Article • Rationale for a Behavioral Clinical Approach to Routinely Prescribing Prism

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ABSTRACT

Background: The application of prism is a challenging clinical question. Prism prescription for the reme-diation of routine visual dysfunction has not been widely used in optometric and/or oph-thalmological practice. In general, prisms are most often prescribed as a last resort. This is rationalized because precise methodology for prescribing an appropriate amount and ori-entation of prism has not been conclusively determined. This paper presents a rationale and process for routinely prescribing and managing therapeutic prism within a pediatric population. Prism application and its clinical effect on horizontal and vertical imbalance as well as its influence on vestibular, proprioception, and visual motor function will be con-sidered. The benefits of prescribing lateral horizontal, vertical, and yoked prism will be presented in a therapeutic and clinical oriented approach.

Case Reports: Case presentations will demonstrate before and after clinical results, using various modes of prism application. In each case presentation, outcomes demonstrate improved ocular motor function, improved awareness of body in space, and a greater sense of self-awareness. Each case presented will demonstrate a patient's apparent increase in self-esteem through a greater sense of their environment as a consequence of their ability to create improved awareness and subsequent movement through space (egocentric process).

Conclusion: The behavioral concept of vision considers any ophthalmic lens application potentially to provide the ability to achieve an alteration of human behavior. The use of prisms emphasizes a lens' effect on posture and balance through one's center of gravity and ultimately one's body orientation in space. It potentially enhances one's ability to rematch eye coordination in relation to coordination of one's body in space. This paper presents the argument that a lens incorporating a prism component can routinely result in a more effi-cient, effective, and effortless visual, motor, and behavioral change, without resulting in prism adaptation.

Keywords: behavior, egocentric process, movement, prism, proprioception, posture, spatial orientation, vestibular

Introduction

Any object viewed through a prism lens will appear dispersed, deviated, and displaced in the direction of the prism apex, as viewed by the observer. Through this lens, an object will appear to be at a different location relative to its actual spatial position, providing, "a mismatch between information received via the visual pathways and the information from vestibular and proprioceptive pathways."[1] These perceived changes in the position of an object can have a profound and pronounced effect on the responsive nature of the visual system, as well as the "total action system of a child."[1] These changes not only affect the visual system but simultaneously cause changes in orientation and proprioception, ultimately affecting body posture and awareness of ones body's position

in space.[2] It is widely accepted that "these lenses are typically used to enhance one's ability to rematch eye coordination in relation to coordination of one's body posture."[3] The use of prism lenses enhances a child's ability simultaneously to rematch sensory and motor input in order to perform a particular behavior in a more effective, efficient, and effortless manner. This typically translates into positive changes in perception, problem solving, and performance.

Prism: Conventional Approach

The conventional use of prism is to neutralize or to compensate for a vertical or horizontal sensory/motor imbalance between the two eyes. Prisms are most commonly considered when treating children with symptomatic binocular dysfunction. Prism application is typically directed towards treatment of children with diplopia, symptomatic heterophoria, heterotropia, and abnormal head posture (torticollis).

There are varying opinions and subsequent questions as to what type of prism to use and how to use it. Questions frequently involve how much prism to prescribe and what method should be used to determine the amount needed. There are some guidelines (recommended course of action) and rules of thumb (broad judgements of a principle based on experience rather than theory) that attempt to answer these questions. Additional considerations are the length of time for which prisms may be prescribed, fear of prism adaptation, and ultimately, the relative and questionable effectiveness that prism lenses can have. Typical methods used to measure the amount of prism to consider are Maddox rod testing, the Turville infinity balance, the modified Thorington method, Von Graefe testing, fixation disparity, flip prism tests, phorias, and vergence ranges.[4] Sheard's and Percival's criteria have also been used to determine the amount of prism prescribed.[4] The question of whether to prescribe full or partial prism prescriptions creates further confusion in the current protocol for clinically prescribing such compensating prism. The contradictory theories of optometry and ophthalmology, combined with crude methods for prescribing, confirm the lack of agreement and inconsistency in prescribing prisms between the two communities. This may cause some clinicians to resist prescribing prism lenses or to prescribe only as a last resort, while it may make other clinicians steer away from these lenses altogether.

Prism: Behavioral Approach

Behavioral optometrists differ in their view of how and when to prescribe prism lenses; however, there is a more unifying theme with regard to the use of prism lenses and their purpose. The behavioral concept of vision considers any ophthalmic lens application potentially to provide the ability to achieve an alteration of human behavior.[1] An inherent behavioral manifestation of a lens is represented by the fact that "the efficient acquisition and processing of visual information requires the development of a good representation of the 3-dimensional structure of body and environmental space. This internal representation of the space world around us would seem to play a vital role in the control of accommodation and convergence."[4] Prisms are but one treatment strategy to support the awareness of space and the ocular function to direct movement within space, yet an essential one.

Amiel Francke's statement that "lenses are an optometrist's most powerful tool"[5] is, I believe, one of the most powerful statements made in all of behavioral optometry. Elliot Forrest also stated that "optometry, as a clinical profession, made its great leap forward when its direction shifted from aiding and reducing asthenopia to the enhancement of perception, performance, and problem-solving through the more efficient

operation of the visual process."[6] This statement identifies and highlights the unique benefit that behavioral lenses and prisms can potentially have, especially when considering their effect on balance (orientation), posture, and movement.

Al Sutton stated that "the response to light, altered by the lens, can affect posture, meaning, and action."[7] Skeffington noted that "the value of a lens is dependent on the orientation and development of that person … the value of a lens is founded in its ability to change orders to a system."[8] Kraskin stated further that "a lens can do nothing to a person, a person can do much with a lens."[8]

Prism lenses are but one treatment option in the quest for "a reliable visual system, which correctly interprets visual and visual-spatial data and enables good integration of this skill with other body senses."[8] In a conversation with Amiel Francke, he stated that "treatment options clinically available are like playing keys on a piano: it depends on the type of music you want to play."[9]

Yoked Prism

During the 1950s, yoked prisms were introduced to the behavioral optometric community by Bruce Wolff. The term yoked was originally used to differentiate it from conventional prism lenses. They are defined as a pair of prismatic spectacle lenses of equal power with their bases oriented in the same direction before each eye.[8] Birnbaum stated that "their effect is to create spatial change."[10] Viewing through yoked prisms will not only have optical effects; it will also have relatively predictable effects upon one's posture/stance and consequently, some feel, upon one's center of gravity and body orientation.[11] There are others who consider this as fulcrum/level aspects of body mechanics. In any event, I believe, all will consider this as a shift in body mechanics.

In addition to their effect on spatial localization in three-dimensional space, yoked prisms have been thought to create spatial change that has an effect on the position of the body's center of mass when standing. The center of gravity of the body shifts opposite to the eye movement gaze shift. The anti-gravity system is concerned with balance and posture, whereas the centering system is described as an attentional and orienting system for selecting where the body, head, and eyes are directed. Convergence has been presented as the overt oculomotor component of this centering system. "The visual perception of space is known to be directly affected by binocular/vergence factors. This idea is frequently utilized in vision therapy practice, as when asking patients to localize space under different degrees of forced vergence."[12]

It is this author's opinion, when considering the treatment option that will yield the maximum effect of the connection between posture, balance, and vision, that vertical yoked prisms are the lenses of choice. Base-up yoked prisms are viewed as "spatially compressive, creating decreased size, decreased distance, downward spatial shift and an associated downward gaze shift, associated with convergence and inward body thrust."[10] Base-down yoked prisms "create an upward spatial shift and consequent upward gaze shift associated with divergence, expanded peripheral awareness, relaxation, backwards and outwards body thrust, and increased near point working distance."[10] Vertical yoked prisms are considered clinically effective across a wide

Table 1. Guidelines for Prescribing Vertical Yoked Prism

Base Up	
0.50 Base Up	Pseudo-convergence insufficiency (CI)
1.0 Base Up	CI without hypotonicity or hyperactivity
2.0 Base Up	CI with hypotonicity or hyperactivity
2.5 Base Up	CI with hypotonicity and hyperactivity or an intermittent exotropia
3.0 Base Up	Constant exotropia

Base Down	
1.0 Base Down	Intermittent accommodative esotropia
2.0 Base Down	Intermittent fusional esotropia
3.0 Base Down	Constant esotropia

range of clinical presentations and patient groups (Table 1). However, there is much greater clinical acceptance of vertical yoked prism in pediatric versus adult populations. This author would postulate that this is because behavioral and mental rigidity is increased with age, and flexibility between vision and motor function is necessary for a yoked prism to have its positive effects. Base-up yoked prisms are considered for exo posture, hypotonicity, and hyperactivity, while base-down yoked prisms are considered for eso posture and hypertonicity.[10] "The true value of a yoked prism is in its influence on balance and orientation. Most often, the behavioral effect is represented by a demonstrable improvement in spatial awareness and orientation of one's body, in space."[11]

The effect of yoked prism lenses is to shift spatial awareness towards the apex. Lateral yoked prism, in my practice, has been used to shift accommodative effort away from an eye experiencing an accommodative spasm/excess. Therefore, base-right prism lenses will shift images towards the left, and base-left prism lenses will shift spatial images towards the right.

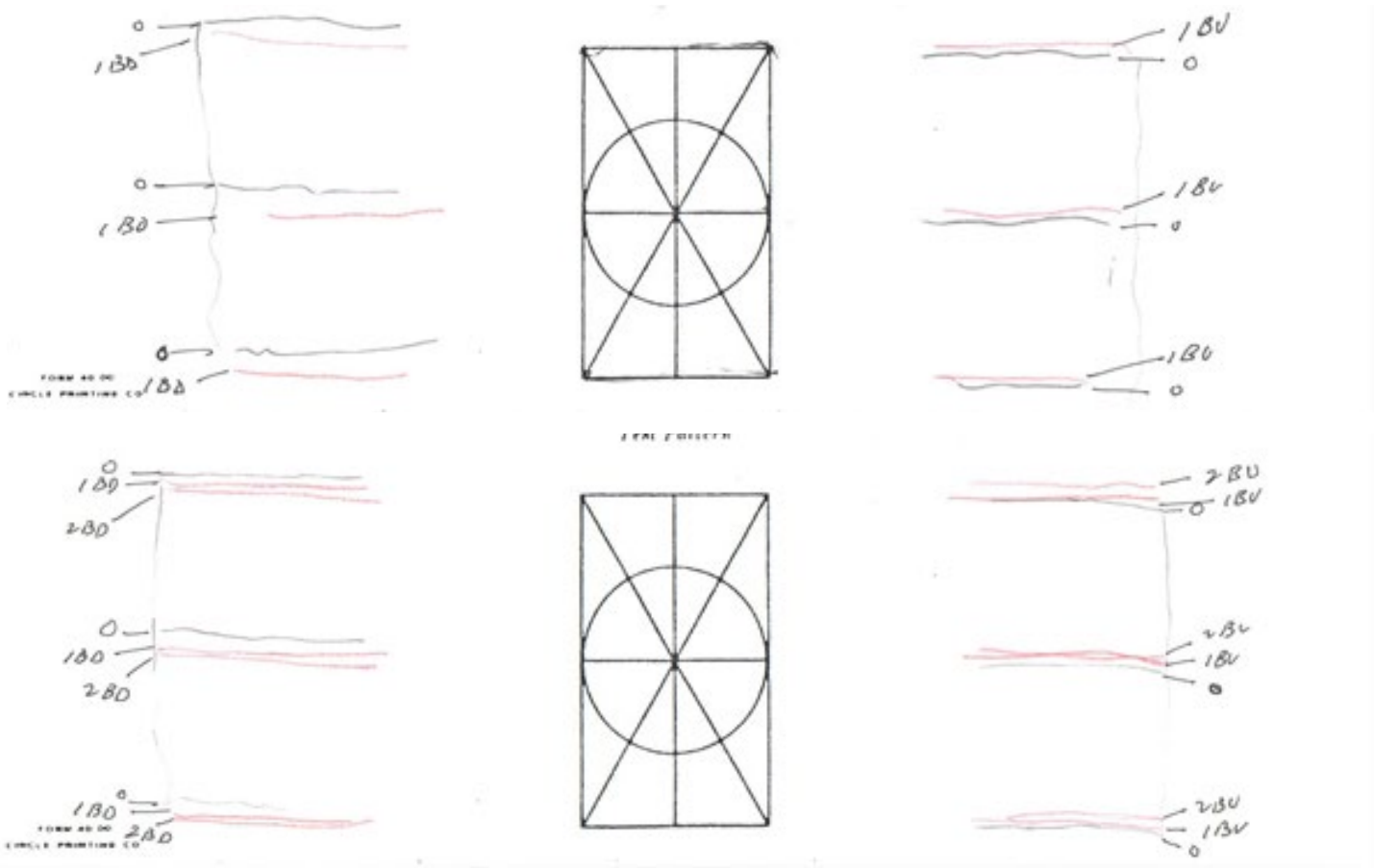
Prescribing Prism Lenses: The Behavioral Approach

A rational analogy for routinely prescribing behavioral prism lenses for therapeutic prescriptions is a car's transmission. It is customarily accepted that a standard-shift transmission maintains greater control of a car as compared to an automatic transmission. With this in mind, a lens has its primary effect on accommodative function and a secondary effect on the vergence system. A prism has its primary effect on vergence function and a secondary effect on the accommodative system. Through the combined use of a therapeutic lens in conjunction with a prism, a practitioner can have greater primary control, affecting both the accommodative and vergence systems simultaneously, similar to a standard-shift automobile, through a clinical behavioral lens prescription.

Therefore, most, if not all, pediatric patients who have a therapeutic lens prescription would further benefit from a prism incorporated into that prescription. The base of the prism is academic; the amount of the prism is based on one's clinical judgment.[8]

Sequential Strategy for Prescribing Prism Lenses

Basic to prescribing lenses and prisms is the idea that vision should be an effortless process, and we as practitioners should have that in the forefront of our minds when prescribing. Lenses, prisms, and vision therapy (affecting the specific patient population in this paper) all play a role in this process. As I have just stated, a therapeutic lens' primary role is to reduce/eliminate accommodative/convergent effort and subsequently to enhance clarity and comfort. A therapeutic prism prescription's primary role is to reduce/eliminate vergence effort and to enhance egocentric process: where I am relative to objects in space. In this paper, the distance prescription was determined by objective and subjective testing and was based on reported clarity and comfort. The bifocal addition was determined by either a fused cross cylinder or a Monocular Estimation Method (MEM) retinoscopy, depending on the reliability of the child. Although not all behavioral optometrists routinely prescribe an addition, it is this author's approach to affect a visual dysfunction by reducing effort, wherever it is to be found; therefore, if an addition is acceptable and appreciated, it will be prescribed. This author does not believe that the amount of effect that each therapeutic component (lenses, prism, and vision therapy) has on each child can be measured. As long as the practitioner has the child's visual behavioral needs in mind when prescribing, this author believes that each child will react differently to



Figures 1 & 2. Cheiroscopic traces demonstrating before and after prism application

each component of the therapeutic process, based on what the patient needs/requires. The following is a sequential approach for prescribing a variety of behavioral prism lenses:

Step One: Assess the patient externally, inclusive of unilateral and alternating cover test at distance and near, extra-ocular motilities/versions, and near point of convergence with awareness of A or V patterns. This will grossly identify an unstable binocular system and/or a vertical or horizontal imbalance.

Step Two: Analyze an appropriate behavioral spherical and/or astigmatic lens prescription for both distance and near space. Non-fusional conditions will warrant a monocular lens assessment, while fusional conditions will necessitate incorporating a binocular assessment for a lens prescription. Clarity and comfort will serve as determining factors.

Step Three: Evaluate phorias and vergence findings, consistent with a behavioral approach. That behavioral approach considers, as Skeffington said, "vision as an external reflection of an internal neurological organization."[3] "The essence of vision is not just physical or physiological. Vision is also an emotional, psychological, and neurological expression."[3] This will further define and refine the direction and extent of the sensory motor imbalance and subsequent potential prism lens used.

Step Four: Further refine and validate the direction and extent of the prism prescription. This step occurs once the nature and the extent of the binocular dysfunction has been identified. The refinement is made with the likely prescription placed into a trial frame. It is important to have the child walk throughout the exam room considering clarity, comfort, and connection in space; i.e., how connected they feel to the space around them (egocentric process). Additionally, having a child read from a book or magazine can help to assess near visual clarity, comfort, and connectedness.

Step Five: Evaluate for a remaining vertical deviation. This step occurs if a vertical imbalance is still detected after horizontal yoked prism

application. Further detection and refinement can be made through the use of an indirect cheiroscopic tracing. If a vertical imbalance still exists, one tracing will be higher than the other. The tracing that is higher is considered the hyper component. Loose vertical prism can be taped in front of the appropriate eye's lens, and another tracing is completed. The amount of prism that is additionally applied to the considered prescription is that which generates tracings of equal height. That amount of vertical prism is added to the trial frame for the final prescription. As evidenced in Figures 1 & 2, the height of the tracing (and therefore, the impact of the hyper deviation) changed as additional vertical prism was added.

Step Six: The final prescription is assessed. The vertical imbalance is equilibrated through the cheiroscopic tracing, and the horizontal imbalance is established through a behavioral assessment. A final therapeutic and/or diagnostic lens/prism prescription is then decided upon.

Step Seven: The final trial frame prism assessment is presented to the patient. Once again, have your patient walk through the exam room considering distance clarity, comfort, and stability/orientation, and then have your patient read from a book to assess near visual clarity and comfort. The patient's final acceptance of your lens is your prescription.

Case Analysis Depicting Prescribed Prism

Case 1: Base Up Yoked Prism

AA (18 years old) always hated to read. He reported seeing double, losing his place, and skipping lines while reading. He also needed to re-read in order to understand what he read. Reading comprehension was limited, and organizational skills were challenged. Despite this, he was a star in soccer. His body was in sync, but his vision was not. He was in psychotherapy for five years prior to the examination to support his self-worth and to improve his poor self-esteem. In this sense, self-worth is basically how much you feel you deserve something as a result of what you have earned or contributed, and self-esteem is more immediate: how you look at a particular moment. His history made no sense, as he seemed to be the epitome of a star college quarterback who had trouble reading.

Findings:

- NPC: 2-inch break/7-inch recovery
- Distance phoria: 1 exo
- Near phoria: 8 exo
- Base-out vergence: distance x/8/4, near x/8/-4
- Base-in vergence: expected levels at near
- Stereo: 20' on Titmus Wirt

The patient fit the model of a typical convergence insufficiency.

Final Prescription:

OD Plano /+1.00 1.0 base up
OS Plano /+1.00 1.0 base up

The basic theory of this symmetric, base-up yoked prism prescription has been previously discussed. Recognize that the yoked prism prescribed is throughout the lens, not just in the add, for all patients presented in this paper.

Findings after the addition of a therapeutic prism prescription and 32 sessions of vision therapy were at or above expected norms (Figures 3 & 4). The patient was able to identify mistakes while reading, as well as having little to no visual fatigue and an increase in his ability to focus. He reported no need to reread and limited skipping of lines and losing place while reading. Most importantly, there was no need for psychotherapy; AA was never psychologically compromised, he was visually compromised. His self-worth and self-esteem had been restored.

Figure 3. Pre-therapy/prism cheiroscopic tracing demonstrating an over-convergent pattern associated with disorganization and suppression

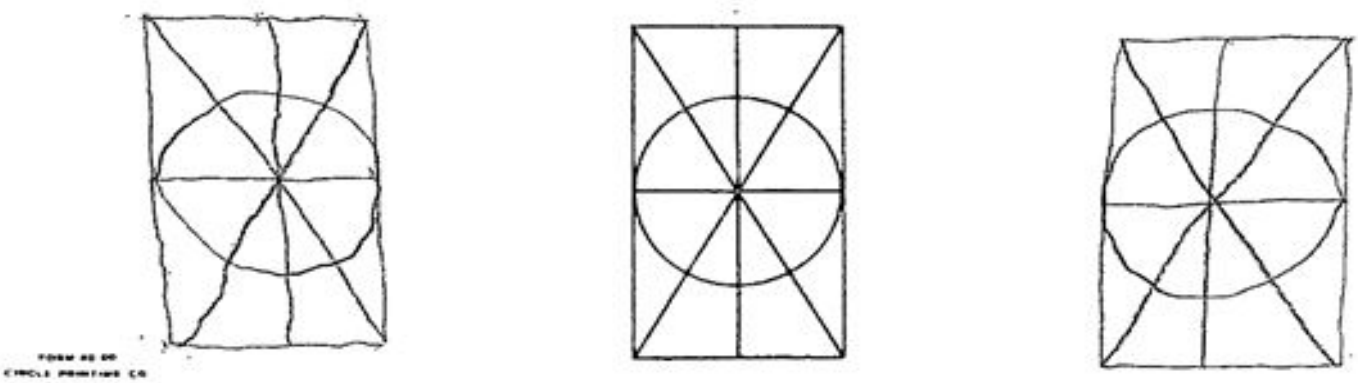


Figure 4. Post-therapy/prism cheiroscopic tracing demonstrating an organized under-convergent pattern without suppression

Case 2: Base Up Yoked / Base Right Yoked

MG (13 years old) did not like to read and had poor results on testing in school. He would lose his place and skip lines while reading and needed to reread for comprehension. He also reported ocular headaches and discomfort, eye rubbing, and a labored approach to reading, exemplifying his motivated approach to learning. A child who struggles in order to achieve is motivated in their learning. The extra effort he put forth resulted in asthenopia, which he tolerated as further demonstration of his motivation. Accommodative spasm/excess was greater in the left eye as compared to the right.

Findings:

- NPC: 2-inch break/5-inch recovery
- Distance phoria: orthophoria
- Near phoria: 6 exophoria
- Base-out vergence at distance: 14/4
- Base-out vergence at near: 8/4
- Base-in vergence ranges at distance and near were reduced

Final Rx:

OD -2.50 / +1.00 1.0 BU 1.0 BI
OS -2.50 / +1.00 1.0 BU 1.0 BO

Symmetric base-up yoked prism was selected because of the low base-out vergence findings for both distance and near, as well as the mildly receded NPC. Base-left prism shifts the visual attention/focus from the left eye towards the right, theoretically to reduce the spasm of the left eye. An applicable analogy would be the reorientation of a computer monitor. If viewing the monitor from the left is causing a strain of the left eye, simply moving the monitor towards the right would reduce stress on the left eye.

After the addition of the therapeutic prism prescription and 24 sessions of vision therapy, MG's findings were now at or above expected norms (Figures 5 & 6). Visual function was accurate. Ocular headaches, discomfort, and eye rubbing had been eliminated, and the left eye spasm was reduced. MG no longer

Figure 5. Pre-therapy/prism cheiroscopic tracing demonstrating an over-convergent pattern associated with disorganization and suppression

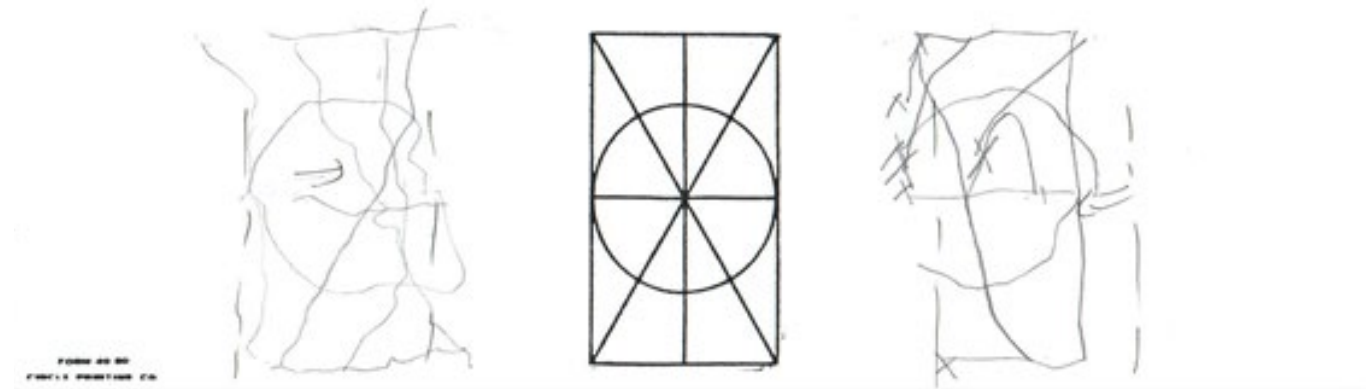


Figure 6. Post-therapy/prism cheiroscopic tracing demonstrating an orthophoric pattern, organized and without suppression

lost his place or skipped lines while reading, and he no longer needed to reread in order to comprehend. Overall confidence had dramatically improved, and self-esteem was established. He was lost to follow-up.

Case 3: Asymmetric Base Up / Base Right Yoked

YB (10 years old) complained about a "traveling eye" and reading inaccuracy. Her right eye turned outward, and she would see words jump on the page. She would lose her place while reading, omit words, reverse letters/words, and have to reread for comprehension. She also reported inattention, distractibility, and a labored reading style. She fatigued easily when performing near visual tasks. She was frustrated and was becoming increasingly anxious, as she was not able to read and learn to her potential.

Findings:

- Distance and near cover test: intermittent alternating exotropia
- Distance and near phorias: greater than 15 exophoria
- Base-out vergence ranges at distance: 8/suppression/0
- Base-out vergence ranges at near: 8/suppression/0
- Base-in vergence ranges: at or near expected values
- A right hyperphoria and an excessive accommodative spasm was observed with the left eye. The spasm was determined through a fluctuating retinoscopic reflex in the left eye and a crisper 20/20 response from the right eye.

Final Rx:

OD -4.50 / +1.00 2.0 BU 1.0 BI
OS -4.50 / +1.00 3.0 BU 1.0 BO

Asymmetric vertical yoked prism addressed the vertical asymmetry, the right hyper, while still maintaining the effects of a BU vertical yoked prism, enhancing convergence. The

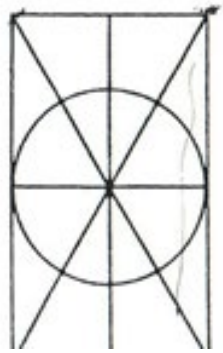


Figure 7. Pre-therapy/prism cheiroscopic tracing demonstrating minimal over-convergent findings associated with marked suppression

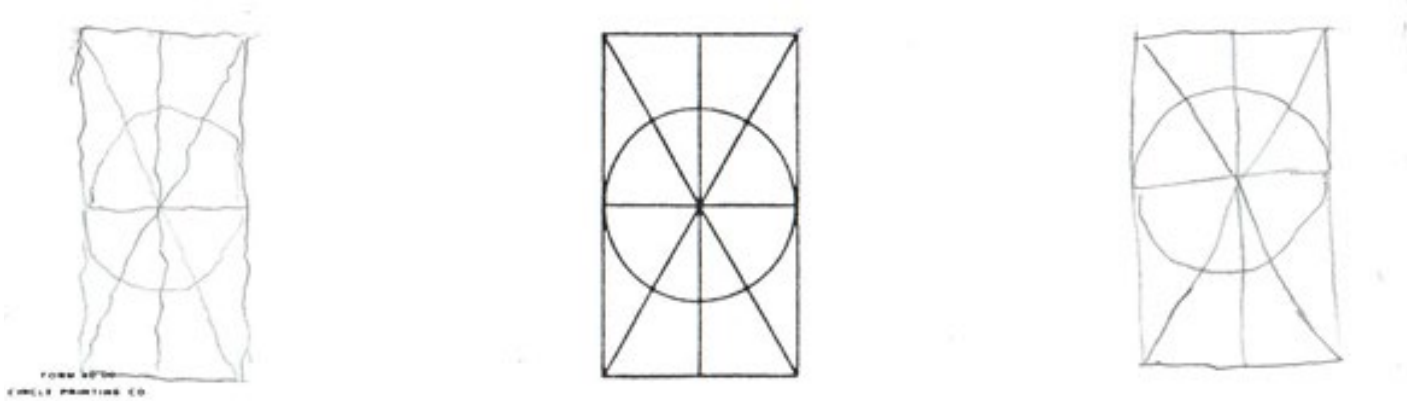


Figure 8. Post-therapy/prism cheiroscopic tracing demonstrating well organized but significantly under-converged findings

amount of the vertical imbalance was finalized through a cheiroscopic trace. An asymmetric lateral prism addressed the accommodative spasm affecting the left eye greater than the right, shifting with base left towards the right field, as in case #2.

YB was able complete to remediate the presenting strabismus through the use of her therapeutic prism prescription and 64 sessions of vision therapy (Figures 7 & 8). She had developed an increased interest in reading and learning, with increased comfort and visual accuracy, all with significantly less effort. Her self-esteem was enhanced.

Case 4: Base Up Yoked Prism / Base In Lateral Prism

AT (11 years old) presented with a chief complaint of a wandering eye. He exhibited defiant behavior and reduced self-esteem. He also complained of ocular headaches, excessive blinking, and difficulty decoding.

Findings:

- Near point of convergence: intermittent alternating exotropia
- Presented with an intermittent alternating exotropia (greater than 30Δ) at near
- Intermittent suppression on most binocular testing
- Base-out vergence range at distance: 20/0
- Base-out vergence range at near: 20/-8
- Base-in findings: at or above expected value
- Titmus Wirt stereo: 70 seconds of arc
- He had a tendency to fall and to bump into objects within his spatial surround, indicating a reduced awareness of his body in space.

Final Rx:

OD +2.50 / +1.50 3.0 BU 2.0 BI
OS +2.50 / +1.50 3.0 BU 2.0 BI

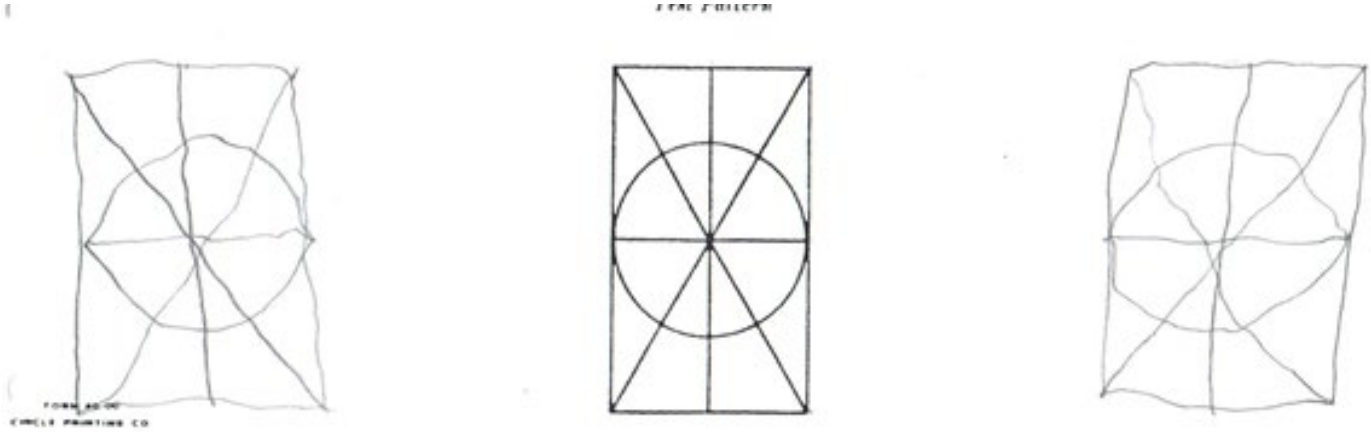


Figure 9. Pre-therapy/prism cheiroscopic tracing demonstrating a disorganized under-convergent pattern

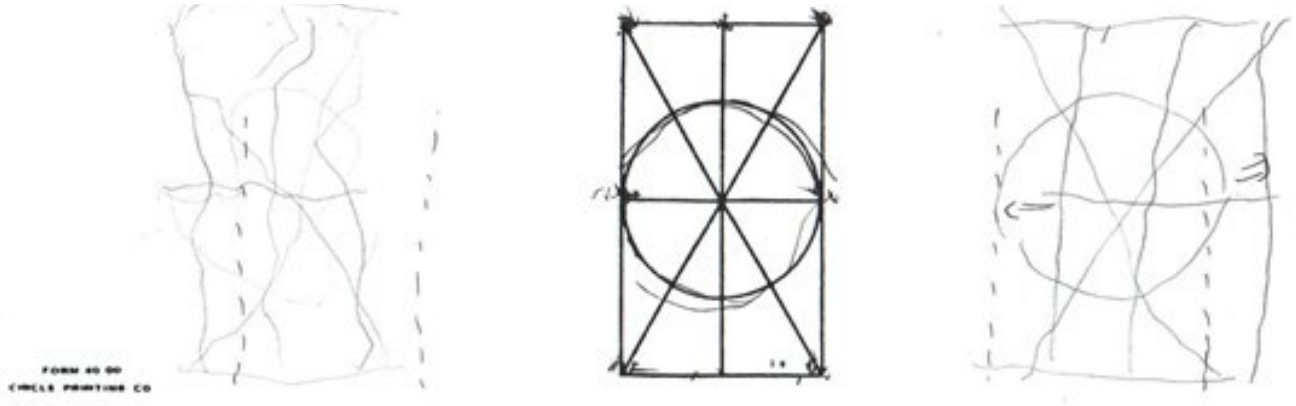


Figure 10. Post-therapy/prism cheiroscopic tracing demonstrating an organized under-convergent pattern

Vertical base-up prism created down gaze, as previously stated, and base-in conventional lateral prism further supported neutralizing the angle of the deviation. The fact that the turn extended beyond 30 prism diopters warranted both yoked and conventional prism.

AT became a comfortable child after wearing his therapeutic lenses and prism and completing 64 sessions of vision therapy. He was not defiant and had a healthy sense of self-esteem. He was orthophoric at distance and near, had distance and near base-out vergence ranges of >30/30, and was at norm or above for base-in vergence. Titmus Wirt stereo was 20 seconds of arc (Figures 9 & 10).

Case 5: Base Down Vertical Yoked Prism / Asymmetric Base Out Lateral Prism

AQ (7 years old) presented with an intermittent alternating esotropia, without compensating/therapeutic lenses, measuring 20 prism diopters at distance and near. His gross motor skills were coordinated, and he was socially engaged but somewhat defiant. He tended to sit very close to the television.

Findings:

- He presented with an intermittent alternating esotropia, without prescription, and orthophoria with his habitual Rx.
- Aided visual acuity was 20/60 OD and OS
- Lang Stereo was not appreciated
- Suppression was demonstrated at distance and near

Final Rx:

OD +6.50 /+2.00 2.0 BD 4.0 BO
OS +7.00-1.00x090 / +2.00 2.0 BD 6.0 BO

Base-down prism promoted up-gaze, encouraging a divergent posture and expanded peripheral awareness. Conventional base-out lateral prism was used to support compensating the deviation. Asymmetry of the base-out prism

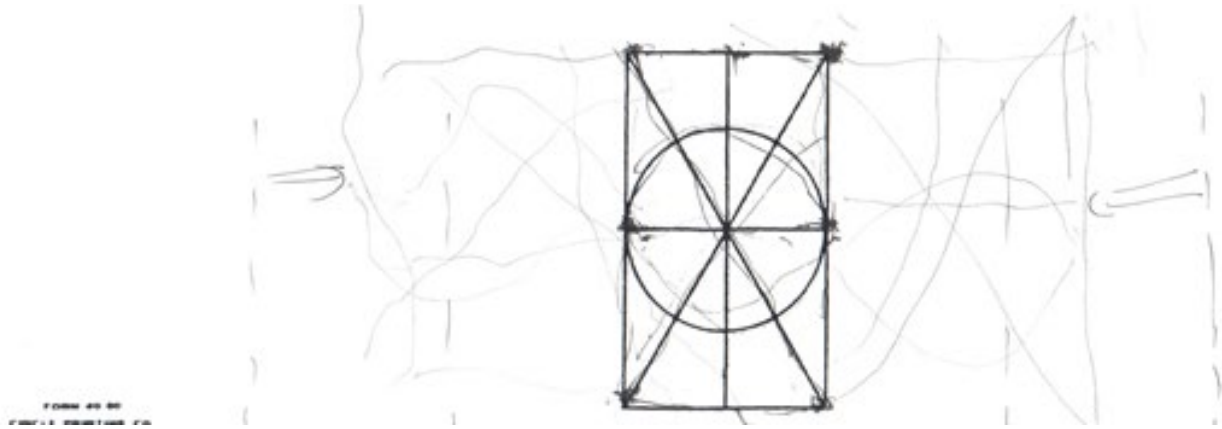


Figure 11. Pre-therapy/prism cheiroscopic tracing demonstrating a disorganized over-convergence pattern

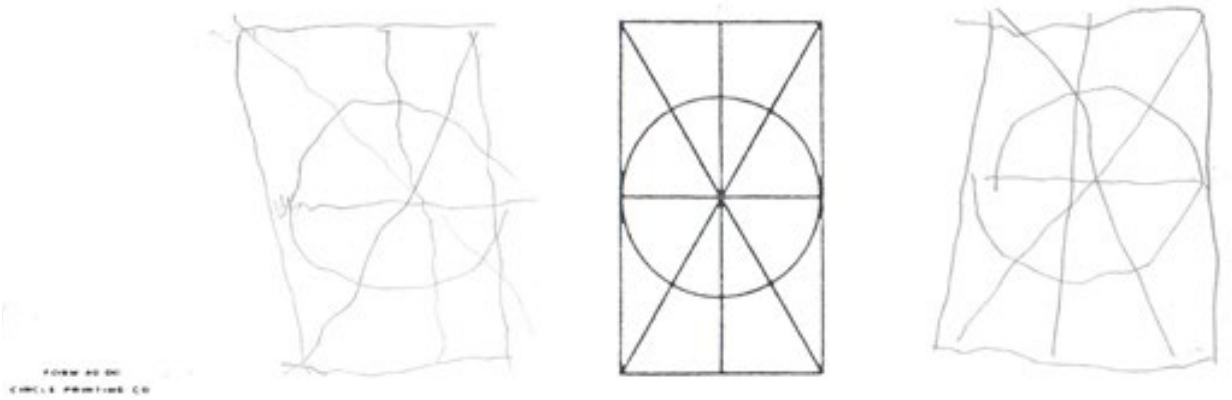


Figure 12. Post-therapy/prism cheiroscopic tracing demonstrating improved organization and an orthophoric pattern

was utilized to address the asymmetric acuity findings that subsequently developed.

After a therapeutic prism prescription and 104 vision therapy sessions, AQ was more comfortable. Base-out and base-in ranges were at or above expected levels at distance and near. Wirt stereo was 200 seconds of arc. Aided visual acuity measured 20/25+/- OD and 20/30+/- OS (Figures 11 & 12). His behavior improved drastically; he presented as a well-adjusted child with good self-esteem and an appropriate working distance. His behavior was no longer defiant.

Conclusion

A therapeutic prism lens prescription is not only a viable strategy for the treatment of visual dysfunction, but it is an essential part of a treatment regimen for behavioral visual function. If one considers the primary and secondary effects of a lens/prism prescription, not prescribing prism, in itself, can limit a patient's achievements in their behavioral visual function, success, and sense of self-worth in their world. The success of prism application, presented in this paper, exemplifies the accomplishment and achievement of a behavioral therapeutic approach to vision and behavior. Follow these guidelines, and you will experience an exaggerated success with your patients.

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