distortion of space and thereby shift the midline to a more centered position. The prism is a wedge of plastic or glass that not only shifts the image toward the apex, but it also compresses and expands space. Placing prisms in the appropriate angle before both eyes with the apex and base end of prism in the same direction will counter the distortion of space caused by the Visual Midline Shift Syndrome. The term used for two prisms placed in the same direction is yoked prism. With the proper yoked prisms prescribed, the midline will be shifted to more centered position. It has been documented that weight- bearing on the affected side will increase in many cases immediately upon the introduction of yoked prisms. The yoked prisms can be used therapeutically to retrain the person how to weight-bear on the neurologically affected side.

The optometrist will often prescribe yoked prisms to be used in conjunction with physical and occupational therapy. The combination maximizes potential of the individual in rehabilitation. In many cases physical and occupational therapists attempt to rehabilitate the person for weight-bearing and ambulation only to have an undiagnosed Visual Midline Shift Syndrome interfere with the therapy. In many cases a person will not succeed beyond a certain point and will “plateau”. The person will then be discharged from therapy. It has been found that with the combination of yoked prisms, the person will go beyond the “plateau” and gain

greater independence as well as become less likely to injure themselves from a fall due to an undiagnosed Visual Midline Shift Syndrome.

Vocational Rehabilitation

Post Trauma Vision Syndrome (PTVS) and Visual Midline Shift Syndrome (VMSS) define two distinct problems associated with vision and cognition and its connection to the other senses, especially motor coordination. Deutch and Fralish in their book *Innovations in Head Injury Rehabilitation* address visual-motor integration problems as barrier to success with the cognitive rehabilitation of brain injuries. Padula's definitions include; acquired strabismus, diplopia, binocular dysfunction, convergence and/or accommodation paresis/paralysis, oculomotor dysfunction, visual-spatial dysfunction, visual perceptual and cognitive deficits, and traumatic visual acuity loss. These problems can manifest themselves as learning disabilities, attention deficit disorders, anxiety and panic disorders, as well as spatial dysfunction affecting balance and posture through the ambient process.

Individuals with Post Trauma Vision Syndrome will experience difficulties with attention, concentration, and cognitive processing. Deutch and Fralish address Cognitive Abilities and Related Disturbances Commonly Seen Following Brain Injury in table 9-1. The major areas included are; Attention - Focused Attention, Sustained Attention and Regulated Attention; Memory - Reception, Information Processing, Sequencing, Chunking, Categorization, Storage, Retrieval; Communication – Language, Pragmatics; Initiation & Planning – Recognition, Generation of Alternative Solutions, Selection of Solution, Action; Organization; Judgement; Processing Speed; Perceptual Process. The cognitive disturbances addressed by Deutch and Fralish are consistent with those dysfunctions described by Padula.

The vocational rehabilitation of individuals who have experienced a neurological event has been viewed as generally inadequate. Vocational rehabilitation professionals are typically viewed as inexperienced and without adequate resources. Emphasis has been on skill training, while failures for persons with brain injuries have been mainly because of impaired work quality, work speed, work endurance or work adaptive abilities and not because of work skills. Due to time and budgetary constraints, patients not showing marked progress in a short period will have services interrupted. Feasibility will be questioned and less desirable outcomes will be considered.

The rehabilitation counselor needs to consider the significance of these findings in the rehabilitation planning and prognosis for success with any patient who has experienced a neurological event. Padula emphasizes that PTVS and VMSS can be significant obstacles to rehabilitation. Undiagnosed and untreated patients will not make adequate progress. Managed care organizations and insurance companies may expend significant money and effort in failed therapies and treatment, before considering neuro-optometric rehabilitation. Once the neuro-optometric rehabilitation is completed, the rehabilitation counselor may encounter resistance, from the payer, to retrying those failed therapies. The importance of early referral is self-evident.

Vocational rehabilitation counselors will typically assess any limitation or disability, and its significance on employment potential, in terms of worker trait functions. Until recently, counselors relied on the *Dictionary of Occupational Titles* (DOT) and its associated worker traits from the revised Handbook for Analyzing Jobs. In recent years, the United States Department of Labor has begun development of a new system called O*NET. The developers of this new job guide planned to expand its capacity by using computer technology. They relied on current research to identify essential functions and worker traits that accurately reflect today's work place and the expectations placed on workers. The new system is expected to be comprehensive, accurately reflecting the essential elements of jobs in a uniform plan. A Beta version is already available for review and feedback.

The work elements defined in O*NET are extensive, numbering over 400, with heavy emphasis being placed on cognitive functions. Review of the **Basic and Cross Functional Skills** indicates that many of them would be affected by the visual/cognitive skills that would be impacted by PTVS and/or MVSS.

Example: Technical Skills-
Equipment Maintenance, Repairing

Operational Definition	Level	Example
Performing routine maintenance and determining when and what kind of maintenance is needed	High Medium Low	Conducting maintenance checks on an experimental aircraft. Clearing moving parts in production machinery. Adding oil to an engine as indicated by a gauge or warning light.
Repairing machines or systems using the needed tools	High Medium Low	Repairing structural damage to a building following and earthquake. Replacing a faulty hydraulic valve. Tightening a screw to get a door to close properly

Both skills give examples, ranging from high skill level to low skill level, that would be affected by a defect in the ambient visual process as defined by Padula. As stated earlier, the ambient visual process matches up with the kinesthetic, proprioceptive, tactile and vestibular systems. In the first example, the individual might have trouble pouring the oil in correctly. In the second example, the individual might have trouble determining which screw to tighten or which direction to turn the screw. If the person had a Visual Midline Shift Syndrome, leaning to one side would cause concern regarding balance and the potential to fall into a machine. It would also interfere with deciding the alignment of the door, so the person can evaluate if the door is correct after adjusting the screw.

The same conclusion is reached after reviewing the Work Context Variables, Abilities and **Generalized Work Activities** as defined by O*NET. While not every attribute of the O*NET system applies to every job, the pervasiveness of the functions affected by PTVS and VMSS exists. The existence of PTVS and/or VMSS would result in a significant impediment to employment at most any level.

Neuro-Optometric Rehabilitation Plan

The plan on the next page typifies services needed from evaluation through completion of treatment. Variations will exist to address the specific needs of different individuals. It is presented here to give the reader an understanding of the steps, costs, and time frames typically included.

Submitted to:

Type of Plan: Original

Type of Service: Vocational

Injured Person: Mark Claim #: SS#:

Injury: Referral date:

RTW Goal: TBD Targeted Job/Job Group: TBD

Note: Rehabilitation Issues to be Addressed and Justification for Services appear on Page 2.

Type of Service	Service Provider	Dates of Service	Estimated Cost
Neuro Optometric Exam.	Dr. Padula	4/1/00	$600.00
Glasses- special for PTVS (2)	Vision Lab	5/1/00 & 11/1/00	$450.00
Glasses for MVSS Fixed Prism *Rotatable Prism*	Vision Lab	5/1/00 & 11/1/00 5/1/00	$1,000.00 *$1,200.00*
Therapy Visits: every 4-6 weeks	Dr. Padula	6/1/00 to 6/1/01 12 months	$150.00/visit @ 9-12 visits = $1350.00 to $1800.00
Vision Therapy B weekly (group)	*Dr. Padula*	*5/1/00 11/1/00*	*$100/session $2,600*
Follow-up visits 1st year every three months	Dr. Padula	12/1/00 to 111/01	$375 x 4 = $1500
Follow-up visits 2nd year B every six months	Dr. Padula	12/1/01 to 11/1/02	$375 x 2 = $750

Plan length: 13 to 19 months Plan estimated costs: $ 4,650 to 6,650

For PTVS:
13 months @ $ 4650 _____

For MVSS: 19
months@$6650 _____

NOTE: all units and costs are estimates

A directory of specialists in neuro-optometric rehabilitation can be obtained by contacting the Neuro-Optometric Rehabilitation Association at 203-453-2222, who can aid in securing local resources. To determine whether an evaluation is necessary, a rehabilitation professional can refer to Figure 3 for guidance. For further illustrations of functional outcomes with neuro-optometric rehabilitation, please refer to the Case Management ListServ.

Conclusion

Post Trauma Vision Syndrome and Visual Midline Shift Syndrome have been found to be prevalent among persons who have suffered from a neurological event such as with TBI, CVA, multiple sclerosis, cerebral palsy, Friedrich's Ataxia, autism, etc. Persons who have PTVS and/or VMSS may experience symptoms that often are diagnosed incorrectly. The effects of these two syndromes can greatly interfere with a costly rehabilitation, employment, recreation, and quality of life. PTVS can also interfere with higher cognitive perceptual processing. This in turn will affect the outcome of cognitive rehabilitation.

These two syndromes are prevalent and require treatment through neuro-optometric rehabilitation. Treatment may include the use of lenses, prisms, and sectoral occlusion. By providing neuro-optometric rehabilitation, potentials for the individual can be maximized and costs involved for rehabilitation can be used for greater effectiveness and possibly minimized.

The visual relationship of the ambient visual process must be recognized in contributing to problems of rehabilitation affecting cognitive and neuro-motor function. It is important to emphasize that PTVS and VMSS can be significant obstacles to rehabilitation and that they are treatable from an optometrist providing neuro-optometric rehabilitation.

For the complete article with Appendix and Case Studies, please refer to the Case Management ListServ.

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Characteristics of Post Trauma Vision Syndrome

The Characteristics of the Post Trauma Vision Syndrome include:
-Exotropia
-Accommodative Insufficiency
-Convergence Insufficiency
-Low Blink Rate
-Spatial Disorientation
-Poor Fixations and Pursuits
-Unstable Peripheral Vision

The Symptoms of the Post Trauma Vision Syndrome include:
-Possible Diplopia
-Objects Appear to Move
-Poor Concentration and Attention
-Staring Behavior
-Asthenopic Symptoms

Figure 2

The Characteristics and Symptoms of the VMSS include:
-Associated Neuromotor Difficulties with Balance, Coordination and Posture
-Leaning Forward/Backward
-Leaning to One Side
-Seeing the Floor Tilted

Figure 3

Rehabilitation Professional's Checklist for Post-Trauma Vision Syndrome and Visual Midline Shift Syndrome

Post-Trauma Vision Syndrome

- Double vision _____
- Headaches _____
- Blurry vision _____
- Dizziness or nausea _____
- Attention or concentration difficulties _____
- Staring behavior (low blink rate) _____
- Spatial disorientation _____
- Loses place when reading _____
- Cannot find beginning of next line (reading) _____
- Comprehension problems _____
- Visual memory problems _____
- Moves backwards from objects too close _____

Visual Midline Shift Syndrome

- Dizziness or nausea _____
- Spatial disorientation _____
- Consistently walked to one side of hallway or room _____
- Bumps into objects when walking _____
- Poor balance or posture; leans back on heels, forward, or to one side when walking, standing, or seated in a wheelchair _____

If one or more symptom is checked, referral for neuro-optometric evaluation would be appropriate.

Definition of Neuro-Optometric Rehabilitation
(reprinted with permission from the Neuro-Optometric Rehabilitation Association)

Neuro-Optometric Rehabilitation is an individualized treatment regimen for patients with visual deficits as a direct result of physical difficulties, traumatic brain injuries and other neurological insults. Neuro-Optometric therapy is a process for rehabilitation of visual/ perceptual/ motor disorders. It includes, but is not limited to, acquired strabismus, diplopia, binocular dysfunction, convergence and/or accommodation paresis/paralysis, oculomotor dysfunction, visual-spatial dysfunction, visual perceptual and cognitive deficits, and traumatic visual acuity loss.

Patients of all ages who have experienced neurological insults require Neuro-Optometric Rehabilitation. Visual problems caused by traumatic brain injury, cerebrovascular accident, cerebral palsy, multiple sclerosis, etc., may interfere with performance, causing the person to be identified as learning disabled or as

having attention deficit disorder. These visual functions can manifest themselves as psychological sequelae such as anxiety and panic disorders, as well as spatial dysfunction affecting balance and posture.

A Neuro-Optometric Rehabilitation treatment plan improves specific acquired visual dysfunctions determined by standardized diagnostic criteria. Treatment regimens and compass medically necessary, non-compensatory lenses and prisms with and without occlusion and other appropriate medical rehabilitation strategies.

Definition of Yoked Prism Glasses

Yoked prism glasses are utilized therapeutically to alter the visual midline concept of a person who has suffered a neuro-motor imbalance as a result of a cerebrovascular accident, traumatic brain injury, or who has had a physical disability from multiple sclerosis or cerebral palsy, to name several. Persons who have a hemiparesis or hemiplegia will have a shift in their concept of their visual midline usually away from their affected side. These shifts in midline can also occur anteriorly or posteriorly. When the visual midline shifts, it causes the person to unconsciously think that their body center is shifted in the direction of their midline. In turn, the person will lean toward the midline shift and essentially reinforce their own hemiparesis or hemiplegia.

The visual midline shift has been documented in literature and neuro-motor problems affecting posture and balance has also been written extensively about in journals of rehabilitation regarding physical and occupational therapy. Through the use of yoked prism glasses, the visual midline can be shifted, which increases the person's ability to transfer weight over the affected side. Yoked prism lenses have been used effectively through neuro-optometric rehabilitation in hospitals and rehabilitation programs throughout the United States. When a person has a visual midline shift, physical therapy will frequently plateau and reach a limit if the visual midline is not rehabilitated through the use of medically necessary yoked prism lenses. Yoked prism lenses are therapeutic and are not compensatory in nature. These prism lenses are only utilized for short periods of time each day (1-2 hours per day) in conjunction with physical and/or occupational therapy. It has been determined that the potential for physical and occupational therapy can be increased and reached more quickly when incorporated with the use of yoked prisms.

Definition of Rotatable Prism glasses

Persons who have sustained a neuro-motor imbalance as a result of a cerebrovascular accident, traumatic brain injury, or physical disability such as multiple sclerosis or cerebral palsy often experience a shift in their concept of visual midline. If a hemiparesis or hemiplegia has occurred, a shift in visual midline usually takes place away from the affected side. These shifts in midline can also occur anteriorly or posteriorly. When the visual midline shifts, it causes the person to unconsciously think that his body center is shifted in the direction of his midline. In turn, the person will lean toward the midline shift and essentially reinforce his own hemiparesis or hemiplegia. This visual midline shift has been documented in literature.

Neuro-motor problems affecting posture and balance have also been written extensively about in physical and occupational therapy journals. When a person has a visual midline shift, physical therapy will frequently plateau. Yoked prism glasses and rotatable prism glasses have been used effectively to shift the visual midline, increasing the persons ability to transfer weight over to the affected side. These therapeutic lenses are not compensatory in nature and are only utilized for short periods of time each day (1-2 hours per day) in conjunction with physical and/or occupational therapy. The purpose of these special prisms is to shift the visual midline thereby enhancing the affect of physical and occupational therapy. It has been determined that the potential for physical and occupational therapy can be increased and reach more quickly when

incorporated with the use of yoked prisms. These lenses have been used effectively through neuro-optometric rehabilitation in hospitals and rehabilitation programs throughout the United States.

During therapy, it sometimes becomes necessary to reorient the position of a prism. Yoked prisms are prescribed and ground into a lens. If a change mast be made, then new glasses must be prescribed with additional expense and delay in rehabilitation. These type of lenses may take 3-4 weeks to fabricate. Rotatable yoked prism glasses, however, are unique in design allowing the doctor to alter the position of the prism to meet the changing needs of the patient. Therefore, the prism can be changed at any time without additional expense to the patient or third party reimbursement program. There also would be no delay in the therapeutic regimen. The rotatable yoked prism glasses are an efficient, cost effective rehabilitation device for treating persons who have the Visual Midline Shift Syndrome as a result of the conditions mentioned in the initial paragraph.

Case Studies

Need for Neuro-Optometric Rehabilitation Services

Working for a number of years with neurologically impaired clients in rehabilitation, it has become very clear that in the majority of cases, the visual system demonstrates dysfunction that interferes with the person's optimal level of performance. Meeting with Dr. William Padula in 1982 opened up a new horizon of possibilities in our rehabilitation program. Since that time, we have included specialized vision care for patients of all ages with neurological impairments.

The concept of a Visual Midline Shift Syndrome has expanded our therapists' understanding of why clients tend to plateau in their physical progress. By correcting the individual's perception of space, the therapists find that limbs become lighter and the client is less fearful in trying new movement challenges. It is possible to advance the client to previously impossible levels of independent function.

More recently we have found this information to be applicable to young children who have suffered brain trauma at birth. While the developing child is not able to explain his or her perceptions verbally, the behavioral responses are quite clear. The increased confidence shown by a child when improved correspondence is established between the visual and postural control systems is impressive. By integrating clearly defined visual experiences into the perceived spatial orientation, the child benefits from the ability of vision to lead movement. In some children movement initiation occurs for the first time after prisms have been used to simulate a movement experience in space.

The importance of applying these concepts to children as well as adults is the possibility of confirming these dynamic systemic interactions as part of integrated development under normal circumstances. As we in rehabilitation take the normal process as our guide to restore function this more specific explanation of how the subsystems in the central nervous system interact with each other is an essential key to returning a larger number of persons to a fuller life.

Case #1

History:

Ernesto, 24 years of age, was involved as a driver in a severe car accident November 28, 1998. He suffered a fracture of the cranium in the left temporal bone, was for 15 days in a total coma from which he gradually emerged, and was discharged after 58 days of hospitalization. Ernesto was left with a mild right hemiplegia with increased tone in right upper and lower limbs, and diminished pelvic control. He received four months of physical therapy and the physical therapist referred Ernesto for vision care, based on her observation of eye misalignment with a tendency to exotropia and consistent diplopia to the right when the client would look to the right and up, or to the right and down. Ernesto was unable to read and fatigued with any close work.

Neuro-Optometric examination:
June 29, 1999

Previous Rx:
OD -4.50 -2.50 x 180
OS -4.50 -1.00 x 180

Findings:
DVA:
OD 20/25
OS 20/20-3
OU 20/20

NVA:
OD 20/40
OS 20/30
OU 20/30-

Cover Test:
Distance: right hyper-exotropia
Near: right hyper-esotropia

Treatment and Recommendations:

No change in Rx at present. Direct pupillary stimulation. Cover/uncover at near and far.
Vigorous stretches especially OD to the right and up, to the right and out. Red and green for luster. Flippers with Rx, +1/-1.

Re-examination:
August 1, 1999
Change in Rx:
OD -4.50 -2.50 x 180 = 4 base right
OS -4.50 -1.00 x 180 = 4 base right
yoked prism
PD 66

Treatment:
Flipper work with 1.25 + / -. Loose prism 6 diopters, monocular rock. Fusion work with Tranaglyphs and work with rotary yoked prisms, base right, base left and vertical dissociation.

Re-examination:
November 22, 1999

Ernesto has no double vision and no headaches. He is walking straighter and has returned to University classes. He feels safer when walking in crowds. Physical therapy has been discontinued and Ernesto continues with horseback riding.

Change of Rx:
OD -4.00 -2.25 x 180 = 3 diopters base rt.
OS -4.00 -1.00 x 180 = 3 diopters base rt.
yoked prism.
PD 67

Treatment:
Flipper work with 1.50 + / -. Stereoscope. Trombone. Continue with cover / uncover with head movement.

Present status:
February, 2000

Ernesto continues with his University studies, and is driving again. He continues his home program in vision and his horseback riding.

Next Neuro-Optometric evaluation for March 10, 2000.

Case #2

History:

Mark is 24 years old and was referred by a neuro-psychologist who had evaluated him following a head injury. Mark was a full-time engineering student who was working his way through college at a local boat yard. One day he was walking next to a fork lift carrying a 3000-pound boat when the hydraulics failed, causing the boat to land on Mark's right shoulder, neck and back area. He the reported that he did not remember very much until at the hospital when he was examined and discharged. Eight months later it was found that he had a fracture of C5 and C6. Since the accident he had almost constant headaches, blurred vision and over the course of several years developed vertical diplopia (double vision) and photophobia (glare sensitivity). Mark also had difficulty with reading and reported seeing words appearing to shift and move. This directly interfered with his comprehension and reading speed. Since the accident, he had difficulty with depth judgment, balance, and due to his visual problems, he could no longer keep up with school work assignments and had to drop out of school. He had been seen by neurologists, ophthalmologists, an optometrist and other specialists. An MRI found no evidence of brain injury to get his balance continued to decline. He received physical and occupational therapy as well as cognitive therapy, however, symptoms persisted and he had difficulty with all aspects of his life. The eye examinations found no abnormalities of his eyes. Although he was told that he could drive, he removed himself from the road because of his significant difficulty with depth perception an awareness of space.

Examination Results:
The entering corrected visual acuity was 20/50 right eye and both eyes, 20/100 left eyes. His near acuity with reading glasses was 20/100. The examination found an intermittent right hyper exotropia (intermittent right eye turned out and upward). The binocular assessment found significant variation with eye alignment along with measurable vertical and horizontal imbalance. Accommodative spasms were found which produced significant variation in refractive state from hyperopia to myopia. The eye health evaluation was unremarkable.

A visual midline assessment was performed. There was a strong shift in concept of visual midline to the right. The behavioral analysis was made while he walked. Mark thoroughly held on to the wall on the right side and leaned against it. If you removed his hands from the wall he would fall to the right. Each step was made with researching movement of the left foot to feel wear the floor was first. Yoked prisms were placed before his eyes in an attempt to shift the midline back to center. After several moments Mark let go of the wall and stood erectly in the middle of the room without holding onto anything. He then proceeded to walk down the hallway with no searching movement of his left foot and with alternate weight transfer and normal gait. When the prisms were removed, he immediately fell to the right.

The Visual Evoked Potential was performed to rule out Post Trauma Vision Syndrome. A P-100 cross pattern reversal analysis was used. The results demonstrated an increase amplitude upon application of base in prisms and binasal occlusion. This test was positive for Post Trauma Vision Syndrome.

Rehabilitation Plan and the Treatment:
The evaluation determined that Mark had Post Trauma Vision Syndrome and Visual Midline Shift Syndrome. Rehabilitation programs that have been designed for him previously could not overcome the significant visual interference and therefore were ineffective at rehabilitating him. Rotatable yoked prisms were recommended due to the highly unstable nature of his visual system for the purpose of treating VMSS. In addition, a low-power asymmetrical yoked prism was designed for full-time wear. The rotatable yoked prisms were used for two hours per day. Although physical therapy was recommended in conjunction with use of the yoked prisms, therapy was denied by the case manager and insurance company due to the fact that a rehabilitation program had been initiated previously and that no further progress was seen possible by the doctors and therapists who had evaluated him.

Mark was seen for progress visits every four weeks and the position of the yoked prism was shifted because as his midline became more center it altered his position sense and required changing the axis of the prism. Treatment continued for 18 months. At the end of this time Mark no longer needed the rotatable yoked prisms but was able to have normalized balance through use of only in low amount of prism in the conventional distance glasses.

The distance glasses included asymmetrical yoked prism and binasal occlusion to treat the Post Trauma Vision Syndrome. During this time the diplopia was eliminated, the photophobia reduced, and Mark was able to read without having the words shift and move about the page. He was now able to read again and was making plans to reapply to college, and was able now to work as a salesman at the boat yard where he was injured. He was also able to resume driving.

Case #3

History:
J.S. is a 45 year old female who was referred for neuro-optometric examination and treatment by her physiatrist, occupational therapist and certified driving instructor. Medical history was noteworthy for suffering a stroke, which left her with persistent left-sided weakness. Visually, her therapists and doctors had

noted she had a tendency to drift to the right while walking and lane center to the right while being evaluated for driving.

Examination:
Pertinent examination findings revealed visual perceptual shift of egocentric midline to her right. There was no evidence of visual field loss, hemi-inattention, oculo-motor dysfunction, binocular vision disorder, or pathology.

Diagnosis:
J.S. was diagnosed with a visual midline shift syndrome secondary to cerebral vascular accident.

Treatment and Recommendations:
J.S. was prescribed prism lenses to wear over her contact lenses. The effects of these were to center her perception of midline. They were prescribed for use when driving and when doing occupational therapy on an intermittent basis to foster transference and minimize habituation.

Outcome:
Effects were immediate, and J.S. passed her driving evaluation as a safe driver. Before use of the prisms, she had been denied driving privileges as an unsafe driver. She still uses the prisms intermittently with success. Transference to normal and regular activities of daily living is occurring and progress continues.

Note: Driving requires eye, hand and foot coordination, with visual skills such as focusing flexibility and spatial perception relationships. These skills are transferable for vocational purposes.

In the current Psychiatric, Diagnostic and Statistical Manual-IV, T.B.I. is referred to as post-concussional disorder. This is a diagnostic that has been difficult to define and treat psychiatrically.

The symptoms include difficulty with attention, concentration difficulties, shifting focus of attention, difficulty performing simultaneous tasks, learning and memory. Some of these can be documented with neuropsychiatric testing, but some cannot in spite of the fact that patients may complain bitterly about their existence.

The incongruence between what the patient says and what the doctor can find sometimes set up a kind of antagonism where the patient does not believe the doctor and the doctor does not believe the patient. Such patients are often labeled “malingering” or “hysterical.” In a malingering patient, he really does not that he is trying to fool the doctor for observable gain, such as avoidance of responsibility, acquiring medication, or getting attention. On the other hand, there are true psychiatric conditions in which the symptoms are used as a defense mechanism to protect the patient’s own self-image so that he is fooling himself and really believes that he cannot hear or cannot walk. These used to be called “conversion hysteria,” and are now called more generally “somaticization disorder.”

In addition, a lot of the vague symptoms after a T.B.I. can easily be diagnosed as anxiety or depression. However, the confounding factor is that treatment of anxiety or depression has not responded as robustly to either talking therapy or psychopheracology in this population.

The DSM IV also describes a list of vague symptoms which are : 1) becomes fatigued easily, 2) disordered sleep, 3) headache, 4) vertigo or dizziness, 5) irritability or aggression on little or no provocation, 6) anxiety, depression or affective lability, 7) changes in personality, and 8) apathy or lack of spontaneity.

Again, these symptoms which could be anxiety, depression or personality disorder do not, when they are present in the post-traumatic brain patient, respond to the normal psychiatric interventions.

ST was a 50-year-old physician who underwent an emergency gallbladder surgery and experience anoxic complications, with sepsis and extensive coma. He as out of his office for three months. It was recognized by all treating physicians and his wife that her was not the same, but everyone expected him to recover completely. The patient complained of memory problems, sleepiness, fatigue, lack of concentration, double vision, blurred vision, difficulty in reading, difficulty in concentrating, and subjectively experienced being a millisecond behind in conversation or situations.

In the subsequent eight years before his admission to the brain injury rehabilitation center, he continue a slow deterioration in function, began to show poor judgment in his personal life and professional life. He was forced to retire. Even in retirement he continued to decline until he was admitted to Dr. Voigt's Rehab Living Center in Covington, LA.

There he was under the care of Dr. Adama, who diagnosed him as VMSS and PTVS and set up an intensive neuro-optometric rehab program and prescribed prism glasses. The effect on the patient was instant. The exercises and the prism glasses produced a dramatic increase in energy. There was a certain sense of clarity, ability to concentrate, and a dramatic decrease in fears of crowds. There was a removal of a kind of vague cloudiness that separates the patient from the world. Also, he quite bumping into things, and if he wore his glasses during yoga, his ability to do the postures and especially to maintain the postures was dramatically improved.

This patient considers his neuro-optometric rehabilitation literally a miracle and a life saver. He has begun a supervised practice of medicine one day a week and has given two one-hour lectures at national meetings, all of which would have been impossible before the rehab experience. Certainly the combined coping strategies, support, physical therapy, recreational therapy, occupational therapy, sleep apnea machine-all of these interventions have led to this dramatic improvement in this aging professional, but his personal subjective sense was that the most dramatic and the most important intervention is the correction of his visional dysfunction.

It is not meant to be critical, but only as a plea for improved education to my fellow professionals regarding our diagnosis. If any of the professionals had been aware of post-traumatic vision dysfunction and simply given me a checklist, I would have checked seven out of twelve symptoms of post-traumatic vision syndrome (double vision, blurred vision, attention/concentration difficulties, losing place when reading, spatial disorientation, comprehension problems, vision memory problems) and two out of the five items on the vision shift syndrome (spatial disorientation and bumping into items while walking). Just the simple addition of this checklist would identify thousands of people who would benefit from treatment of this reversible condition.

Neuro-Optometric Rehabilitation Protocol

I. History:

- Review of medical records
- Determination of medical diagnosis
- Review of symptoms
- Review of visual difficulties related to daily living, work, recreation
- Review of balance difficulties
- Review of cognitive function
- Review of past and present therapies
- Analysis of all habitual prescriptive glasses

II. Examination

1. Visual Activity

- Monocular and binocular (use of two eyes) distance acuity (with habitual correction)
- Monocular and binocular near acuity (with habitual correction).
- Behavioral observations

B. Sensory-Motor

- *Pursuits and Saccades*- monocular and binocular qualitative assessment of tracking ability.
- *Convergence*- qualitative assessment of convergence skill with break (loss of eye alignment) and recovery
- *Cover Test*- analysis of state of eye alignment
- *Maddox Rod Test*- analysis of state of eye alignment
- *Red Lens Test*- determination of binocularity at distance and near ranges
- *Worth 4 Dot Test*- determination of binocularity at distance and near ranges
- *Stereo Test*- analysis of binocularity related to depth perception
- *Object Localization*- functional analysis of depth perception
- *Color Vision Test*- analysis of color perception

3. Ocular Health

- *Ophthalmoscopy (direct and indirect)*- to examine the state of interior eye health
- *Biomicroscopy*- to examine the state of health of the anterior portion of the eye
- *Pupil Reaction*- to examine the effect of light stimulation on pupil reaction
- *Visual Field*- to examine the scope of peripheral visual field for each eye using standard techniques

4. Refractive Sequence

- Refraction- to evaluate the prescription lenses necessary to improve acuity at distance and near
- *Binocular balance*- after refracting each eye individually, a balance of the prescription should be made for using both eyes together
- *Refractive Sequences*- to develop detailed analysis of:
  - Phoria tests- balance of the visual state affecting eye muscle balance for near and far ranges
  - Duction Test - to analyze the limits of binocularity for distance and near ranges as well as the reserve ability to maintain the eyes in alignment

- Accommodative Tests- to evaluate the lenses necessary to balance binocularity and improve acuity at a near range. This should include dynamic performance related test to evaluate the ability to focus during reading and work related activities
- Binocular Tests- to evaluate the visual ability to use the two eyes under dynamic conditions
- Prism/Binasal Occlusion Assessment- to evaluate the use of prisms and binasal occlusion to treat Post Trauma Vision Syndrome and/or binocular difficulties

5. Visual Midline Assessment

- *Visual Midline Test*- to determine the position of visual midline concept laterally and in the anterior/posterior dimension during seated and standing positions
- *Behavioral Observation of Visual Midline Shift while walking*- to assess visual midline concept affecting posture and balance while walking
- *Prism Assessment*- to evaluate the use of yoked prisms to affect Visual Midline Shift Syndrome and thereby improve posture and balance while walking

6. Visual-Perceptual Tests

- Analysis of reaction time, fine motor, object localization, spatial organization, peripheral awareness, time-space judgements, near-far fixations, etc.

G. Visual Evoked Potentials (VEP)

- Analysis of brain wave function of the occipital cortex. Tests should be performed first monocularly to rule out afferent sensory nerve deficits and then binocularly (according to protocol of testing for Post Trauma Vision Syndrome) to rule out PTVS.

III. Diagnosis, Conclusions, Recommendations

- *Diagnosis*
  - review of visual diagnosis and to rule out Post Trauma Vision Syndrome and Visual Midline Shift Syndrome

- *Etiology*
  - review discussion of etiology related to diagnosis.

- *Recommendations*
  - prescription of lenses, prisms, occlusion for treatment
  - prescription of other visual rehabilitation recommendations
  - recommendation for other referrals as needed.
  - discussion of vision problem related to daily living skills, work, recreation, etc.
  - discussion of future treatment options

Prescription Visual Rehabilitative Devices

Post Trauma Vision Syndrome (PTVS)

Distance Glasses- The doctor will often choose to prescribe distance prism glasses (sometimes with bifocals) to treat the condition of PTVS. (approximate cost is $150 to $250)

Near Vision Glasses- Separate reading glasses will sometimes be prescribed if the prism need is different than the distance glasses and/or if there is a need for computer glasses. (approximate cost is $150 to $250)

Sectoral Occlusion- Binasal or bi-temporal occlusion may be prescribed to treat PTVS. Spot patches or central occlusion patches will be prescribed to treat diplopia (double vision).

Visual Midline Shift Syndrome (VMSS)

Yoked prisms will be prescribed to treat a VMSS affecting posture and balance. The prism may be very low in power and included into the distance glasses or/and be higher power (fixed prisms or rotatable prisms). The costs for separate fixed prism depends on power but may range from $350 to $500. The rotatable prisms are used if it is likely that the prism may need to be changed. Although the cost is higher ($900-$1200), it is efficient due to the potential need for prescription changes.

Visual Field Loss (Homonymous Hemianopsia)

A sectoral prism can be designed into a portion of each eyeglass lens. When the person shifts gaze into the prism, he/she will be able to see further into the area of visual field loss. The doctor will train the person to use these to improve awareness in the area of field loss. The result will primarily increase the safety of the person from tripping or bumping into objects. Simple enhanced field systems can be made out of press-on prisms at a low cost ($100 to $150), however, the quality of optics is very poor. Ground-in enhanced field prisms are better in quality and have a higher success rate but are more expensive ($900 to $1600).

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