Behavioral optometric science student manual

Angela Darveaux
Pacific University
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Abstract
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Other Authors of Manual: Katherine Chhor, Kristel Rogers, and Kim Schweiger

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BEHAVIORAL OPTOMETRIC SCIENCE
STUDENT MANUAL
OPT 562

By
ANGELA DARVEAUX

A thesis submitted to the faculty of the
College of Optometry
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Advisor:
Bradley Coffey, O.D., FAAO
BEHAVIORAL OPTOMETRIC SCIENCE
STUDENT MANUAL
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Angela Darveaux obtained a bachelors of science degree in Zoology from North Dakota State University in Fargo, N.D. She will graduate from Pacific University College of Optometry in May 2006. She plans to raise her family and practice in a full-spectrum primary care optometric practice in the Midwest.
Advisor: Bradley Coffey, O.D., FAAO

Final Grade
ABSTRACT

Purpose: To provide the first year optometry student with a simplified guide to behavioral optometry terminology and concepts. The goal is for the student to gain a better understanding of behavioral optometry throughout the first semester.

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Other Authors of Manual: Katherine Chhor, Kristel Rogers, and Kim Schweiger
Treatment Options: Lenses and Prism

Optometrists have numerous therapeutic tools to choose from in their pursuit of individualized and effective patient care. Ophthalmic lenses are one of the most commonly prescribed therapies available to optometrists. There are several types of lenses available, including convex, concave, toric (astigmatic), and prismatic lenses. Properties of plus, minus, and prismatic lenses, and their relationship to behavioral optometry will be discussed further.

Plus Lenses

Plus lenses are named based upon their optical properties. They are also known as convex lenses based upon their convex shape. This shape causes the plus lens to converge incident light. Therefore, plus lenses are also known as converging or convex lenses. (See figure 1.1 and 1.2). Plus lenses produce an image that is magnified, upright, and real.

As was discussed earlier in this manual, hyperopia results in the image being formed behind the retina of the non-accommodating eye (due to the optical power being too low or the axial length too short). In order to compensate this condition, a plus lens is used to converge the light onto the retina so that a clear image is seen by the patient. This added power compensates for the lack of power of the hyperopic eye.

Plus lenses also relax accommodation. When the unaided eye accommodates, plus power is added to focus a near object on the retina. Plus lenses provide this added power so the patient does not have to accommodate as much.
Plus lenses are also used to aid the presbyopic patient. Presbyopia is defined as the inability of the accommodative system to add the necessary power to the system required by the dioptric demand of the working distance. This means that presbyopes are not able to accommodate enough to see close targets. The closer the object is to the person, the more accommodation is necessary to focus the object on the retina. As people become presbyopic, they find that they must hold reading materials (or other nearpoint work) further away from their eyes in order to see it clearly. Patients complain, "My arms have become too short to see clearly."

To explain the effect that plus lenses have on binocular convergence and pupil size, the near triad must be understood. The near triad includes convergence, accommodation, and pupil constriction. Since the near triad includes accommodation, when accommodation is relaxed, a relaxation of convergence will also occur with plus lenses in place. Similarly, slight pupil dilation will also be seen.

Convergence excess is a binocular vergence condition that benefits therapeutically from using plus lenses. Convergence excess results from over convergence when looking at a near object. In order to relax the excessive convergence when the pt views a near target, the optometrist prescribes an additional amount of plus to relax accommodation, and hence convergence, through the near triad. The amount of plus prescribed is additional to any amount that is required to compensate for the patient’s refractive condition. Providing additional plus for a patient with convergence excess will allow the patient to relax convergence somewhat in order to comfortably see the target.
they desire to see. Therefore, myopic patients will receive less minus power while hyperopic patients will receive more plus power to be used only when viewing nearpoint targets.

**Quiz yourself:**

1) Plus lenses are prescribed for patients who are ____________.
   - a) Presbyopic
   - b) Hyperopic
   - c) Far-sighted
   - d) All of the above

2) Plus lenses are also known as ________________.
   - a) Converging lenses
   - b) Diverging lenses

3) Plus lenses cause relaxation of accommodation, ________, and ________.
   - a) Convergence
   - b) Relaxation of convergence
   - c) Pupil miosis (pupil size to decrease)
   - d) Pupil dilation
   - e) b and c
   - f) b and d

 Answers: 1) d, 2) a, 3) f

Plus lenses are also used to improve visual efficiency for people who have occupational demands for prolonged periods of accommodation. For example, if a young architect is constantly working at 40 centimeters, it may be beneficial for him/her to wear plus lenses in the range +0.75 to +2.00 D in order to reduce the amount of accommodation necessary to perform the visual tasks. Using reading glasses (or occupational “stress-relieving lenses”) may prevent the unnecessary overwork by the architect’s accommodative system or an unfavorable near point stress adaptation (for further explanations of this concept refer to Chapter covering Nearpoint Stress).
Minus Lenses

Minus lenses are also named based upon their optical properties. They have a concave shape and therefore minus lenses diverge light. They may also be referred to as diverging or concave lenses. Because of these properties, minus lenses produce an image that is minified, inverted, and virtual. See figure 1.1 and 1.2.

Minus lenses are used to compensate myopia. Myopic eyes focus light in front of the retina because there is too much power in the optical system relative to the axial length of the eye. Therefore, a minus lens is used to diverge the light so that it is focused on the retina.

In contrast to a plus lens, a minus lens stronger than that necessary to compensate myopia will stimulate accommodation. With a minus lens in place, the light coming into an emmetropic eye will be diverged and will focus behind the retina. In order for the eye to focus the light on the retina, more power will need to be added to converge the light onto the retina. To do this, the eye will need to add plus power by means of accommodation.

Once accommodation has been stimulated, through the near triad, convergence and pupillary constriction will also occur. Therefore, with minus lenses (with power greater than that necessary to compensate any myopic refractive condition) in place, an eso-ward shift in phoria and a decrease in pupil size will be seen secondary to stimulation of accommodation.

Divergence excess and convergence insufficiency are two vergence conditions that might benefit therapeutically from the use of minus lenses. To
clarify, when the patient is looking at a far object, divergence excess results from a response of divergence than is greater than necessary. Similarly, convergence insufficiency results from a deficient convergence response when the patient is looking at a near object. By means of prescribing added minus (greater than is necessary to compensate for the patient's refractive condition), convergence is stimulated through the near triad. Providing additional minus to a patient with divergence excess will cause their eyes to converge to the necessary target, while extra minus prescribed to a patient with convergence insufficiency would theoretically improve the convergence response at near. Therefore, myopic patients would receive added minus while hyperopic patients would receive less plus. For reasons beyond the scope of the present discussion, added minus is virtually never prescribed for convergence insufficiency in clinical practice. The preferred treatment for convergence is VT or, in some cases, the prescription of small amounts of base-in prism (see later).

**Figure 1.1**
**Quiz yourself:**

1) Minus lenses are prescribed for patients who are ____________:
   a) Myopic
   b) Nearsighted
   c) Farsighted
   d) a and b

2) Minus lenses are also known as ________________:
   a) Converging lenses
   b) Diverging lenses

3) Minus lenses stimulate accommodation, ________, and ____________:
   a) Cause pupil dilation
   b) Cause pupil miosis
   c) Divergence
   d) Convergence
   e) b and d
   f) a and c

*Answers: 1) d, 2) b, 3) e*

**Prisms**

Prisms are beneficial for a variety of patients who experience **diplopia** (double vision) or conditions of excessive heterophoria. Diplopia results from a misalignment of the patient's eyes relative to the position of the viewed target. Consequently, the patient experiences a loss of normal sensory fusion and
**stereopsis** (also known as 3-dimensional perception or binocular depth perception). In order for normal sensory fusion and stereopsis to occur, both eyes must be aligned and the images seen by each must be interpreted as similar. If this does not occur, two separate images are perceived and the brain does not interpret them as one object. For those patients who lack stereopsis, prisms are sometimes useful in order to provide aligned images for the brain to interpret correctly. There are several conditions that may benefit from the use of prisms, some of which will be explained later in this chapter.

Prism power is measured in **prism diopters** (°), which are defined as the amount of prism power required to deviate a ray of light one centimeter over one meter. *See figure 2.1.* This means that the image of the object is moved one centimeter over a distance of one meter. This equals one prism diopter.

**Figure 2.1**

Prism diopters are also useful in calculating individual vergence demands. For example, a person with a small interpupillary distance has to deviate their eyes less than a person with a wider interpupillary distance to see the same object at the same distance in space. *See figure 2.2.*
**Consider the object to be 5 meters from each patient**

To calculate the amount of vergence required as use Formula 2.1.

**Formula 2.1- Measuring Vergence Demands in Prism Diopters**

\[ V (\Delta) = \frac{Pd}{	ext{target distance}} \]

Thus, for Patient 1, in Figure 2.2, the amount of vergence demand is \( 9 \Delta \) (45cm / 5m = 9 \( \Delta \)). For Patient 2, the vergence demand is \( 11 \Delta \) (55cm / 5m = 11 \( \Delta \)). Therefore, it can be assumed that for an object equidistant from two patients, the patient with the greater interpupillary distance will require more vergence to converge their eyes to the object. This is one of several important considerations to take into account when prescribing prisms to your patients.

The optical properties of prisms are different and simpler than those of plus and minus lenses. The easiest way to remember what occurs with the image and light in a prism is to remember, "the image goes toward the apex." Therefore, the light must go toward the base of the prism. *See figure 2.3*
Although in optometry, we are concerned primarily with a prism's effect on image displacement (the image is displaced toward the apex), the convention for prescribing prisms is to specify the orientation of the base. Commonly prescribed orientations are base up, base down, base in (or nasal), and base out (or temporal). There are several different optometric uses of prisms and each has been named.

In a patient with normal sensory fusion, a low-power prism placed in front of an eye will stimulate a vergence movement in the direction of the apex of the prism. This is a normal fusional vergence response. For a patient with a vertical or horizontal deviation of one eye from central gaze (tropia or strabismus) and abnormal or disrupted sensory fusion, normal fusional vergence responses do not occur. In these cases, the goal is to use prism to move the image to the point where the eye is abnormally directed. The type of prism used to compensate for this abnormality is called a compensating or relieving prism. With a tropic (strabismic) patient, the compensating prism goal is to prescribe the amount of prism diopters necessary for the patient to see one image, without requiring a fusional vergence response. See figure 2.4.
Table of abnormal fusion tropia and vergence compensation:

<table>
<thead>
<tr>
<th>Type of prism:</th>
<th>With abnormal fusion, type of tropia compensated:</th>
<th>With normal fusion present, type of vergence movement:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base out/temporal</td>
<td>Eso deviations</td>
<td>Convergence</td>
</tr>
<tr>
<td>Base in/nasal</td>
<td>Exo deviations</td>
<td>Divergence</td>
</tr>
<tr>
<td>Base up</td>
<td>Hypo deviations</td>
<td>Infravergence</td>
</tr>
</tbody>
</table>
Type of prism:  | With abnormal fusion, type of tropia compensated: | With normal fusion present, type of vergence movement:
---|---|---
Base down | Hyper deviations | Supravergence

**Quiz yourself:**

1) When light passes through a prism, the image is displaced toward the ________, while the light is displaced toward the ________.
   a) base, base
   b) base, apex
   c) apex, base
   d) apex, apex

2) When normal sensory fusion is present, base down prism stimulates a/an ________ vergence movement.
   a) con-
   b) di-
   c) supra-
   d) infra-

3) When normal sensory fusion is present, base in/nasal prism stimulates a/an ________ vergence movement.
   a) con-
   b) di-
   c) supra-
   d) infra-

4) Eso deviation is compensated by a ________.
   a) base down prism
   b) base up prism
   c) base in/nasal prism
   d) base out/temporal prism

Answers: 1) c, 2) c, 3) b, 4) d

**Training prism** is a vision therapy tool used for pts with excessive phorias or tropias. A relative amount of prism is prescribed, requiring the patient
to rely on their vergence system to compensate for the lack of prism diopters NOT prescribed. For example, an 8\(^{\circ}\) exotropic pt presents for treatment. Only, 6\(^{\circ}\) base in is prescribed. Thus, the patient is required to converge 2\(^{\circ}\) in order to achieve normal sensory fusion and see normally. Gradually, the amount of prism diopters prescribed is decreased as the pt develops greater fusional convergence reserve ability to overcome the strabismus. Training prism can also be used for active vision therapy in a procedure where the prism is handheld and is inserted and removed repeatedly to stimulate fusional vergence responses.

**Yoked prism** is another therapeutic tool used by optometrists. Yoked prisms are prisms that are prescribed with the bases oriented the same direction (e.g., bases up, down, right, or left) before both eyes. There are several types of patients who benefit from the use of yoked prisms. For example, a patient with left lateral rectus muscle paresis is unable (or barely able) to abduct the left eye. When the pt looks to the left by moving the eyes and not the head, they will experience diplopia since the left eye does not abduct normally. These patients typically present with a head turn (the head is usually turned toward the affected muscle) to avoid the affected field of gaze. A prolonged head tilt or turn can have an unfavorable affect on the spinal column, resulting in neck and/or back pain. Using yoked prisms placed bases left would shift the images to the pt’s right, thus reducing the necessity for the head turn in order to maintain single binocular vision. Optimally, this will alleviate the patient’s back pain and enable her to engage in activities that she may not have been able to otherwise. Another patient that would benefit from yoked prisms is a patient that has a visual field loss due to retinal damage or damage to the visual pathway in the brain. A type
of visual field defect that may benefit from yoked prisms is **hemianopsia**. In this defect, the patient is not able to see half of the visual field. *See figure 2.5.*

**Figure 2.5**  
*Depiction of right hemianopsia (the black portion of the field cannot be seen).*

(Note: remember when looking at a visual field readout, the doctor reads the field as if looking through the patient’s eyes.)

The patient in figure 2.3 would benefit from yoked prisms placed bases right. The image of the objects that are not seen in the right field would be shifted leftward to an area of the retina that still functions normally.

Finally, yoked prisms are used to affect posture and working distances. For a patient that slouches, prescribing base down prisms may cause the patient to stand up straighter. This may alleviate neck and lower back pain. A patient, who is constantly looking down, for example an architect looking at blue prints, may find it advantageous to wear base down prism while working. Base down prisms would shift the image upward, often resulting in an increase in working distance and improved comfort and visual performance.
Questions:

1) Amanda, a 50-year old woman, presents to your office claiming that she thinks she needs a better pair of glasses since she is constantly bumping into things. Upon further questioning, it is found that she tends to run into things on her left side. Being the astute doctor that you are, you decide to perform a visual field. You find that Amanda has a left hemianopsia as shown below. (Remember when reading a visual field that the black parts are not seen by the patient). She might benefit from __________.

   ![Visual Field Diagram]

   a) Yoked prism, bases right
   b) Yoked prism, bases left
   c) Yoked prism, bases up
   d) Yoked prism, bases down

2) Jonathon, a 20-year old male, presents to your office with a right head turn. During the entrance skills portion of your exam, you find that Jonathon is unable to abduct his right eye due to a right lateral rectus muscle paresis. Jonathon might benefit from __________.

   a) Yoked prism, bases right
   b) Yoked prism, bases left
   c) Yoked prism, bases up
   d) Yoked prism, bases down

3) A patient is referred to your office with a left lateral rectus paralysis due to a recent stroke. This condition would benefit from __________.

   a) Yoked prism, bases right
   b) Yoked prism, bases left
   c) Yoked prism, bases up
   d) Yoked prism, bases down

4) A 65-year old male newspaper copy editor presents to your office. During the case history portion of your exam, you find that although otherwise healthy, he experiences lower back pain. Upon further questioning, you find that the back pain is due to constantly straining his neck to look at his paperwork. This patient might benefit from __________.

   a. Yoked prism, bases right
   b. Yoked prism, bases left
   c. Yoked prism, bases up
   d. Yoked prism, bases down

Answers: 1) b, 2) a, 3) b, 4) d
**Induced Prism**

Prism is not always intentionally prescribed—it occurs unintentionally in non-prismatic lenses. To illustrate, a minus lens is basically two prisms placed apex-to-apex, while a plus lens is basically two prisms placed base-to-base. See figure 2.6.

**Figure 2.6**

- **Minus lens**
  ![Minus lens](image)
- **Plus lens**
  ![Plus lens](image)

(Note: the picture above relates to only one plane of a lens (x-plane), these shapes are also relevant in the perpendicular plane as well (y-plane)).

The *optical center* of a lens is the region of the lens, the "sweet spot," where there are no prism effects. When a patient is looking through a spot other than the lens's optical center, s/he is looking through some amount of "induced" prism. The higher the lens power or the greater the amount of decentration from the optical center, the more *induced prism* the patient will experience. See formula 2.2.
Formula 2.2- INDUCED PRISM FORMULA:

\[
\text{Lens power (D) x amount of decentration (cm) = induced prism in}^\Delta
\]

Typically, the amount of induced prism is not a problem for patient with roughly the same prescription in each eye. On the other hand, a patient with a difference of more than a couple of diopters in each eye, or anisometropia, will experience different amounts of prism induced in each lens, creating vergence demands. These differential induced prism amounts can be especially troublesome when the pt looks upward or downward, since our ability to make vertical fusional vergence movements is much less than our ability to make horizontal fusional vergence movements.

Prescribing prism in spectacles can be advantageous therapeutically but very costly at the same time. Small amounts of prism can be incorporated into a spectacle Rx by intentionally “decentering” the lenses without incurring added laboratory costs for prism. The prescribed interpupillary distance (or p.d.) can be specified as different from the pt’s true PD in order to provide the patient with the necessary amount of prism (base in or out). For example, you decided to Rx a small amount of base in prism for a patient with myopia. Therefore, if the prescribed spectacle p.d. is increased, base-in prism will be induced and the patient will enjoy the benefit of the prism Rx without paying the extra cost to have the prism “ground in” by the laboratory. Likewise, the optical center (the point in a lens where no prism is present) can be moved up or down to induce base up or down prism. The direction that the lens needs to be moved is dependent on the type of lens you are using. For example, in order to produce a base out prism...
effect using a minus lens, one must decrease the spectacle p.d. The amount of prism diopters required depends on the strength of the lens and the type of lens (plus/minus). With this in mind, the induced prism formula can be worked backward to calculate the amount of decentration in centimeters needed for the desired amount of prism.

Questions:
*To answer the following questions, decide whether you as the prescribing doctor need to increase/decrease the interpupillary distance (p.d.), taking into consideration the amount (in centimeters) that the p.d. needs to be moved relative to the dioptic power of the patient’s lenses.

1. 5 D myopic patient, you desire $10^\circ$ of base-in prism,
   a) Increase p.d. by 2 centimeters
   b) Decrease p.d. by 2 centimeters
   c) Increase p.d. by 3 centimeters
   d) Decrease p.d. by 3 centimeters

2. 5 D hyperopic patient, you desire $15^\circ$ of base-out prism
   a) Increase p.d. by 3 centimeters
   b) Decrease p.d. by 3 centimeters
   c) Increase p.d. by 2.5 centimeters
   d) Decrease p.d. by 2.5 centimeters

3. 6 D myopic patient, you desire $9^\circ$ of yoked base down-prism
   a) Move optical center up by 2 centimeters
   b) Move optical center down by 2 centimeters
   c) Move optical center up by 1.5 centimeters
   d) Move optical center down 1.5 centimeters

4. 6 D hyperopic patient, you desire $12^\circ$ of yoked base up prism
   a) Move optical center up by 3 centimeters
   b) Move optical center down by 3 centimeters
   c) Move optical center up by 2 centimeters
   d) Move optical center down 2 centimeters

Answers: 1) a, 2) a, 3) c, 4) c
Vision Therapy

Vision therapy (or VT) can be a life altering experience for patients who successfully complete the necessary treatment for their condition. For patients who may have otherwise visually struggled through life with compromised visual function, the help of VT may open a completely new world to them. Conditions that may benefit from VT include eye movement disorders, binocular disorders, amblyopia, strabismus, and other conditions. VT is a beneficial option for patients for a variety of reasons. First, VT is a safe therapeutic option that does not require surgery. Therefore, VT may be less expensive than surgery and more appealing to patients who have an aversion to surgical procedures. Second, VT is based upon simple eye exercises that people of different ages are able to complete. VT can be customized to each individual patient and his or her visual condition. For example, a patient may have an intermittent strabismus (meaning that it is not always present). This patient sees normally for most of the day until his eyes become “tired.” It is at this point that the patient experiences diplopia. Since this condition is sporadic, the patient may not benefit from prescribed prism. However, this patient may be able to utilize VT to train and strengthen the fusional vergence response so the recurrence of the diplopic episodes are fewer (or even discontinued). VT is also a means to correct physical anomalies that may affect a person both psychologically and socially. For example, a child with strabismus may be teased by other “normal” children. This may have a detrimental effect on the child’s confidence and interaction with other children. Later in life, this same condition may have an affect on the patient’s career aspirations. A good appearance affects the likelihood of attaining a job. For
example, a person who wears a suit to an interview is more likely to receive the position than a person with equal qualifications who wears ripped jeans and a t-shirt to the interview. Many studies have shown that strabismus is viewed negatively in many occupational and social situations.

Strabismus is only one of many visual conditions for which VT is often the treatment of choice. Perhaps the most common condition routinely treated with VT is convergence insufficiency, a binocular vision dysfunction in which there is inadequate convergence ability when performing visual tasks at near such as reading, desk work, computer use, and hobby activities. Convergence insufficiency affects nearly 5% of the population (about 5 people in the Opt 562 classroom) and results in reduced productivity, distractibility, headache or eyeache, and difficulty maintaining attention when doing close work.

There are several situations in which the type of VT used is dependent on the therapy's goal. As discussed earlier, VT may be beneficial to patients who are no longer responding positively to the current therapy prescribed by their optometrist, such as prescription lenses. Similarly, not all visual dysfunctions are treatable with lenses alone, and VT may be necessary for effective management.

There are several different therapeutic strategies or philosophical approaches within the realm of vision therapy. Each of these strategies aims to train “our visual system and brain to work at peak efficiency.” (Quoted from Behavioral optometry supplemental course reading- Vision Therapy). Some of the more common types of VT approaches are discussed below.
Developmental Vision Therapy

Developmental vision therapy utilizes the findings of psychologist Jean Piaget regarding child development. Piaget found that there were critical periods during a child's development. Each stage must be complete during a critical period in the child's life in order for an adequate connection between sensory and motor functions to be established. Developmentally, it was found that fine motor skills are dependent on the development of adequate gross motor skills. For example, an infant must first learn to move its entire hand before it is able to move its pinky finger. If this hierarchy of development is not completed successfully and the infant develops specific sensory-motor functions without developing the underlying foundational skills (called splinter skills), the system is more likely to breakdown under periods of stress and fatigue. This type of development tends to hinder the formation of well-rounded sensory-motor skills. What benefit would there be to being able to move your pinky finger and not your whole hand as well? It was also found that in order for fine oculomotor control to be integrated developmentally the infant must acquire body awareness, laterality and directionality. Laterality is the ability to distinguish the right and left sides of your body while directionality is the ability to project right-ness and left-ness onto the world. For example, a person is able to determine their right and left hand from each and therefore has laterality. Directionality is realizing that the box is on the right-hand side of the ball (see figure 3.1). This type of recognition is important for many real-life situations, and is essential in learning to move the eyes properly for skilled reading.
Developmental VT teaches patients the necessary underlying skills that they did not learn before developing splinter skills. This enables the patient to redevelop the skills that have brought them to VT in the first place.

Orthoptics

Another VT approach, orthoptics, is utilized by both optometrists and ophthalmologists alike. Orthoptics includes occlusion therapy (patching, occluder contact lenses, occlusion foils, and penalization therapies involving either ophthalmic drugs or blurring lenses) for management of amblyopia ("lazy eye"). Occlusion therapy involves patching or blurring the preferred eye in order to "force" the non-preferred (amblyopic) eye to work harder. Optimally, the repetition of this therapy teaches both eyes to work equally, and fosters development of normal binocular vision.

Historically, orthoptics has also involved the use of instrument-based VT used primarily to improve fusional vergence ability. Ophthalmologists use
orthoptics primarily pre- and post-strabismus surgery, Optometrists also utilize orthoptics in the management of strabismus and amblyopia, and have significantly expanded the principles of orthoptics for use in managing non-strabismic binocular vision conditions.

Visual Skills Remediation and Enhancement

Visual skills remediation and enhancement is another type of VT. As the name implies, this strategy teaches the patient new, beneficial visual skills while breaking the detrimental visual behaviors. Oculomotor dysfunction (OMD; difficulty with precise eye movement), accommodative spasm, accommodative infacility, and binocular dysfunctions are all visual dysfunctions that benefit from this type of VT. As Table 3.1 shows, a considerable portion of the general population suffers from these types of visual dysfunction. Therefore, it can be assumed that with help, a large portion of these individuals requires and may possibly benefit from visual skills remediation and enhancement.

<table>
<thead>
<tr>
<th>Table 3.1</th>
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<table>
<thead>
<tr>
<th>Type of Visual dysfunction</th>
<th>Incidence in general population</th>
<th>Incidence in specific group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oculomotor, accommodative, and/or binocular disorder</td>
<td>15% (13-21%)</td>
<td>*People w/reading problems= 50-80%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*Computer workers= up to 50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*High among hearing impaired ind., and those with cerebral palsy or developmental disabilities</td>
</tr>
<tr>
<td>Strabismus</td>
<td>4-8%</td>
<td></td>
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<tr>
<td>Amblyopia</td>
<td>2-8%</td>
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Sports Optometry

VT can also be used to enhance visual function that is already “normal.” Sports vision therapy aims to improve the visual skills necessary for an athlete to perform at her peak. The sports world has become a multi-million dollar industry in which athletes are required to perform at their highest level. One aspect of an athlete's game that can be improved is the athlete's visual efficiency. Sports vision enhancement therapy is designed to enhance sport-specific visual skills that may be adequate for activities of daily living such as reading, but may not be developed enough for peak performance in a sport such as basketball. The enhancement of these skills is accomplished through VT procedures designed specifically for the sport. For example, eye-hand coordination is a necessary skill for professional racecar drivers. If one is able to improve those skills, it may result in better performance on the racetrack. Another example is eye-body coordination in hockey. If a goalie is able to improve upon this skill and more quickly and accurately move his body to block the puck and stop the opposing team from scoring, this will likely be very beneficial to a career.

Rehabilitative Vision Therapy

Rehabilitative VT (rehab VT) refers to treatment of visual conditions that occur secondary to head injury or stroke (CVA). For example, a car crash may leave a patient with 20/400 visual acuity or worse due to a brain or facial injury. The goal of rehab therapy is to maximize visual function given the type of injuries
sustained. This type of VT is often rendered in conjunction with low vision services.

Biofeedback

The final category of VT is discussed here is biofeedback. The normal individual is typically unaware of the physiological processes that take place for vision to occur. When a person looks at an object, they just see it without thinking; they involuntarily control the processes that enable them to see clearly. Biofeedback training enables the patient to become aware of the physiological process involved and optimally learn to voluntarily control them. In a sense, all VT involves some level of biofeedback. Formal optometric biofeedback instruments and procedures have been developed for training of accommodation, vergence, eye movement accuracy, visual acuity, and EEG attributes.
REFERENCES

Coffey, Bradley. Behavioral Optometry Notes, 2002